Annex VII

NATIONALLY DETERMINED CONTRIBUTIONS IMPLEMENTATION PLAN

(2021-2030)

MINISTRY OF ENVIRONMENT

Nationally Determined Contributions Implementation Plan (2021-2030)

First published : July 2023

Published by : Climate Change Secretariat

Ministry of Environment
'Sobadampiyasa', 416/1/C, Robert Gunawardena Mawatha,
Battaramulla
www.climatechange.lk

ISBN: 978-624-5817-33-7

Funded by : Climate Promise Project – UNDP, Sri Lanka

The updated Nationally Determined Contributions of Sri Lanka has been approved by the Cabinet of Ministers on 12th July 2021. (Cabinet Paper No. 21/1259/321/012)

Abbreviations

AAC	Automobile Association of Ceylon
AAIB	Agricultural and Agrarian Insurance Board
AERs	Agro Ecological Regions
AGA	Assistant Government Agent
AGD	Attorney Generals Department
AIS	Automatic Identification Systems
ASMET	Association of Small and Medium Enterprises in Tourism
BAU	Business-As-Usual
BDS	Biodiversity Secretariat
BOI	Board of Investment
C&HSs	Cities and Human Settlements
CAASL	Civil Aviation Authority of Sri Lanka
CARP	Council for Agricultural Research Policy
CBOs	Community Based Organisations
CBSL	Central Bank of Sri Lanka
CC&CRMD	Coast Conservation and Coastal Resources Management Department
CCB	Coconut Cultivation Board
CCC	Ceylon Chamber of Commerce
CCF	Central Cultural Fund
CCS	Climate Change Secretariat
CDA	Coconut Development Authority
CDMA	Code Division Multiple Access
CEA	Central Environment Authority
CEB	Ceylon Electricity Board
CIAs	Chambers and Industry Associations
CIDA	Construction Industry Development Authority
CMC	Colombo Municipal Council
COP	Conference of Parties
CPC	Ceylon Petroleum Cooperation
CPSTL	Ceylon Petroleum Storage Terminals Limited
CRI	Coconut Research Institute
CRIP	Climate Resilience Improvement Project
CRIWMP	Climate Resilient Integrated Water Management Project
CRWSP	Climate Resilient Water Safety Plan
CSA	Climate Smart Agriculture
CSC	Ceylon Shipping Corporation
CWC	Ceylon Workers Congress
CZMP	Coastal Zone Management Plan
D4S	Design for Sustainability
DAD	Department of Agrarian Development
DAPH	Department of Animal Production and Health
DArch	Department of Archeology
DC	Desiccated Coconut
DCS	Department of Census and Statistics
DEA	Department of Export Agriculture

DEM	Digital Elevation Model
DFAR	Department of Fisheries and Aquatic Resources
DMC	Disaster Management Centre
DMT	Department of Motor Traffic
DNBG	Department of National Botanic Gardens
DNCWS	Department of National Community Water Supply
DNM	Department of National Museums
DNZG	Department of National Zoological Gardens
DoA	Department of Agriculture
DoGI	Department of Government Information
DoI&EC	Department of Imports and Exports Control
DPRD	Disaster Preparedness and Response Division
DRR	Disaster Risk Reduction
DS	Divisional/District Secretariat
DSM	Demand Side Management
DSS	Department of Social Services
DWC	Department of Wildlife Conservation
EAFM	Ecosystem Approach to Fisheries Management
EDB	Export Development Board
EE	Energy Efficiency
EEI&C	Energy Efficiency Improvement & Conservation
EFC	Employers' Federation of Ceylon
EPL	Environment Protection License
EPZs	Export Processing Zones
ERD	Department of External Resources
ESA	Environmental Sensitive area
ESCO	Energy Service Company
ESCAMP	Ecosystem Conservation & Management Project
EVs	Electric Vehicles
FAO	Food and Agriculture Organisation
FCRDI	Food Crop Research and Development Institute
FD	Forest Department
FHB	Family Health Bureau
FMD	Foot & Mouth Disease
FMRC	Farm Mechanization Research Centre
FOs	Farmer Organizations
FRDI	Fruit Research & Development Institute
FSMP	Forestry Sector Master Plan
GAP	Good Agriculture Practices
GBCSL	Green Building Council of Sri Lanka
GCF	Green Climate Fund
GHG	Greenhouse Gas
GoSL	Government of Sri Lanka
GPP	Green Public Procurement
GPPP	Green Public Procurement Policy
GSMB	Geological Survey and Mines Bureau
GSTC	Global Sustainable Tourism Council
HARTI	Hector Kobbekaduwa Agrarian Research and Training Institute

HBASL	Hadabima Authority of Sri Lanka
HEM	High Efficiency Motors
HHAP	Heat-Health Action Plan
HORDI	Horticulture Research and Development Institute
HPB	Health Promotion Bureau
ICE	Internal Combustion Engine
IAS	Invasive Alien Species
ICT	Information and Communication Technology
ICTA	Information and Communication Technology Agency
ID	Department of Irrigation
IDB	Industrial Development Board
IESL	Institution of Engineers, Sri Lanka
ILO	International Labour Organization
IMD	Irrigation Management Division
INGO	International Non -Governmental Organisation
INM	Integrated Nutrient Management
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IPNS	Integrated Plant Nutrient System
IPs	Industrial Parks
IRBM	Integrated River Basin Management
IRCSL	Insurance Regulatory Commission of Sri Lanka
IRD	Inland Revenue Department
ISB	Industrial Services Bureau
IT	Information Technology
ITI	Industrial Technological Institute
IUCN	International Union for Conservation of Nature
IWMI	International Water Management Institute
IWRM	Integrated Water Resource Management
KPIs	Key Performance Indicators
L&D	Loss and Damage
LAs	Local Authorities
LCA	Life Cycle Assessment
LECO	Lanka Electricity Company
LHI	Lanka Hydraulic Institute
LINDEL	Lanka Industrial Estates Limited
LRC	Land Reforms Corporation
LRT	Light Rail Transit
LRWHF	Lanka Rain Water Harvesting Forum
LTGEP	Long Term Generation Expansion Plan
LUPPD	Land Use Policy Planning Department
M&E	Monitoring and Evaluation
MASL	Mahaweli Authority of Sri Lanka
MCs	Municipal Councils
MD	Department of Meteorology
MDGs	Millennium Development Goal
MEPA	Marine Environment Protection Agency
MoA	Ministry of Agriculture
MoD	Ministry of Defense

MoDM	Ministry of Disaster Management
MoE	Ministry of Environment
MoEd	Ministry of Education
MoF	Ministry of Finance
MoFish	Ministry of Fisheries
MoH	Ministry of Health
MoI	Ministry of Industries
MoIrri	Ministry of Irrigation
MoP&E	Ministry of Power & Energy
MoPlant	Ministry of Plantation
MoRR&HRA	Ministry of Rehabilitation, Resettlement & Hindu Religious Affairs
MoSD&VT	Ministry of Skills Development and Vocational Training Bo
DoSS	Department of Social Services
MoSTR	Ministry of Science Technology and Research
MoT	Ministry of Transport
MoTrad	Ministry of Trade
MoUD&H	Ministry of Urban Development and Housing
MoWL&FC	Ministry of Wildlife and Forest Conservation
MoWS	Ministry of Water Supply
MoWCSD	Ministry of Women, Child Affairs and Social Development
MRI	Medical Research Institute
MRV	Measurement Reporting and Verification
MSMEs	Micro, Small and Medium Enterprises
MSS	Merchant Shipping Secretariat
MSW	Municipal Solid Waste
NAICC	National Agriculture Information and Communication Centre
NAQDA	National Aquaculture Development Authority
NaPID	National Policy for Industrial Development
NARA	National Aquatic Resources Research and Development Agency
NBD	Dept of National Budget
NBSAP	National Biodiversity Strategic Action Plan
NCD	Non Communicable Disease
NCPC	National Cleaner Production Centre
NCPI	National Consumer Price Index
NCRE	Non Conventional Renewable Energy
NDCs	Nationally Determined Contributions
NDRSC	National Disaster Relief Support Centre
NEAP	National Environmental Action Plan
NECCC	National Expert Committee on Climate Change
NEDA	National Enterprise Development authority
NEEA	National Energy Efficiency Award
NERDC	National Engineering Research and Development Centre
NGO	Non Governmental Organisation
NGRS	National Green Reporting System
NH	National Herbarium
NHDA	National Housing Development Authority
NHSPEC	National Strategic Plan for Health, Environment and Climate Change
NIPHM	National Institute of Post-Harvest Management

NLDB	National Livestock Development Board
NOU	National Ozone Unit
NPD	Department of National Planning
NPP	National Physical Plan
NPPD	Department of National Physical Planning
NRC	National Research Council
NRE	New Renewable Energy
NRMC	Natural Resource Management Centre
NRW	Non-revenue Water
NSC	National Steering Committee
NSF	National Science Foundation
NSWMSC	National Solid waste Management Support Center
NTC	National Transport Commission
NWPEA	North Western Province Environmental Authority
NWSDB	National Water Supply and Drainage Board
O&M	Operation and Maintenance
PAEA	Protected Agriculture Entrepreneurs Association
PAs	Protected Areas
PC	Provincial Council
PDAPH	Provincial Department of Animal Production and Health
PDHS	Provincial Director of Health Services
PDNA	Post Disaster Needs Assessment
PDoA~~s~~	Provincial Department of Agriculture
PGRC	Plant Genetic Resources Centre
PHDT	Plantation Human Development Trust
PHS	Private Health Services
PID	Provincial Irrigation Department
PMC	Planning and Monitoring Committee
PMoA	Provincial Ministry of Agriculture
PMoH,	Provincial Ministry of Health
PPP	Public-Private Partnership
PRDA	Provincial Road Development Authority
PRPTAs	Provincial Road Passenger Transport Authorities
PUCSL	Public Utility Commission of Sri Lanka
PV	Photo -voltaic
RDA	Road Development Authority
RDHS	Regional Director of Health Services
RE	Renewable Energy
RECP	Resource Efficient Cleaner Production
RISC	Regional Industry Service Committee
RMPs	Risk Management Plans
RPCs	Regional Plantation Companies
RRDI	Rice Research and Development Institute
RRI	Rubber Research Institute
RWH	Rain Water Harvesting
RWHS	Rain Water Harvesting System
RWSSs	Rural Water Supply Schemes
SCP	Sustainable Consumption and Production

SD	Survey Department
SD&CC	State Development and Construction Corporation
SDGs	Sustainable Development Goals
SEPC	Socio Economics and Planning Centre
SLAITO	Sri Lanka Association of Inbound Tour Operators
SLC	Sri Lanka Customs
SLCF	Sri Lanka Climate Fund
SLCG	Sri Lanka Coast Guard
SLEB	Sri Lanka Energy Balance
SLECIC	Sri Lanka Export Credit Insurance Corporation
SLEMA	Sri Lanka Energy Managers Association
SLGAP	Sri Lanka Good Agriculture Practices
SLIA	Sri Lanka Institute of Architects
SLIE	Sri Lanka Institute of Engineers
SLINTGL	Sri Lanka Institute of National Tourist Guide Lecturers
SLIP	Sri Lanka Institute of Packaging
SLMA	Sri Lanka Medical Association
SLN	Sri Lanka Navy
SLLDC	Sri Lanka Land Development Corporation
SLP	Sri Lanka Police
SLPA	Sri Lanka Ports Authority
SLR	Sri Lanka Railway
SLSDC	Sri Lanka Sustainable Development Council
SLSEA	Sri Lanka Sustainable Energy Authority
SLSI	Sri Lanka Standards Institution
SLT	Sri Lanka Telecom
SLTB	Sri Lanka Tea Board
SLTDA	Sri Lanka Tourism Development Authority
SLTrB	Sri Lanka Transport Board
SLVET	Sri Lanka Vehicle Emission Testing
SMART	Specific, Measurable, Achievable, Relevant, and Time-bound
SME	Small and Medium Enterprises
SMIs	Small and Medium Industries
STEM	Science, Technology, Engineering, and Mathematics
STC	State Timber Corporation
STrC	State Trading Corporation
THASL	The Hotels Association of Sri Lanka
TMR	Total Mixed Ration
TOU	Time-of-Use
ToT	Training of Trainers
TR	Tons of Refrigerent
TRC	Telecommunications Regulatory Commission
TRI	Tea Research Institute
TROF	Trees Outside Forests
TSHDA	Tea Small Holdings Development Authority
UCs	Urban Councils
UDA	Urban Development Authority
UGC	University Grants Commission

UN	United Nations
UNDP-SGP	United Nations Development Project – Small Grants Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children' Fund
UNIDO	United Nations Industrial Development Organization
UoSJP	University of Sri Jayewardenepura
UoM	University of Moratuwa
UoP	University of Peradeniya
USDA	Urban Settlement Development Authority
VFD	Variable Frequency Drives
VIC	Veterinary Information Centre
VOC	Volatile Organic Compound
VMS	Vessel Monitoring System
VRI	Veterinary Research Institute
VTA	Vocational Training Authority
WFH	Work-From-Home
WIM	Warsaw International Mechanism
WIMS	Weather Information Management System
WM	Waste Management
WMA-WP	Waste Management Authority (Western Province)
WRB	Water Resources Board
WSP	Water Safety Plan
WSSs	Water Supply Schemes
YEDD	Youth, Elderly, Displaced and Disabled

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Sri Lanka is a low-emitting nation and a unique illustration of a nation that has both attained high levels of human development and maintained emissions considerably below the long-term average required to meet global warming targets. However, as Sri Lanka's economic activities that are connected to energy consumption are growing. There is a tendency for the country's emissions to rise. Sri Lanka also ranks high among the nations that are most susceptible to hazards brought on by climate change that have a negative impact on economy, environment (including ecosystem services), and people. Natural disasters have wreaked havoc on the nation's economy and way of life during the previous few decades.

As a signatory to the Paris Agreement on Climate Change, Sri Lanka has submitted its updated Nationally Determined Contributions (NDCs) in 2021, in order to pave the path for the nation to realise its economic, human, and social advancements along a more sustainable trajectory, while contributing to the global Climate Action efforts. The updated NDCs include six mitigation sectors (Electricity, Transport, Industry, Waste, Forestry and Agriculture), nine adaptation sectors (Agriculture, Fisheries, Livestock, Water, Biodiversity, Coastal & Marine, Health, Urban Planning & Human Settlement and Tourism & Recreation) and Loss & Damage (L&D). The purpose of the NDC Implementation Plan presented in this report is to operationalize the updated NDCs.

Social inclusion and gender responsiveness are crucial components of NDC implementation, as expressed in the updated NDC Communication of 2021[1]. The gender relations and dynamics in Sri Lanka limit women's ownership and access to production resources such as land, credit, technology, information, energy, water, as well as for social protection and employment. Women are also behind in their representation in the governing bodies and decision-making positions.

Women and girls are less able to adapt to changes in climatic conditions. They are also more likely to be exposed to disaster-induced risks and losses relating to their livelihoods. Gender responsiveness is a key criterion to realize the optimum potential of men and women through climate action and to narrow down existing disparities. The NDC Implementation Plan has integrated actions in four sectors, namely, Power, Fisheries, Livestock and Water to improve gender responsiveness in those sectors. Further, generalized gender actions have been recommended to increase gender sensitivity for other NDC sectors. Thus, the NDC implementation plans provide a vehicle to support the national policy commitments on gender equality and sustainable development commitments.

Another important aspect of the NDC Implementation Plans is that the activities and sub-activites identified under each NDC should be further elaborated by the agencies responsibe for implementation in developing their own comprehensive action plans in-line with the institutional frameworks in order to achieve the commitment of 14.5% greenhouse gas emission reduction from the BAU while increasing climate resilience

[1] Ministry of Environment, Updated Nationally Determined Contributions under the Paris Agreement on Climate Change, July 2021

To support the nation, accomplishing its development goals in tandem with NDCs, an SDG alignment exercise was carried out by primary consideration of the direct interlinkages to align all activities under each NDC implementation plan with the SDGs.

The implementation mechanism of the NDC and the supporting legal and policy factors are outlined in Chapter 1. The COVID-19 pandemic and the current economic crisis have negative effects on the implementation of the NDCs, and these effects are also examined in this section along with a possible way forward. Further, the multi-stakeholder inclusive and participatory approach used in the development of NDC implementation plans is described in Chapter 2.

The NDC Implementation Plan for the six mitigation sectors are presented in Chapter 3 along with sectoral introductions. Chapter 4 presents the NDC implementation plans for the nine adaption sectors. Chapter 5 presents the NDC implementation plans for the loss and damage (L&D) sector. Chapter 6 outlines the Means of Implementation including general recommendations for gender mainstreaming and social inclusion. The country would encounter numerous obstacles in the areas of finances, technology, and human capital when operationalizing the proposed NDC Implementation Plan into action. The final chapter, Chapter 6, introduces and discusses these challenges. Further, the results of the SDG alignment exercise are also presented to illustrate the degree of alignment of NDCs in this chapter, along with an explanation of how gender responsiveness was addressed. This chapter also includes a section on the monitoring mechanism.

1 BACKGROUND AND OVERVIEW OF NDC

Despite being listed as a low-risk country for 2023 in the INFORM risk index, which ranks Sri Lanka 106th out of 191 countries[2], the island nation is extremely vulnerable to the effects of climate change. In the past 20 years, in general, Sri Lanka has achieved significant progress in boosting incomes and lowering poverty, though there has been a setback during COVID-19 pandemic and present economic crisis. The effects of climate change, however, pose a serious threat to much of these advancements. Commercial agriculture, manufacturing, tourism, and other primary economic drivers are all particularly vulnerable to extreme weather conditions and sea level rise. Deforestation, soil erosion, and biodiversity loss, among others, also pose a threat to the nation's economic production. Sri Lanka has long sought to expand its economy and human development in a low-carbon manner. It has also taken many measures to increase its resilience to global climate change and to keep climate change at a low level through mitigation activities.

In particular, Sri Lanka has also undertaken several efforts that are in line with the global coordinated mission to combat the detrimental impacts of climate change. The submission of Intended Nationally Determined Contributions (INDCs) in response to Decisions 1/CP.19 and 1/CP.20 of the Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) was one of these early initiatives. First version was submitted in October 2015, followed by an improved version in April 2016. Subsequently, NDCs of Sri Lanka were prepared covering 14 sectors based on the Readiness Plan 2017-2019 for the implementation of INDCs, and submitted in September 2016. Sri Lanka's updated NDCs, which constituted a more ambitious, quantitative, and thorough assessment of the mitigation potential (in six sectors) and adaptation strategies (in nine sectors) and loss & damage (L&D) for the next decade (2021-2030), were submitted in 2021. The National Adaptation Plan for Climate Change Impacts in Sri Lanka -2016-2025 (NAP) was also developed in accordance with the extensive set of rules and guidelines outlined by the UNFCCC. It is currently being revised and Provincial Adaptation Plans are also being prepared.

As the global net anthropogenic GHG emissions have continued to rise, the achievement of the Paris Agreement's temperature goals of holding temperature rise to well below 2°C and pursuing efforts to limit to 1.5°C) has become more challenging[3]. In response, some notable decisions have been taken related to climate actions at the recent sessions of COP climate summits. At the 26th meeting of the COP (COP26) held in Glasgow, UK in November 2021, the parties agreed to the Glasgow Climate Pact that expects an accelerated action on climate in this decade by moving away from coal power, halting and reversing deforestation, reducing methane emissions and speeding up the switch to electric vehicles (EVs). For the first time, COP agreed on phasing out unabated coal power. In its updated NDCs, Sri Lanka too has committed to no capacity addition of coal power plants in the future. Set against a difficult geopolitical backdrop, the 27th meeting of the COP (COP27) held in Sharm El Sheikh resulted in countries delivering a package of decisions that reaffirmed their commitment to the

[2] The INFORM Risk Index is a global, open-source risk assessment for humanitarian crises and disasters. https://drmkc.jrc.ec.europa.eu/inform-index
[3] IPCC Sixth Assessment report (AR6), 2023. https://www.ipcc.ch/assessment-report/ar6/

temperature goal of the Paris Agreement. The package also strengthened action by countries to cut GHG emissions and adapt to the inevitable impacts of climate change, as well as boosting the support of finance, technology and capacity building needed by developing countries. It endorsed the requirement of rapid, deep and sustained reductions in GHG emissions, including reducing global CO_2 emissions by 45% relative to the 2010 level by 2030 with more ambitious NDCs and to net-zero around mid-century. Creating a specific fund for loss and damage (L&D) marked an important point of progress, with the issue added to the official agenda and adopted for the first time at COP27.

In relation to the policy environment, one of Sri Lanka's historic efforts to combat climate change was the launching of the National Environmental Action Plan (NEAP) in the 1990s. NEAP 2022-2030 is the fourth and most recent series of NEAPs. In order to solve environmental challenges of the twenty-first century and achieve sustainable development in line with the NEAP 2022-2030 is crucial because it contains strategies and action plans under nine thematic areas, in line with the National Environment Policy of 2021. Action plan of each of these nine thematic areas provides information on key performance indicators (KPIs), targets, timelines, responsible lead agencies, other key agencies, indicative budgets, and the relevance to SDGs. While the nine thematic areas are related to the NDC mitigation and adaptation sectors, the thematic area 3 is explicitly on Climate Actions. There are several key initiatives taken by the Ministry of Environment to reduce global warming under several Multilateral Agreements. Some of which is the "Colombo Declaration on Sustainable Nitrogen Management" which was adopted in 2019 and outlines an ambition to 'halve nitrogen waste by 2030'. In 2022 it was later defined as "Encourage member states to accelerate actions to significantly reduce nitrogen waste globally by 2030 and beyond through the improvement of sustainable nitrogen management." A National Nitrogen Policy Report was prepared in 2022 and will be followed by the development of a Roadmap and Action Plan[4]. The Kigali Cooling Plan (2020-2038)[5] was developed under the Montreal Protocol to reduce use of Ozone Depleting Substances (substitution of refrigerants that have less Global Warming Potential while not harming the ozone layer),

Other initiatives of Sri Lanka include, but are not limited to:

- National Climate Change Policy (2012) [under review]
- National Environment Policy (2022)
- National Environmentally Sensitive Areas Policy (2022)
- National Policy on Disaster Management (2013)
- Sri Lanka Disaster Management Plan 2018-2030
- Coastal Zone and Coastal Resource Management Plan (2018)
- Strategic Action Plan for Adaptation of Irrigation and Water Resources Sector for Climate Change (2018)

[4] Nissanka, S.P., Jayaweera, A., & Yang A. (2022). Nitrogen Policy Report: Sri Lanka. South Asia Nitrogen Hub (SANH): Peradeniya, Sri Lanka, and Edinburgh, UK
[5] https://www.cleancoolingcollaborative.org/wp-content/uploads/2021/07/Sri-Lanka-NCAP-Final.pdf

- National Policy on Waste Management (2019)
- National Agriculture Policy (draft)
- National Energy Policy & Strategies of Sri Lanka (2019)
- Long-Term Electricity Generation Expansion Plans
- National Policy on Sustainable Consumption and Production for Sri Lanka (2019)
- National REDD+ Investment Framework and Action Plan (NRIFAP) (2017)
- National Policy on Natural Gas (2019)

1.1 NDC Sectors of Sri Lanka

As stated in *Table 1-1*. Sri Lanka identified six (6) sectors for mitigation and nine (9) for adaptation. andLoss and damage.

Table 1-1 Mitigation and Adaptation Sectors of Sri Lanka

NDC Category	Sector
Mitigation Sectors	Electricity (Power) Sector
	Transport Sector
	Industry Sector
	Waste Sector
	Forestry Sector
	Agriculture Sector (inclusive of Livestock)*
Adaptation Sectors	Agriculture Sector*
	Fisheries Sector
	Livestock Sector
	Water Sector
	Biodiversity Sector
	Coastal and Marine Sector
	Health Sector
	Urban Planning and Human Settlement Sector
	Tourism and Recreation Sector
Loss and Damage	Relevant to all sectors

* Agriculture is considered under both mitigation and adaptation sectors.

Women contribute significantly to climate change adaptation by building resilience to it, particularly in the fields of agriculture, livestock management, energy, disaster risk reduction, forestry, water management, and health. By addressing gender equality and social inclusion issues in gender-sensitive sectors, gender-responsive NDC Implementation Plans will create economic opportunities that cater to the skills and ambitions of women and men, ensuring that benefits are enjoyed and attained by those who traditionally lack access. The NDC implementation plans have highlighted four sectors that are gender-sensitive, including the Energy (Power) Sector under Mitigation and the Water, Fisheries, and Livestock Sectors under Adaptation.

1.2 Monitoring of NDC Implementation

Sri Lanka has implemented a number of actions to execute the overarching NDC at the operational, strategic, and policy levels. The broad framework that directs the nation's priorities on climate change was initiated with the introduction of Sri Lanka's Climate Change Policy (2012), which was followed by several related national policy instruments[6]. Sri Lanka produced a Readiness Plan 2016-2019 to identify and fulfil the prerequisites for NDC implementation to assist NDC implementation and monitoring as well as the mainstreaming of climate measures into sectoral strategies.

It should be highlighted that the NDCs identified are high level actions and each agency responsible for implementation is expected to develop their own comprehensive action plan in line with their mandates and institutional framework. In this process, the lead agency should consult the other key agencies identified in the activities and sub-activities, as appropriate, in developing and implementing the plan.

The NDC implementation and monitoring mechanism is overseen by the National Steering Committee and Planning & Monitoring Committees established through a Cabinet decision (Cabinet Paper ME/2021/12 dated 07.07.2021).

1.2.1 Institutional Arrangement for Implementation

Figure 1-1 shows the general institutional framework, while the following subsections briefly focus on the important institutional structures. As the country's UNFCCC focal point, the Ministry of Environment (MoE) oversees the institutional framework.

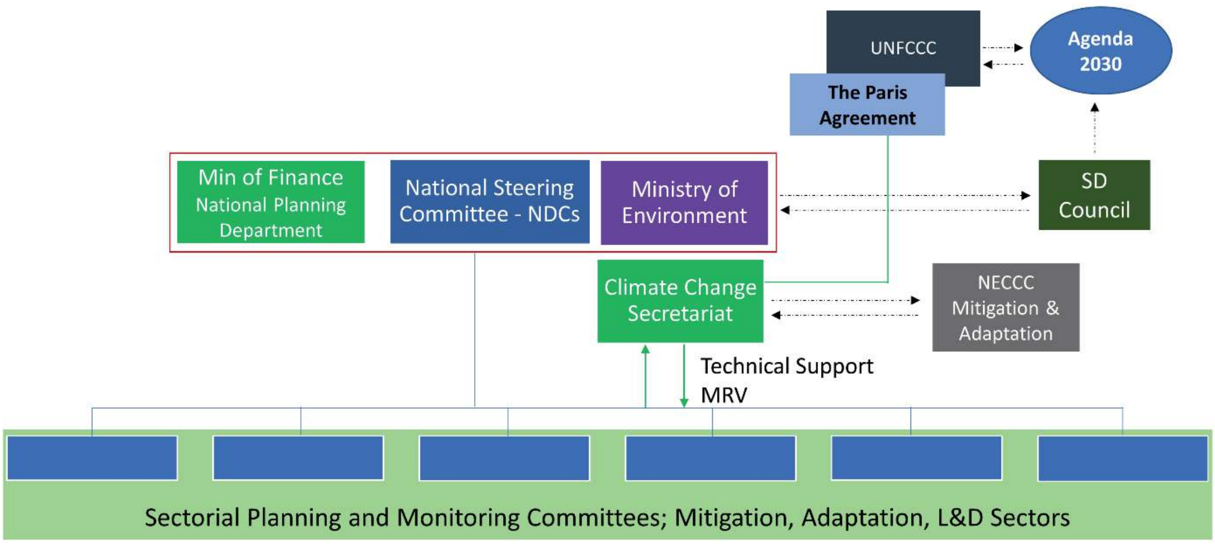


Figure 1-1 Institutional architecture for climate response (Source: Updated NDC,2021)

[6] These include National Adaptation Plan (NAP) in 2016 and the updated Nationally Determined Contributions (NDCs) in 2021, and National Environment Action Plan (NEAP) 2022-2030.

1.2.2 National Steering Committee for NDC Implementation

The Government of Sri Lanka (GoSL) established an inter-agency National Steering Committee (NSC), which is chaired by the Secretary of the Ministry of Environment, to oversee the implementation of NDCs. Members of the NSC are the line ministry secretaries in charge of NDC sectors. Further, the National Sustainable Development Council, the Department of Fiscal Policy, the National Planning Department, and the Ministry of Finance are all represented in the NSC and collaborate closely. The NSC is responsible for making sure that NDCs are carried out as intended, with adequate inter-agency coordination on duties that require cooperation with other agencies. To further encourage policy consistency at the highest level, the NSC also reduces duplication of effort, offers practical solutions to implementation barriers, and tracks overall progress in comparison to timelines.

1.2.3 Ministry of Environment & Climate Change Secretariat

The national focal point to the UNFCCC is the Ministry of Environment. The Climate Change Secretariat (CCS), a specialised division within this ministry, was established in 2008. Since then, the CCS has established an Inter-Agency Committee on Climate Change as well as National Experts Committees (NECs) on climate change adaptation and mitigation. The CCS, which was created to assist the Ministry of the Environment in its capacity as the country's focal point for the UNFCCC and climate funds (such as the Green Climate Fund and Adaptation Fund), is in charge of creating national inventories of GHGs, assisting technology transfer to the adaptation and mitigation sectors, facilitating the implementation of GHG reduction and resilience-building actions, collecting and disseminating climate data, and more. Reporting of the National Communications (NCs) to the convention and the reporting requirement under the Paris Agreement are the mandate of CCS. Further, CCS serves as the facilitator, coordinator, and communicator supporting the implementation and monitoring of climate action within this institutional framework.

1.2.4 Sectoral Planning and Monitoring Committees

Each NDC sector has its own Planning and Monitoring Committee (PMC). These PMCs are comprised of the relevant department and/or institute leaders. The sectoral development plans will fully incorporate the NDC implementation and monitoring plans, which are supported by the PMCs. The inclusion of climate measures into the regular planning framework of all sectors will give the NDCs precedence for domestic/public finance or foreign donor support. Each sectoral PMC is chaired by the secretary of the ministry responsible of the subject. The PMC is tasked with carrying out the NDC implementation plans with the support from the public and private sectors. The technical, budgetary, and capacity requirements for NDC implementation are carefully examined by each PMC, and they make sure that the NSC and CCS are aware of these requirements. The sectoral PMC must also monitor implementation delays to ensure that safeguards are in place for climate initiatives that can jeopardise sustainable development.

1.3 Key Legal and Policy Underpinnings of NDC Implementation

The legal and policy foundations for NDC implementation will be provided by national policies and legislations including the Climate Change Policy, National Environment Act, and National

Environment Policy as well as policies and acts of relevant NDC sectors.

1.4 Circumstantial Implications on NDC Implementation

As NDCs are formulated in consideration of the country's particular circumstances and development priorities, it is customary that the identified activities and related attributes represent a dynamic state-of-affairs, which need revisits and revisions as appropriate in the implementation process to realize the achievement of climate goals. However, the occurrence and subsequent evolutions of the state-of-affairs of the COVID-19 pandemic are unprecedented, and the influences on the NDCs may need particular considerations and could lead to significant changes. It is a global scenario that the pandemic is not just a health issue but also a human development crisis affecting the economy and society at large, as emphasized in the Human Development Report (HDR) 2020. For the first time since the Human Development Index (HDI) started to be measured, the year 2020 showed a negative value for HDI. In Sri Lanka, the situation has become more critical with urgent and serious issues such as critically low forex, sovereign debt, political instability, the rising cost of living, and shortage of essential goods (energy, food, and medicines). As per the National Consumer Price Index (NCPI), the consumer price inflation has been very high, particularly since March 2022 to date. In 2020 and 2021, the year-on-year percentage change of NCPI remains around 4% to 8%, while in January 2022, it was around 15% and continued to increase with reaching 74% in September 2022. In January 2023, it was recorded as 54%[7]. Under these circumstances, the GoSL was compelled to respond to the immediacy, rather than long-lasting solutions to other known issues, in particular, the climate actions/NDCs and SDGs.

Yet, there have been positive consequences that arose from the pandemic, too. Technology advancements, digitization (including e-commerce and virtual platforms), innovations, decentralization of supply chains, and opportunities for local value addition are a few examples. Further, new forms of local and global partnerships and networks of actors have emerged stretching well beyond the country level to cities, institutions, businesses, health professionals, scientists, researchers, civil society, the media as well as individuals. In the meantime, the development partners and donors have pledged to support developing countries in COVID-19 recovery by aligning the investments and technical assistance to leverage development progress, while meeting climate change goals.

Accordingly, many countries and regions have reformulated their development agendas with the concept of "build-back-better" through green/low-carbon development in several sectors of the economy as the most effective pathway to recover from the present crisis and progress towards climate goals and SDGs. Sri Lanka too, as highlighted in the updated NDC document, recognizes its responsibility to uphold the Paris Agreement's objective of containing global warming. It is affirmed that the country will strive to steer development, especially post-COVID-19 economic recovery and livelihood needs, along a low-emission trajectory that supports both mitigation and adaptation to climate change, with a strong focus on reaching high-income and human development in the next decade.

[7] CBSL (2023), Consumer price inflation, online. Available: https://www.cbsl.gov.lk/measures-of-consumer-price-inflation, Accessed on 16th March 2023.

Thus, in the development of the implementation and monitoring plans, the implications of the change in circumstances that arose from post-pandemic state-of-affairs on NDCs will be appraised, along with the gender responsiveness, social inclusivity, and SDG alignment.

1.5 Way Forward

Despite many constraints, for the successful NDC implementations, as stated in Section 1.4, active participation of all relevant stakeholders is essential through developing their own comprehensive action plans based on high-level NDCs in the implementation plans in line with their institutional frameworks, thus, the following way-forward actions are proposed.

1. Dedicated / Designated unit within each stakeholder organization for NDC implementation, monitoring and coordination
2. Assembly of a climate action group for each sector and firming up of a programme of action
3. Mainstreaming of NDCs in to sectoral annual / long term development plans of stakeholders and providing budget allocations
4. Aligning with activities / outputs of donor funded projects
5. Capacity building of stakeholders
6. Implement an effective communication strategy to improve awareness of all stakeholders
7. Build awareness & competencies on NDCs at all levels (strategic, tactical & operational)
8. Obtain top-management endorsement and commitment throughout the NDC cycle.
9. Rapid development of sector capacity to prepare project proposals to seek external support (Means of implementation)
10. Formulate and operationalize multi-agency engagement platform
11. Effective coordination mechanism of sectoral stakeholders
12. Effective system for data management
13. Establishment of a compliance, Measurement, Reporting and Verification (MRV) and data submission frameworks
14. Enforce regulations on meeting climate obligations to cover all sector entities
15. Incorporate progress reporting of NDCs as a mandatory section in Annual Reports

2 METHODOLOGY

2.1 Methodology Followed for the Preparation of NDC Implementation Plans

Updated NDCs (2021) were developed by the Climate Change Secretariat of the Ministry of Environment following a a Specific, Measurable, Achievable, Relevant, and Time-bound (SMART) approach. Simultaneouslythe draft NDC implementation plans were prepared in consultation with relevant stakeholders. Thus, as depicted in Figure 2-1, the process of developing the NDC implementation plans commenced with reviewing the existing draft plans and identifying the gaps. Recommendations were made for gender inclusion in four prioritized sectors (power, water, fisheries, and livestock). The key activities of the process are listed in *Table 2-1*.

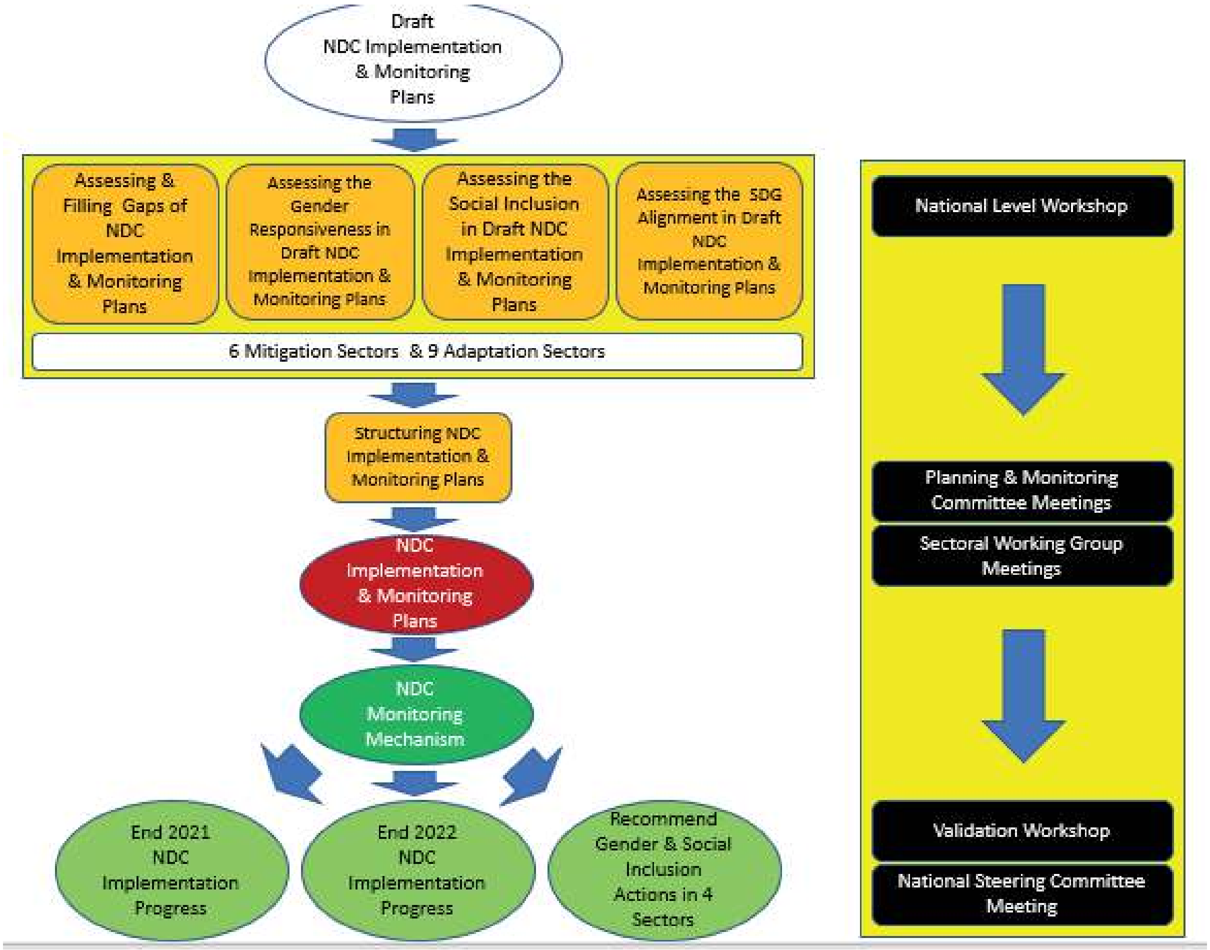


Figure 2-1: Schematic diagram of the methodology

Table 2-1 Activities followed

Activity No	Key Activity	Description
1	Gap Assessment	Existing gaps in the draft NDC Implementation Plans developed by CCS/MoE during the process of updating NDCs in 2021 were assessed. A strategic framework for the gap analysis was followed to ensure the entirety and transparency.
2	NDC Implementation Plans Structure	The structure for the NDC Implementation Plans was finalized with the consent of CCS and UNDP Sri Lanka.
3	Gap Filling	By conducting a series of sectoral working group meetings, the gaps in the draft NDC Implementation Plans (developed by CCS/MoE in 2021) were filled.
4	SDG Alignment Assessment	This activity had been conducted during the preparation of updated NDCs with the use of SCAN-tool of UNDP. This SDG alignment assessment was reviewed and updated.
5	Key Stakeholder Meetings	A series of stakeholder consultation meetings (Working groups, Planning & monitoring committees) was conducted to develop NDC implementation plans through inclusive and participatory approach.
6	Gender Responsiveness and Social Inclusion Assessment	A rapid assessment was conducted to assess: (i) the gender and social inclusion in the draft NDC Implementation Plans, (ii) the available gender-related information such as national and sectoral policies, (iii) the existing mechanisms in the prioritized sectors (power, water, fisheries, and livestock) to mainstream gender in the NDC implementation plans, and (iv) gaps in institutional mechanism and staff capacity through a questionnaire survey.
7	Recommendation for Gender & Social Inclusions	Integrated gender-responsive and socially inclusive actions for NDC Implementation Plans in prioritized mitigation and adaptation sectors (i.e., water, fisheries, livestock, power)[8] were identified based on the outcomes of the assessments and examples/best practices drawn from other countries and those that can

[8] In addition to these four sectors, a similar assessment has been done for Agriculture (adaptation) sector under another project.

		be applied from Sri Lanka as well.
8	NDC Monitoring Mechanism	Outline a monitoring framework that is consistent and mutually reinforcing. National level monitoring framework agreed by the stakeholders at the time of revising NDCs in 2021 was further endorsed. In consultation with relevant stakeholders, SMART KPIs and targets were set enabling the closer monitoring of implementation plans
9	NDC Implementation Plans	The NDC Implementation Plans in a publishable format through the consent of CCS were developed.
10	Progress reporting	Progress of NDCs was identified for the years 2021 and 2022, and GHG emission reduction estimates were calculated for mitigation sectors.
11	SDG Alignment	Alignment of NDCs with SDGs was appraised in consideration of direct interlinkages of each NDC activity/sub-activity with relevant SDG target/s.
12	Validation Workshop	Sectoral validation workshops were conducted to validate the developed implementation and monitoring plans.
13	National Steering Committee (NSC) Meeting	NDC implementation plans were presented to the NSC for their endorsement.

2.2 Data Sources and/or Scenarios Relied Upon

The development of NDC implementation plans followed in-depth stakeholder consultations. Thus, when developing the implementation plans, activities, and KPIs, sector-specific policies, pertinent national policies, sectoral data, and constraints were considered. The implementation plans were also validated to make sure that the KPIs and targets are specific, measurable, attainable, realistic and time-bound (SMART).

3 NDC IMPLEMENTATION – MITIGATION

3.1 Overview

Sri Lanka has historically pursued 'low carbon' socio-economic development and has one of the lowest per capita carbon emissions rates (1.0 CO_2 per capita as at 2020 according to Workd Bank) (https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=LK) for a lower middle-income country. This could be attributed to the economic model utilized by the country, where less reliance on energy-intensive industries and greater use of renewable energy (RE) resources such as biomass, hydro, solar, and wind are promoted. However, over the past decade, a variety of fundamental systemic issues, arisen particularly from the gaps in policies, institutions and structures, have undermined the low-carbon growth trajectory and lowered the environmental sustainability of the country, as evident in many sectors such as energy, industry, transport, waste, agriculture, and forestry, as well as natural resource management. This situation is further worsened with the multiple and complex socio-economic challenges that have emerged post COVID-19 pandemic.

In order to address these issues, the GoSL has taken a number of initiatives and interventions in the political and policy spheres, supported by various development partners, seeking a momentum to drive the low-carbon and sustainable development agendas forward. In particular, the updated NDCs with prioritized mitigation measures for implementation during the period 2021 and 2030 for a more ambitious climate commitment with net-zero carbon targets by 2050 provide clear guidance for responsible agencies and other stakeholders/ key supportive institutions to align their programmes to climate action. These measures have a high potential to reduce GHG emissions and are closely connected with the nation's SDGs. Further, while updated NDCs are formulated in consideration of several national and sectoal policies, the emphasis on climate action is reflected more in the recent revisions and development of related policies, strategies and plans. Some examples include: Climate Prosperity Plan (2022), National Environment Policy (2022), National Climate Change Policy (Under review), National Policy for Sustainable Development (Draft), National Policy for Sustainable Consumption & Production (2019), National Energy Policy & Strategies (2019), National Environment Action Plan 2022-2030 (NEAP) (2022), National Industry Policy (Draft), National Agriculture Policy (Draft), National Transport Policy (Draft). The aforementioned policy directives generally favor low-carbon and resource-efficient activities, circular economy concepts, and the promotion of GHG sinks by increasing forest/tree cover. Further, Sri Lanka has taken various proactive measures in recent years to access and mobilize finance to support a low-carbon pathway.

For instance, the power sector has facilitated private investment in RE using supportive legislative tools including feed-in tariffs, various roof-top solar power connecting schemes such as "net metering", "net accounting" and "net plus", etc. Energy efficiency (EE) is encouraged by high electricity consumer tariff rates that rationalize use, Time-of-Use (TOU) billing, etc., and is backed by financial incentives to promote the shift from incandescent bulbs to CFL and then to LED lighting. The amount of managed waste in metropolitan areas has significantly increased because of investments in waste-to-energy and waste composting programs in major municipalities. Large-scale waste producers, like hotels and livestock farms, have been compelled by legal requirements and environmental concerns to make investments in on-site waste management.

The MoE has developed the NEAP covering the period from 2022 to 2030 under the theme 'pathway to sustainable development in Sri Lanka' based on the National Environmental Policy (NEP). The Ministry of Industries is in the process of introducing a National Industry Policy (pending Cabinet approval) through which there is a commitment to transform existing industrial parks to "Eco Industrial Parks" and to build all new industrial parks under "green or eco" themes. The industry has adopted concepts like circular economy, energy efficiency, and cleaner production. For sustainability and marketing advantages, some major industrial production facilities and some industrial sectors such as tea industry are increasingly aiming for "carbon neutrality".

With the middle-income development aspirations, the transport sector has seen a gradual modal shift from public to private transportation. In 2005, the contribution of public transport systems (buses and railways) to passenger transport was 70%, which ~~has~~ reduced by 50% in 2015 and 33% in 2021[9]. In 2021, cars, motorcycles, and three-wheelers contributed to about 85.5% of the active fleet of 5.53 million vehicles[10]. In the meantime, large investments are planned to modernize passenger transportation systems, including the aging railway and expressway network, electrification of railways, and encourage more private users to purchase hybrid and (EVs. In particular, with the recent import restrictions imposed by the GoSL on internal combustion engine (ICE) vehicles, there is a renewed interest in EVs, including local manufacture and value addition. With the assistance of development partners, a number of pilot projects have been initiated for promoting EVs, including including retrofit in ICE vehicles, and establishment of charging infrastructure.

The policy and political level emphasis on low-carbon development is also reflected in the recent interventions of the GoSL, including Climate Prosperity Plan, Net-zero Carbon Roadmap, and the proposal to establish an International Climate Change University. Nevertheless, the implementation of these policies and programmes has been hindered by the limitations in financing, which is aggravated further by the present economic crisis. In order to overcome these challenges, the GoSL is exploring opportunities to access climate financing and other sources. Some notable initiatives related to financing include the Sri Lanka Green Finance Taxonomy published by Central Bank of Sri Lanka (CBSL) in 2022 and SDG Investor Map (2022) formulated with the guidance of Sri Lanka Sustainable Development Council (SLSDC) and Board of Investment (BOI), which intend to provide conducive environment to unlock investments for low-carbon and sustainable developments. The MoE has recently appointed an expert committee to identify the country's potential of carbon trading and develop

[9] National Transport Commission (NTC), National Transport Statistics 2022.
[10] CBSL, Economic and Social Statistics of Sri Lanka 2022.

Carbon Trading Strategy of Sri Lanka.

3.1.1 Unconditional and Conditional Policy Responses

Although committed by the GoSL, the successful implementation of NDCs depends on several factors, particularly on the availability of resources such as data, finance, technology, skills and expertise. Accordingly, some of the NDCs identified are relatively easier to implement, while others require more efforts and international supports from other parties and development partners. Thus, in general, NDCs are categorized as conditional and unconditional. The implementation of conditional NDCs require additional resources beyond the capabilities of the country and, in some cases, more conducive governance and legislative environment. For example, several conditional NDCs are restricted due to the technology's infancy and lack of market readiness (commercial viability) locally. These steps are crucial for a long-term shift in direction toward low-carbon routes in major sectors such as power, transport, industry, waste, forestry, agriculture, and livestock. These conditional NDC actions account for additional 10.5%[11] of GHG emissions reduction respective to the BAU scenario for the period 2021-2030, and account for the major component of the total amount of 14.5% reduction[12]. The unconditional NDCs are the actions that have been identified in national plans and programs, prioritised for national investments (public and private) which can be implemented with domestic capacity. These actions amount to 4.0%of GHG emissions reduction respective to the BAU scenario for the period 2021-2030. Table 3-1 includes the possible GHG emsission reduction (both unconditional and conditional) quantification of the mitigation sectors.

It should be noted that the real potential of GHG emissions reduction would be much higher than the amounts mentioned above as a wide range of co-benefits including the GHG emissions reduction of both mitigation and adaptation measures implemented in the country have not been assessed due to the unavailability of required data and related MRV systems.

Table 3-1Commitment of GHG emission reduction from mitigation sectors (adapted from Updated NDC, 2021)

Sector	Unconditional	Amount ($MTCO_2$ eq)	Conditional	Amount ($MTCO_2$ eq)	Total % ($MTCO_2$ eq)
Power	5%	9,819,000	20%	39,274,000	25% (49,093,000)
Transport	1%	1,337,000	3%	4,011,000	4% (5,348,000)
Industry	4%	2,088,000	3%	1,482,000	7%

[11] For the six sectors covered in this revision (power, transport, industry, waste, agriculture & livestock, forestry). Analysis excluding the emissions & emissions reduction activities in certain sub sectors such as some land use categories.

[12] Updated NDC Sri Lanka, 2021

					(3,570,000)
Waste	8.5%	1,969,000	2.5%	580,000	11% (2,549,000)
Forestry	2%	705,000	5%	1,652,000	7% (2,357,000)
Agriculture (including livestock)	4%	2,477,400	3%	1,858,000	7% (4,335,400)
TOTAL	**4%**		**10.5%**		**14.5% (67,252,400)**

3.2 Electricity (Power) Sector

In Sri Lanka, there are three main ways to generate electricity: thermal power (which uses fossil fuels like coal and oil), large hydropower, and other new RE sources (small hydro, solar, wind, and biomass) which are also referred to as nonconventional renewable energy (NCRE) or new renewable energy (NRE) resources. The nation's electrification rate for all potential customers is almost 100%. According to CEB[13], the total installed capacity by 2021 was 4,186 MW, a 1.9% (79 MW) decline from the year 2020 because certain power plants owned by independent power producers were shut down due to their retirement. Furthermore, as shown in Figure 3-1,

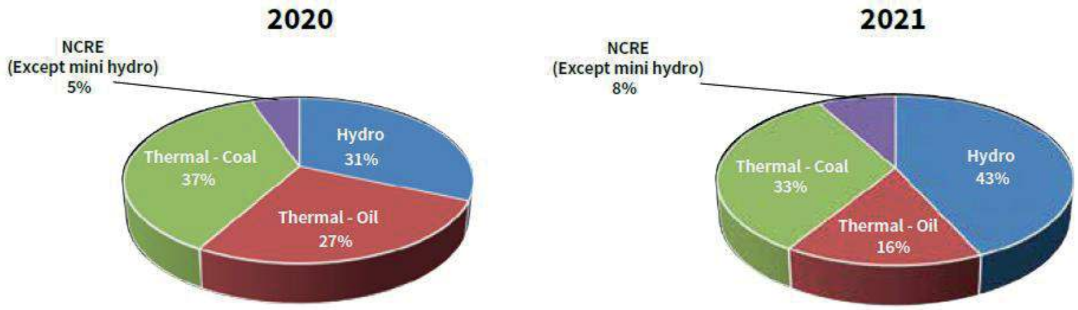


Figure 3-1 Share of generation source in 2020 and 2021 [13]

there has been a shift in the energy sources used to generate electricity that is more environmentally friendly (mainly NCRE sources such as solar and wind).

Sri Lanka adopted a comprehensive approach while creating its National Energy Policy & Strategies (2019) to ensure the supply of energy is secure, equitable, and sustainable. The 10 pillars of this legislation direct the nation to maximise the development of domestic RE sources, diversify the generation mix, and reduce reliance on fossil fuel imports. With a target of reaching 70% electricity generation utilising RE sources by 2030, these initiatives are anticipated to advance RE-based power generation further.

[13] CEB, Sales and Generation Handbook, 2021

According to the Sri Lanka Energy Balance (SLEB) published by SLSEA the demand for electricity was growing by around 5% annually during 2010 to 2020[14]. However, it only slightly decreased in 2020 due to the reduced economic activity brought on by the COVID-19 pandemic. Nevertheless, it is expected that long-term growth trends will continue to be followed by future expansion plans for electricity generation, regardless of any reduction in demand that may have occurred in the recent past or in the present due to import restrictions brought on by the depletion of foreign reserves, prolonged power outages, and scarcity of petroleum products. Figure 3-2 shows how well Sri Lanka's economic activities and electricity demand coupled. As a result, it is reasonable to expect that electricity demand will rise along with the economic development. It has previously been predicted that, starting in 2026, the peak demand will move from the night to the day, reflecting greater industry activity[15].

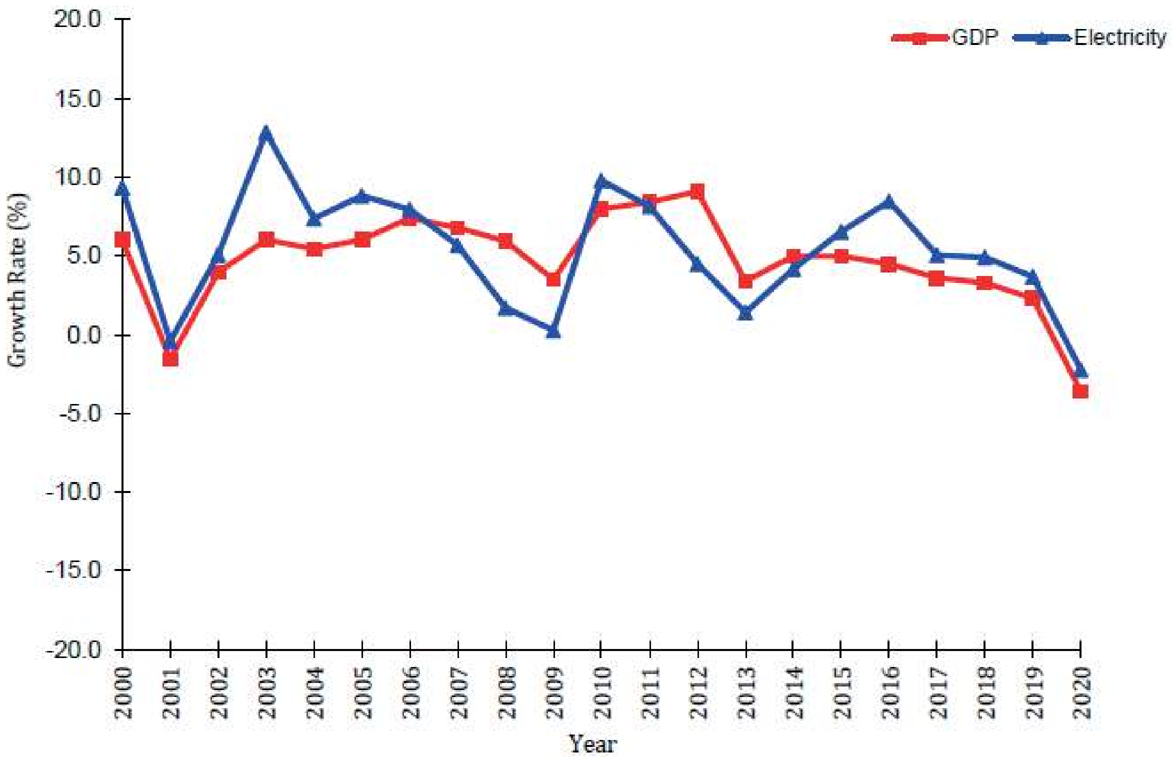


Figure 3-2 GDP growth rate and sales of electricity[15]

With the emphasis given by the GoSL for RE, a significant progress has been seen in the capacity addition of renewable energy, particularly from wind, solar, hydro, and biomass. Among these, the most prominent development in the recent past is attributed to solar PV rooftop systems, reaching ~~to~~ a total capacity close to 700 MW at the end of the year 2022. There are about 47,000 rooftop systems in domestic, commercial and industrial establishments, with capacities ranging from a few kW to a few MW, supported by over 470 technology suppliers. The development of solar PV rooftop sector is largely governed by the national programme titled "Battle for Solar Energy", with three different feed-in tariff schemes

[14] SLSEA, Sri Lanka Energy Balance 2020
[15] CEB, Long-Term Generation Expansion Plan 2022-2041

identified as net-metering, net-accounting and net-plus, allowing the electricity consumers to either bank the excess generation or sell the electricity to CEB. It is expected to add 1,000 MW of solar electricity to the national grid by 2025 and 1,500 MW by 2030 through this intervention[16].

Another area of intervention that attributed to further reduction of GHG emissions from the power sector is the ongoing Energy Efficiency Improvement & Conservation (EEI&C) programme. This area includes numerous Demand Side Management (DSM) initiatives as well as transmission and distribution loss reduction efforts. The key programmes implemented, particularly by SLSEA (and its predecessor Energy Conservation Fund), cover policies, regulations, codes, appliance labelling, guidelines, education/awareness and other promotional programmes. More recently, a major EEI&C effort has been initiated with the implementation of Operation DSM (ODSM) programme developed by Presidential Task Force on Energy Demand Side Management. It comprises of nine thrust areas: efficient lighting, efficient fans, efficient motors, efficient refrigerators, eliminating incandescent lamps, efficient air conditioning, smart homes, green buildings, and efficient pumps, targeting a total electricity demand of nearly 2,000 GWh during its implementation period of 2016 to 2020[17]. Currently, the programme generated by the Presidential Task Force is being carried forward by the SLSEA.

Further, the ‘no further additions of coal power plants’, conversion of current fuel oil-based combined cycle power plants to natural gas (NG) and the construction of new NG power plants will aid in the endeavour to reduce emissions and support the NDCs. The five NDCs shown in *Table 3-2* are anticipated to significantly reduce the GHG emissions between 2021-2030 period and ultimately direct the country to achieve the net-zero carbon target by 2050 in the power sector

Table 3-2 NDCs of Electricity (Power) Sector

NDC #	NDC Actions
1	Enhance renewable energy contribution to the national electricity generation mix by increasing Solar PV, Wind, Hydro and Sustainable Biomass based electricity generations
2	Implement Demand Side Management (DSM) measures by promoting energy efficient equipment, technologies and system improvements in a national energy efficiency improvement and conservation (EEI&C) programme
3	Conversion of existing fuel oil-based combined cycle power plants to Natural Gas (NG) and establishment of new NG plants as conditional measures (once the necessary infrastructure is available)
4	Transmission and distribution network efficiency improvements (Loss reduction of 0.5% compared with BAU by 2030) as unconditional measures (Target – Approximately 1,848 GWh energy savings between 2021-2030)
5	Conduct R&D activities to implement pilot scale projects for NCRE sources that

[16] SLSEA, Soorya Bala Sangramaya (Battle for Solar Energy, https://www.energy.gov.lk/index.php/en/soorya-bala-sangramaya

[17] SLSEA, Operation Demand Side Management, https://www.energy.gov.lk/ODSM/

	have not yet reached commercial maturity and develop other grid supporting infrastructures as conditional measures

As shown in *Figure 3-3*, it is anticipated that the implementation of NDCs will reduce GHG emissions in the electricity (power) sector by 25% compared to the BAU scenario (5% unconditionally and 20% conditionally), which equates to an estimated mitigation level of 9,819,000 MT unconditionally and 39,274,000 MT conditionally (totaling 49,093,000 MT) of carbon dioxide equivalent between 2021 and 2030. This estimation was done taking the Ceylon Electricity Board's Long Term Generation Expansion Plan (LTGEP) of 2013 as the baseline. LTGEP of 2022 which was introduced after updating the NDCs has provisions to accommodate more RE renewable based generation in the energy mix.

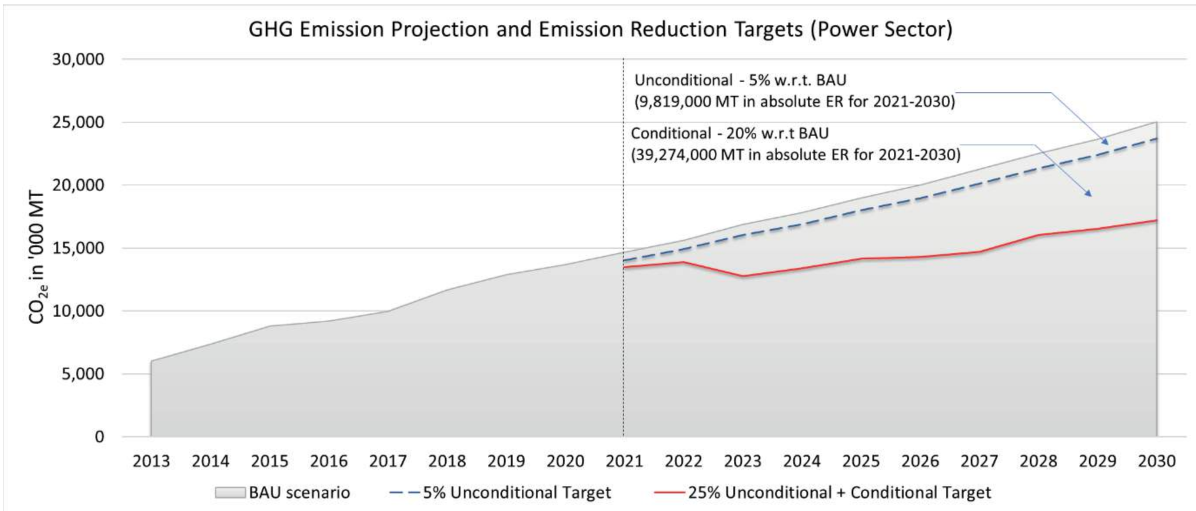


Figure 3-3 Power Sector GHG Emission Projection and Emission Reduction Targets

3.2.1 Gender Aspects in the Energy (Power) Sector

The National Energy Policy & Strategies 2019,[18] formulated in alignment with the current global trends in energy, Goal 7 of the SDGs ,[19] and other future aspirations of Sri Lanka, have declared to ensure that convenient and affordable energy services are available for equitable development of Sri Lanka using clean, safe, sustainable, reliable and economically feasible energy supply. Under the clause 'Providing Access to Energy Services', the policy aims to introduce strategies for new productive uses for electricity in agriculture, rural and primary industries with emphasis on empowerment of women and youth; and outlines that a home productivity improvement programme, with energy efficiency and conservation as the central theme will be launched to empower women.

Women play a major role in mitigation. They are promoters of renewable energy. Clean

[18] Ministry of Power, Energy and Business Development (August 2019). National Energy Policy and Strategies of Sri Lanka. Gazette Extraordinary 2135/61. https://www.energy.gov.lk/images/resources/downloads/national-energy-policy-2019-en.pdf

[19] SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all

cooking stoves, sustainable fuelwood, domestic solar and biogas are often managed by women. Efficient energy systems will benefit women by providing time for entrepreneurship and quality time with their families while building a low carbon footprint.

3.2.2 Recommendations for Gender Responsive NDC Planning and Implementation in the Energy (Power) Sector

In consideration of the above highlighted status of women with reference to the energy sector, it is important to facilitate, support and enhance the role of women from user, producer and entrepreneur perspectives through the NDC implementation, for more efficient and effective overall mitigation outcomes. The following recommendations are suggested for consideration:

I Overall:

i. NDC activity planning and implementation in the sector need to take into account the differential energy needs, and priorities of men and women, and gender-defined roles in energy production, distribution and utilisation at households, community and the market (through conducting a gender assessment and analysis for the Energy Sector, with specific attention to GHG mitigation aspects). .

ii. Take into consideration the role women play as (i) energy suppliers and (ii) energy consumers (currently invisible due to lack of disaggregated data, policy gaps and stereotypes), aiming for greater engagement of women in mitigation activities.

iii. Promote and facilitate women's participation as technicians, professionals and managers in the energy sector: set targets to reach and maintain the share of women scientists, officials, technical officers at the national and local levels.

iv. Include collection of sex disaggregated data, develop targets, indicators and KPIs to review gender responsive activities, mitigation outcomes, for the progress review and monitoring of the NDC plan.

II. Engagement of women in production and supply of sustainable energy options identified in the NDCs:

i. Proactively target and engage women in renewable energy production, supply and service provider programmes, as individual entreprenurs and as part of SME s, (such as solar PV, sustainable biomass production and services).

ii. Include and target women in providing training on sustainable energy technologies, and in providing credit, subsidies, to enhance their position as sustainable energy production entrepreneurs and users.

III. Enabling women to use clean energy sources for enterprices/livelihoods, for cooking and lighting:

i. Proactively promote the use of affordable, accessible, cleaner fuels and energy efficient technologies as a mitigation measure: introduce and promote clean energy options to minimize the use of fossil fuels, biogas, and biomass for cooking, clean energy sourced technologies for entrepreneurship/livelihood support activities. In fact, biomass is the only affordable and accessible energy source for majority of the rural communities and micro, small and medium enterprises (MSMEs). The engagement of women is prominent in these sectors, throughout the entire value chain from generation of biomass to final usage.

(Please see Table 3.2.3 for specific actions for gender and socially inclusive implementation)

3.2.3 Electricity (Power) Sector NDC Implementation Plan

NDC 1 - Enhance renewable energy contribution to the national electricity generation mix by increasing Solar PV, Wind, Hydro and Sustainable Biomass based electricity generations (Target: Develop an additional capacity of 3,867 MW renewable energy over the RE capacity considered in Business-As-Usual scenario, out of which approximately 950 MW are on an unconditional basis and 2,917 MW on a conditional basis)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1 Establish wind, solar (rooftop, small-scale and large solar PV), biomass12, large and small hydro power plants	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.1.1 - Establish wind power plants	SLSEA, CEB	MoP&E, CEA, Private investors, Land custodians	MW installed	CEB statistical digest & SLEB	178 MW	Addition of 865 MW (Unconditional 128 MW, Conditional 737 MW)	√	√	√	√	√	√	√	√	√	√	7.2
1.1.2 – Establish rooftop and ground-mounted solar PV	SLSEA, CEB	MoP&E, LECO, Solar PV service providers, Private investors, CEA, Land custodians	MW installed	CEB statistical digest & SLEB	425 MW	Addition of 2,263 MW (Unconditional 335 MW, Conditional 1,928 MW)	√	√	√	√	√	√	√	√	√	√	7.2
1.1.2.1 Encourage and increase women in the rooftop solar PV installation programme	SLSEA	MoP&E, LECO, Solar PV service providers, Private investors, CEA, Land custodians	Number of women in the rooftop solar PV installation programme increased	CEB statistical digest & SLEB with data on women's engagement and numbers of women in the programme	Approximately 200 women out of 10,000 (2%)	Increase from 2% to 5%		√	√	√	√	√	√	√	√	√	5.a, 5.b, 5.c, 7.2, 13.1, 13.2

1.1.3 – Power generation through sustainable biomass resources	SLSEA	MoP&E, MoE, MoLR, CEA, MASL, LAs, Land custodians	MW installed	CEB statistical digest & SLEB	50 MW	Addition of 65 MW (Unconditional 10 MW, Conditional 55 MW)	√	√	√	√	√	√	√	√	√	√	7.2
1.1,3.1. Encourage women in supplying sustainable biomass for power plants	SLSEA	MoP&E, MoE, MoLR, CEA, MASL, LAs, Land custodians	No of women suppliers	CEB statistical digest & SLEB with data on women suppliers	Baseline to be provided by SLSEA in 2023	Target to be set by SLSEA in 2023		√	√	√	√	√	√	√	√	√	7, 5
1.3.1.1 Establish an institutional mechanism to enable the collection of sex disaggregated data	SLSEA	CEB, LECO	Sex disaggregated data collection institutional mechanism	CEB statistical digest & SLEB	0	Institutional mechanism for consistent collection of sex disaggregated data established			√								7, 5
1.1.4 - Establish large and small hydro power plants	SLSEA, CEB	MoP&E, CEA, MASL, LAs, Land custodians	MW installed	CEB statistical digest & SLEB	410 MW	Addition of Large Hydro: Unconditional 31 MW. Mini Hydro: Unconditional 20 MW, Conditional 110 MW (Total Mini Hydro 130 MW)	√	√	√	√	√	√	√	√	√	√	7.2
1.2 - Develop the required transmission network infrastructure to enable integration of renewable energy	CEB	MoP&E, CEB	Length of network infrastructure developed/upgraded	CEB statistical digest	3,160 km	480 km. (Could be a very elaborate target under REDMAP)	√	√	√	√	√	√	√	√	√	√	7.b

NDC 2 -Implement Demand Side Management (DSM) measures by promoting energy efficient equipment, technologies, and system improvements in a national energy efficiency improvement and conservation (EEI&C) programme

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1 – Realize energy saving of 2,603 GWh by phasing out incandescent bulbs as an unconditional measure	SLSEA	CEB, MoP&E, SLSI	GWh saved	SLEB	14 GWh	2,603 GWh	√	√	√	√	√						7.3
2.2 – Realize energy saving of 5,189 GWh by introducing efficient lighting, fans, refrigerators, and chillers as a conditional measure	SLSEA	CEB, MoP&E, SLSI, EE service providers, Private sector	GWh saved	SLEB	724 GWh	5,189 GWh (2023-401) (2024-600) (2025-794) (2026-1,051) (2027-1,549) (2028-1,487) (2029-1,737) (2030-1,737)			√	√	√	√	√	√	√	√	7.3
2.3 - Implement energy efficiency building code on a mandatory basis	SLSEA	MoP&E, UDA, LAs, CIDA, Institute of Architects, IESL, GBCSL, Construction companies	Number of installations	SLSEA records of building applications	None	1,073 GWh		√									7.3

2.4 – Promote High Efficiency Motors (HEM), Variable Frequency Drives (VFD), tri-generation, and other energy efficiency measures in the industrial sectors	SLSEA	CEB, MoP&E, MoI, EE service providers, Chambers of Commerce and Industry Associations (CC&IAs), Private Investors	GWh saved	SLEB / SLSEA statistical information	HEM - 775 GWh VFD - 590 GWh (Facilitated by Energy NAMA Project) Efficient Chillers - 1,300 GWh	466 GWh (2024-10) (2025-20) (2026-50) (2027-86) (2028-100) (2029-100) (2030-100)				√	√	√	√	√	√	√	7.3
2.5 Plan and implement specific and targeted activities to engage women service providers and energy users in the promotion of measures for demand side management (DSM)	SLSEA	CEB, MoP&E, SLSI	No of women focused/targeted specific activities conducted No of women befitted	Progress reports, Numbers of women service providers and energy users engaged/reached	Baseline to be established through an industry census	100 women per year		√	√	√	√	√	√	√	√	√	5.8, 7, 5

NDC 3 – Conversion of existing fuel oil-based combined cycle power plants to Natural Gas (NG) and establishment of new NG plants as conditional measures (once the necessary infrastructure is available).

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1 – Conversion of existing 600 MW of fuel oil-based power plants to NG	CEB	MoP&E, MoE, MoF	MW converted	CEB statistical digest	0 MW	600 MW					√	√	√	√	√	√	13.1
3.2 – Establishment of new combined cycle power plants in place of anticipated coal power capacity additions in the BAU and gas turbines with approximately 700 MW of	CEB	MoP&E, MoE, MoF, Private sectors (IPPs)	MW established	CEB statistical digest	0 MW	830 MW					√	√	√	√	√	√	13.1

capacities to be operated from NG																	

NDC 4 – Transmission and distribution network efficiency improvements (Loss reduction of 0.5% compared with BAU by 2030) as unconditional measures (Target – Approximately 1,848 GWh energy savings between 2021-2030)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4.1 – Carry out developments in the transmission network, reconductoring of existing transmission lines and reactive power compensation activities	CEB	MoP&E, MoF	GWh saved	CEB statistical digest	302 GWh	1,848 GWh	√	√	√	√	√	√	√	√	√	√	7.b
4.2 – Carry out the conversion from bare conductors to bundled conductors, line maintenance, load balancing and reduction of line length by installation of transformers in the distribution system	CEB	MoP&E, MoF	GWh saved	CEB statistical digest	As reported above	GWh target shall be established through a loss reduction study	√	√	√	√	√	√	√	√	√	√	7.b

NDC 5 – Conduct R&D activities to implement pilot scale projects for NCRE sources that have not yet reached commercial maturity and develop other grid supporting infrastructures as conditional measures

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
5.1 – Conduct R&D activities to implement pilot scale projects for new renewable energy (NRE) sources (exotic technologies) like Geothermal Energy conversion, Ocean Thermal Energy Conversion (OTEC), Ocean Energy (Wave), etc. which have not yet reached commercial scale maturity	SLSEA	CEB, MoP&E, Academia	Number of exotic technologies researched and piloted	CEB statistical digest & SLEB	Initial studies are in progress.	5 technologies to be piloted	√	√	√	√	√	√	√	√	√	√	7.a

5.2 - Develop pumped storage hydro power plants and pilot scale storage systems such as Behind the Meter (BtM) and Grid Scale Battery Energy Storage (BES) solutions, to support the integration of intermittent renewable energy to the system	CEB, SLSEA	MoP&E, Academia, Private sector	Number of installations / MW installed, MWh storage capacity	CEB statistical digest & SLEB	Initial studies is conducte d for pump storage.	600 MW PSPP installation, 100 MW BESS installation (for grid support services)	√	√	√	√	√	√	√	√	√	√	7.a
5.3 – Introduce ICT interventions such as Smart Grids Technologies to support integration of intermittent renewable energy to the system	SLSEA	CEB, MoP&E, Academia	Number of interventions	SLSEA annual report	One Smart Mini-grid in operation (in Galamud una village (Knuckle s)	4 new ICT interventio ns introduced	√	√	√	√	√	√	√	√	√	√	7.a
5.4 - Conduct a gender assessment and analysis for the Energy sector to identify main gender issues in the sector relevant for mitigation, and to set a baseline	MoP&E	SLSEA, CEB, PUCSL	Main gender issues in the sector identified Baseline for introducing/pr omoting gender responsive mitigation measures identified	Sector gender assessment document with recommendati ons for identifying and promoting gender responsive mitigation activities available	0	Gender assessment document on the energy sector with updated information .			√								5.a, 5.b, 5.c, 7.1, 7.2, 7.3, 13.1, 13.2
5.4.1 - Build awareness and capacities of the main planning and implementation teams/agencies on gender issues in the energy sector	MoP&E	International agencies	Gender awareness at the planning and decision-making level	No of Awareness and training programmes conducted on gender issues, on gender responsive	Partial awarenes s created	All agencies of MoP&E gender sensitized				√	√	√	√	√	√	√	5.a, 5.b, 5.c, 7.1, 7.2, 7.3, 13.1, 13.2

				planning &implementation No of officials trained													

3.3 Transport Sector

Road vehicles dominate Sri Lanka's transportation sector, in both passenger and freight sectors, contributing more than 95% of passenger kilometers travelled and more than 99% of ton-kilometers. The demand for passenger transportation peaked in 2019 at roughly 231.5 billion passenger kilometres, but due to travel limitations brought on by the COVID-19 pandemic, the demand fell to 185.5 billion passenger kilometres in 2020. This reduction was also associated with moving passengers away from public transport. In 2021, this was recovered to 191.8 billion passenger-km, which is still less than the 2020 value. In 2019, the public transport modes (buses and railways) had a total modal share of 40.6%, while it was only 36.3% in 2020 and 33.0% in 2021. The corresponding modal share in 2019, 2020, 2021 of motorcycles: 8.0%, 9.1%, 9.1%, three-wheelers: 19.9%, 21.8%, 22.6% and motor cars 17.6%, 18.5%, 19.5%, respectively[20]. At the end of 2021, total vehicle registered was 8.33 million, while the active vehicle fleet (based on annual revenue license data) was around 5.53 million, of which 54.30% are motorcycles, 18.14% three-wheelers, 13.04% motor cars, and 0.94% buses[21].

In fact, a gradual deterioration of the public transport modes has seen over several year, for example about 70% modal share in 2005 and 50% modal share in 2015 in passenger transportation. Under the business-as-usual (BAU) scenario, the share of public transportation will decline further. Despite investments and attempts to improve public transportation options, the quality and availability of public transportation are yet below expectation. This and rising per capita income have resulted in a gradual decrease in passengers using public transportation and an increase in private vehicles. Transport sector is the main consumer of the imported petroleum fuels. In 2021, the total crude oil imports was 1,182.000 metric tons (123.9 billion LKR) and the total refined products imports was 4,553,000 metric tons (564.7 billion LKR)[22]. Although Sri Lanka adopts Euro 4 emission standards and continues with the vehicle emission testing (VET) programme, the considerable share of inefficient vehicles in operation leads to higher GHG emissions.

The increase in private vehicle use in urban areas has increased traffic congestion, road accidents, and air pollution, and in turn impacted the economy, environment, and society. High dependence on road transport, as against railways or water-based transport modes, tend to increase total energy consumption and air pollution. Though Sri Lanka Railway (SLR) played a dominant role in the past, its share of passenger and freight transportation has shrunk over time (4.3% in 2015 to 1.1% in 2021). SLR has identified the potential to improve its services as a low-cost mass transportation mode for passengers and goods, and thereby reduce urban and suburban traffic congestion to a great extent. On the other hand, non-motorized transport share is very low in urban areas and is reducing in rural areas. Three-wheelers, school, and

---

[20] NTC, National Transport Statistics 2022, National Transport Commission (NTC), [Online]. Available: https://www.ntc.gov.lk/corporate/pdf/2022/statistics_Report/stat_2022_EN.pdf

[21] CBSL, Chapter 2: Economic and Social Infrastructure, Economic and Social Statistics of Sri Lanka 2021, Volume XLIII, Central Bank of Sri Lanka (CBSL), July 2021, [Online]. Available: https://www.cbsl.gov.lk/sites/default/files/cbslweb_documents/publications/ess_2021_economic_and_social_infrastructure_e.pdf

[22] CBSL, Chapter 1: National Output, Expenditure and Income, Economic and Social Statistics of Sri Lanka 2022, Central Bank of Sri Lanka (CBSL)

office vans are providing substantial services to communities that do not have direct access to buses or trains. Recent infrastructure developments in the sector such as expressways, park & ride facilities, multimodal transport hubs, etc. are expected to reduce the emission footprint while positively contributing to the environment and economy.

The present economic crisis too is having profound effects on the transport sector, with restricted importation and controlled issuance of petroleum fuel, and t banning of importation of ICE vehicles. Import relaxation and other promotional programmes of EVs, including retrofitting of electric drivetrains in existing ICE vehicles, are expected to have a significant shift towards electric mobility, with renewable energy integration for charging. There are about 60 fast charging stations in Sri Lanka, mostly located in Colombo and in a few in other major cities. Around 7 of these are operated by the Ceylon Electricity Board (CEB), and others are operated by private sector organizations. However, there are no plans from the private sector to expand the network due to the lack of new EVs and the unviability of the existing fleet. Many previously functioning charging stations have either shut down or are functioning at a loss. Nevertheless, some local developers of charging stations have started exporting their products to neighbouring countries, having markets with more commercial potential. Meanwhile, SLSEA has developed a proposal to establish solar PV assisted EV charging stations, one in each district. However, this proposal is yet to be implemented due to lack of finance.

In the above context, the updated NDCs in the transport sector has been formulated under the overarching Avoid-Shift-Improve (A-S-I) conceptual framework, in a hierarchical order, with due consideration of local circumstances and policy priorities. Here, the Avoid element refers to organizing the land use, social and economic activities in such a way that the need for transport and the use of fossil fuels is reduced, Shift implies the use of environment-friendly modes like public transport and non-motorized transport (NMT) to reduce energy consumption per trip and Improve reflects the consumption of as little energy as possible per vehicle-km by using advanced technologies & cleaner fuels and by optimizing vehicle operation[23].

Accordingly, the updated NDCs are expected to enhance the transport sector system performance, trip performance and vehicle performance in an integrated manner, that will re-invigorate public transportation including railways, buses, and improve intermodal connectivity between rail, road, and water-based transportation, while improving energy efficiency/fuel economy to save foreign exchange contributing to the economy, local and global air pollution, apart from its contribution to GHG emissions reduction. *Table 3-3* lists the key actions proposed to support transport sector emissions reduction, and the related GHG emission reduction projections are presented in Figure 3-4.

Table 3-3 NDCs of Transport Sector

NDC #	NDC
1	Transport sector system improvement

[23] GIZ, "Sustainable Urban Transport: Avoid-Shift-Improve (A-S-I)", Transformative Urban Mobility Initiative (TUMI), German Corporation for International Cooperation GmbH (GIZ), March 2019, [Online]. Available: https://www.transformative-mobility.org/assets/publications/ASI_TUMI_SUTP_iNUA_No-9_April-2019.pdf

2	Promote public passenger transport
3	Shift freight to efficient modes
4	Rapid transit for passenger transport
5	Promote non-motorized transport modes
6	Introduce taxes and other instruments to promote public transport
7	Introduce inland water transport modes
8	Modernizing & upgrading of suburban railway
9	Promote electric mobility & hybrid vehicles
10	Improve vehicle fleet efficiency
11	Road infrastructure development
12	Reduce GHG emission from the marine sector
13	Supportive policy framework and activities

It is expected that the implementation of updated NDCs will result in GHG emissions reduction against BAU scenario by 4.0% in the transport sector (1.0% unconditionally and 3.0% conditionally) equivalent to an estimated mitigation level of 1,337,000 MT unconditionally and 4,011,000 MT conditionally (total of 5,348,000 MT) of carbon dioxide equivalent during the period of 2021-2030 (see Figure 3-4). It should be noted that there are additional emission reductions from various initiatives, which are difficult to be accounted for as no systematic reporting/accounting arrangement is yet in place.

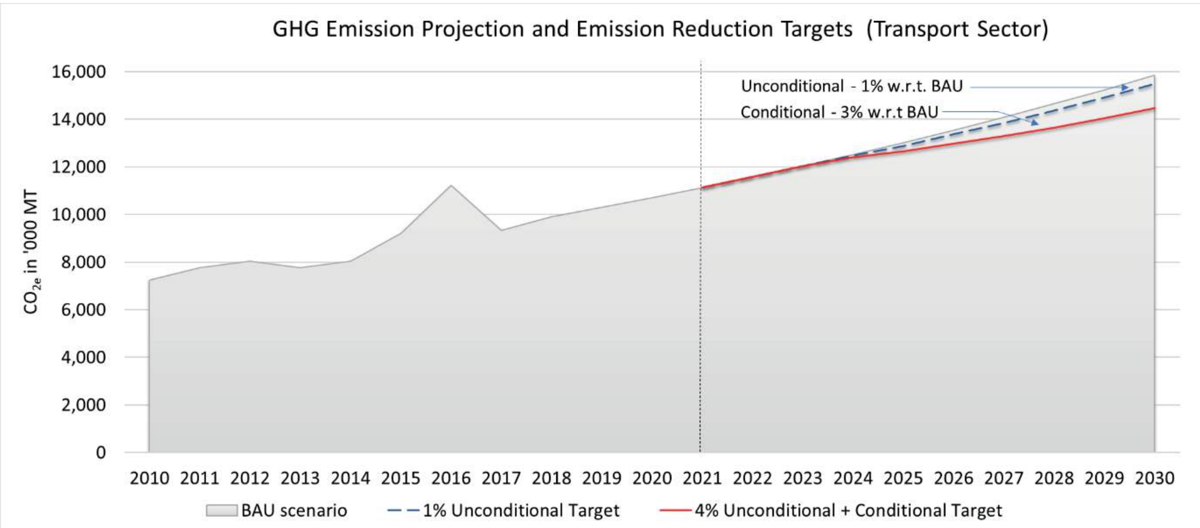


Figure 3-4 Transport Sector GHG Emission Projection and Emission Reduction Targets

The appraisal of the transport sector NDCs indicates the presence of constraints and limitations that have resulted in lack of progress and non-implementation of several activities and sub-activates. For example, the project on Light Rail Transport in Colombo city under NDC4 Rapid transit for passenger transport has been cancelled. Though there are more recent discussions to re-initiate it, still there is no commitment for implementation. Some private sector organizations have initiated programmes to transport goods in more efficient railway system. One case example is diversion of transportation of wheat flour from road to railway by Prima Ceylon Ltd (under NDC3). Though this was done during few years, there are issues for continuation due to fee structure disagreement between the parties with the recent price hike of petroleum fuels.

Thus, in order to achieve the above targets in GHG mitigation, strategic interventions are required to be identified and implemented in an urgent basis.

3.3.1 Transport Sector NDC Implementation Plan

NDC 1 - Transport Sector System Improvement																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1: Avoid the need to travel (through remote meetings, Information and communications technology (ICT) applications, Enterprise resource planning (ERP) systems, process automation, flexible time, work-from-home, etc.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.1.1: Promote e-shopping facilities Covering Lanka Sathosa retail outlets, Cooperative shops and supermarket chain, STC, Online platforms	MoTrad	MoF, STC, CAASL, CIAs, Lanka Sathosa, ICTA, ICT Service Providers, Private sector agencies	Percentage number of Business Entities having e-shopping facilities	Data sources: CBSL, Financing Institutions	Baseline to be establishe d	Target to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 8.4, 11.6
1.1.2: Make arrangements for flexible work time, work-from-home (WFH), etc.	MoPA	MoL, Ministry in charge of Productivity, EFC	1. Number of organizations having WFH options 2. Percentage number of employees engaged in WFH	Respective ministries; CCC (representing the Private sector)	Baselines to be establishe d	Targets to be established	-	-	-	-	-	√	√	√	√	√	3.6, 3.9, 8.4, 11.6
1.1.3: Introduce ICT applications for public sector institutions to promote (i) virtual meetings (ii) remote service delivery	ICTA	All relevant public sector institutions, Academia, Private IT	1. Number and percentage of public sector institutions	ICTA records	Baselines to be establishe d	Targets to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 8.4, 11.6

		service providers, TRC	adopting ICT applications 2. Percentage number of meetings conducted online; 3. Number of services provided through remote mode														
1.2: Reducing commuting distances and travel time	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.2.1: Introduce urban rental residential facilities through relevant policy changes	UDA	MoUD&H, LAs, Private developers	Number of urban rental facilities available	Records of MoUD&H, UDA, LAs,	None	Target to be established	√	√	√	√	√	√	√	√	√	√	11.a
1.3: Improve traffic and Traffic light management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.3.1: Introduce demand responsive signals such as sensor controlled adjustable traffic lights to avoid unnecessary waiting	RDA	MoT, SLP, SLR, SD&CC, LAs	1. Number of installations 2. Number of cities covered	Records of RDA, Academia	None	Target to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 11.6
1.3.2: Introduce signal synchronization	RDA	MoT, SLP, SD&CC, LAs	1. Number of installations; 2. Number of cities covered	Records of RDA, Academia	None	Target to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 11.7
1.3.3: Introduce area wide traffic controls	UDA	MoT, RDA, SLP, LAs	Number of area wide traffic controls introduced	Records of MoT, RDA, LAs	None	Target to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 11.7
1.4: Improve Parking management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.4.1: Introduce “Park & Ride” concept with the use of multi-transport	MoT	RDA, UDA, SLTrB, SLR,	1. Number of "Park &	Records of MoT, RDA,	None	1. 7 by 2025	√	√	√	√	√						3.6, 3.9, 11.7

hubs and low-floor busses		NTC, LAs, Private sector Public Transport Operators	Ride" facilities introduced 2. Parking capacity in each facility 3. Number of users in each facility	LAs		2. Target for parking capacity in each facility to be established 3. Target for number of users in each facility to be established											
1.4.2: Construct multipurpose transport centers in main cities (Kottawa, Kadawatha, Anuradhapura)	MoT	RDA, UDA, SLTrB, SLR, NTC, LAs, Private sector Public Transport Operators	1. Number of multipurpose transport centers established 2. The Capacity in each center 3. Number of users in each center	Records of MoT, RDA, LAs	None	1. 3 multipurpose transport centers by 2025 2. The target for the capacity in each center to be established 3. The target for the number of users in each center to be established	√	√	√	√	√						3.6, 3.9, 11.7
1.4.3: Provide off-street parking	UDA	MoT, RDA, SLP, LAs	Capacity of off-street parking (in terms of space and/or number of	Records of UDA, LAs	Baseline to be established	Target to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 11.7

			vehicles provided) introduced														
1.4.4: Discourage road side parking through regulations, pricing	RDA	MoT, UDA, SLP, LAs	Number of km having roadside parking restrictions.	Records of RDA, UDA, LAs	Baseline to be establishe d	Target to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 11.7
1.5: Introduce Intelligent transport management systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.5.1: Introduce systems to track bus movements (such as GPS)	MoT	NTC, SLTrB, PRPTAs, Private sector Public Transport Operators	Number of busses fitted with tracking systems	Records of MoT, NTC, SLTrB, Private sector Public Transport Operators	1,400 (in 2020) This covers all Luxury and Super Luxury buses and 60 % Semi-Luxury buses	3,200 private buses and 4,000 SLTrB busses by 2025	√	√	√	√	√						9.1, 11.2
1.5.2: Provide seat reservation facilities including online systems	MoT	ICTA, SLTrB, SLR, NTC, Private sector Public Transport Operators	Number of bus stands having seat reservation facilities	Records of ICTA, SLTrB, SLR, Private sector Public Transport Operators	None	18 major bus stands by 2025	√	√	√	√	√						9.1, 11.2
1.5.3: Introduce integrated timetables for public & private transport	MoT	ICTA, SLTrB, SLR, NTC, Private sector Public Transport Operators	Number of routes using integrated time tables	Records of NTC, SLTrB, SLR	None	Whole country by 2030	√	√	√	√	√	√	√	√	√	√	9.1, 11.2
1.5.4: Introduce transit cards	MoT	ICTA, SLTrB, SLR, NTC, Private sector Public Transport	1. Percentage coverage of bus fleet by transit card facility	Records of SLTrB, SLR, Private sector Public Transport	None	1. 100% bus fleet by 2025 2. 100%	√	√	√	√	√						9.1, 11.2

		Operators	2. Percentage coverage of railway fleet by transit card facility	Operators, Card issuers		railway fleet by 2025											
1.6: Improve Road architecture (road signs, signaling, signage, etc.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1.6.1: Develop road infrastructure for bus priority lanes	RDA	MoT, UDA, LAs	1. Number of cities covered 2. Length of bus priority lanes in km	Records of RDA, UDA, LAs	None	1. All major cities by 2030 2. Target for the length to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 9.1, 11.2, 11.6
1.6.2: Allocate space for bus bays	RDA	MoT, SLP, PRPTAs, LAs	Number of new bus bases established	Records of RDA, LAs	Baseline to be established	Target to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 9.1, 11.2, 11.6

NDC 2 - Promote Public Passenger Transport

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Improve public road transport for reliability, affordability, accessibility, availability, comfort and safety	MoT	NTC, SLTrB, PRPTAs, Private sector Public Transport Operators	1. Number of modernized buses introduced 2. Model share of buses in passenger transport (%)	Records of MoT, NTC, Public, Transport Operators and academic publications	1. No moderniz ed buses 2. 19.8% of passenger transport (of 158.6 billion Passenger-km)	1. 1,000 by 2025 2. Target for the model share to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 9.1, 11.2

2.2: Improve railway transport for reliability, affordability, accessibility, availability, comfort and safety	MoT	SLR, NTC	Passenger model share of rail transport (%)	Records of SLR, MoT, NTC, and academic publications	0.9% of passenger transport (of 185.5 billion Passenger-km)	Target to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 9.1, 11.2
2.3: Transport mode integration	MoT	ICTA, NTC, SLTrB, SLR, UDA, Private sector Public Transport Operators	Number of integrations in major locations (Rail and bus stations)	Records of MoT, NTC, SLTrB, SLR	10	Target to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 9.1, 11.2
2.4: Improve last mile connectivity	MoT	NTC, SLTrB, SLR, UDA, LAs, Private sector Public Transport Operators, Taxi Operators, Three Wheelers Associations,	Number of locations having organized last mile connectivity	Records of MoT, NTC, SLTrB, SLR	Informal arrangements	Target to be established	√	√	√	√	√						9.1, 11.2

NDC 3 - Shift Freight to Efficient Modes

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1: Switch back to rail from road transport	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.1.1: Divert transport of wheat flour from road to railway (Prima Ceylon Ltd.)	SLR	MoT, Prima Ceylon Ltd	1. Number of tons handled by railway 2. Number of prime movers	Records of SLR	1. Baseline to be established	1. Target to be established 2. Prime movers: 26	√	√	√	√	√	-	-	-	-	-	3.6, 3.9, 9.1, 11.6

			replaced 3. Number of lorries replaced		2. Prime movers replaced: 26 (up & down) during the year; 3. Lorries: None	(up & down) during every two weeks by 2025; 3. Lorries: 1,144 from Trinco to Seeduwa in 2020, 200 from Trinco to Jaffna in 2022, 100 from Trinco to Colombo for export in 2025, 260 from Trinco to Galle in 2024											
3.1.2: Petroleum product transport by railway	SLR	MoT, CPC, CPSTL	1. Liters of petroleum products transported by railway 2. % volume of petroleum products transported by railways	Records of SLR and CPC; Reports of CPSTL	1. 872,651 kilo liters 2. 58.8%	Targets to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 9.1, 11.6

3.1.3: Other materials (cement, sand, etc.)	SLR	Product manufacturers and suppliers	Weight or volume of other materials (cement, sand, etc.) transported per year	Records of SLR	Baseline to estimated	Target to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 9.1, 11.6
3.2: Promote transporting petroleum products by pipeline	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.2.1: Jet fuel transport by pipe from Muthurajawela to BIA for aircrafts	CPC	CAASL	Number of bowsers avoided	Records of CPC, CAASL	None	Target to be established	√	√	√								3.6, 3.9, 9.1, 11.6
3.3: Introduce rail-based transport system with inland container depots	SLR	Private sector logistic partners	1. Number of 20' and 40' containers 2. Volume or weight handled per year	Records of SLR	None	Targets to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 9.1, 11.6

NDC 4 - Rapid Transport for Passenger Transport

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4.1: Introduce Light Rail Transport in Colombo city	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.1.1: PPP-based Western Region	MoF	SLR, UDA,	1. Distance	Records of	The	1. Distance	√	√	√	√	√	√	√	√	√	√	3.6, 3.9,

Megapolis LRT system (Three lines: Red, Green, Blue)		LAs	covered by LRT 2. Passengers served by functioning LRT	MoT	project was at the feasibility study stage	covered by LRT: Green line = 28.6 km; Red line = 32.4 km; Blue line = 21.5 km 2. Targets for the passenger served to be established											9.1, 11.2, 11.6

NDC 5 - Promote non-Motorized Transport Modes

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
5.1: Promote the use of bicycles	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.1.1: Introduce new bicycle lanes	UDA	MoPC&LG, RDA, LAs	1. Distance covered (km) by new bicycle lanes 2. Number of City Development Pans with integrated bicycle lanes implemented	Records of UDA, RDA, PCs, LAs, PRDAs	Bicycle lanes are introduced in some localities but the specific figures for the baselines to be estimated	1. Target to be established for distance; 2. 45 Cities by 2030	√	√	√	√	√	√	√	√	√	√	3.9, 9.1, 11.2, 11.6

5.1.2: Promote cycle renting facilities	Respective LAs	MoPC&LG, UDA, RDA	1. Number of cycle parking facility locations established 2. Total capacity 3. Number of cities covered	Records of UDA, RDA, PCs, LAs, PRDAs	None	1. Target to be established for the number of parking locations and total capacity 2. Target to be established for the total capacity 3. All major cities covered by 2030	√	√	√	√	√	√	√	√	√	√	3.9, 9.1, 11.2, 11.6
5.1.3: Replace school transports by bicycles in Jaffna MC	MC Jaffna	MoT, Northern Provincial Council & LA	1. Number of schools covered 2. % Number of students using bicycles	Records of MoT, Northern Provincial Council and MC Jaffna	Bicycles are used by school community on Jaffna MC, but specific amount for the baselines to be estimated	Targets to be established	√	√	√								3.9, 9.1, 11.2, 11.6
5.2: Improve the facilities for pedestrian walkways	UDA	RDA, PRDAs, PCs, MCs and LAs	1. Number of locations having improved facilities for pedestrian walkways 2. Total	Records of UDA, PCs, MCs, LAs, PRDAs	Improve the facilities for pedestrian walkways are introduce	1. Target to be established for the number of locations 2. Target to be	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 9.1, 11.2, 11.6

			length covered by improved pedestrian walkways 3. Number of cities covered		d in some localities but the specific figures for the baselines to be estimated	established for the total length; 3. 45 Cities by 2030											

NDC 6 - Introduce taxes and other instruments to promote public transport

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
6.1: Change the existing vehicle emission charging system from the present vehicle based to vehicle type, fuel used and emission-based system plus the total km travel (Introduce emission tax based on vehicle emission performance and distance travelled)	DMT	MoF, MoT, MoE, CEA, SLVET Operators	Upgraded vehicle emission testing scheme	Records of DMT	Vehicle based system	Vehicle type, fuel used and emission-based system by 2023				√	√	√	√	√	√	√	3.6, 3.9, 9.1, 11.2, 11.6
6.2: Restrict the entry of individual modes of transport to sensitive areas and congested areas of major cities during peak hours through a levy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6.2.1: Introduce Corden based pricing mechanism to discourage poor performing vehicles entering to city limits	MoT	MoF, UDA, LAs	Percentage of reduction of vehicles entering into identified cities during restricted times	Records of MoT, UDA, LAs	Not estimated	Target to be established	√	√	√								3.6, 3.9, 9.1, 11.2, 11.6

6.3: Develop Park & Ride infrastructure developments combined with Corden based pricing mechanism	MoT	MoF, RDA, NTC, SLTrB, SLR, LAs	1. Number of Park & Ride infrastructure facilities developed that are combined with Corden based pricing mechanism; 2. Total capacity	Records of MoT, NTC, UDA, LAs,	Yet to be develope d	1. Number of Park & Ride infrastructu re facilities 5 by 2025 2. Target for the total capacity to be established	√	√	√	√	√						3.6, 3.9, 9.1, 11.2, 11.6

NDC 7 - Introduce Inland Water Transport Modes

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
7.1: Introduce canal-based water transport using diesel or grid electricity-powered boat service for selected canal routes	SLLDC	SLN, UDA, NTC	1. Number of km in canal transport 2. Number of boats in service 3. Number of passenger-km /year	Records of SLN, UDA & SLLDC	Not commenc ed	Targets to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 11.6
7.2: Introduce water transport system in Inland water bodies	ID	SLN, MASL, Private Operators	1. Number of km covered in Inland water bodies 2. Number of boats in	Records of ID, MASL and SLN	Not commenc ed	Targets to be established	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 11.6

			service 3. Number of passenger-km /year														

NDC 8 - Modernizing & Upgrading of Suburban Railway

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
8.1: Electrification of railway lines	SLR	MoT, MoF, MoP&E, CEB,	Number of railway lines	SLR records	Not commenced	Five (05) – Colombo to Padukka; Colombo to Panadura; Colombo to Veyangoda; Colombo to Veyangoda; Puttalam line; Kandy suburban line By 2030	√	√	√	√	√	√	√	√	√	√	3.6, 3.9, 9.1, 11.2
8.2: Develop new railway lines and expansion of existing railway network	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.2.1: Develop new railway lines	SLR	MoT, MoF	1. Number of new railway lines introduced 2. Total km	SLR records	Not commenced	1. Two (02) by 2025 (Kurunegala to Habarana and Matara to Beliatta) 2. Total length =	√	√	√	√	√						3.6, 3.9, 9.1, 11.2

						105 km											
8.2.2: Introduce railway double lines	SLR	MoT, MoF	1. Number of railway double lines introduced 2. Total km	SLR records	None	1. One (01) by 2025 (Polgahawela to Kurunegal); 2. Total length = 20 km	√	√	√	√	√						3.6, 3.9, 9.1, 11.2
8.2.3 Extend railway lines	SLR	MoT, MoF	1. Number of railway lines extended 2. Total km	SLR records	Not commenced	1. One (01) by 2025 (Hambantota to Kataragama) 2. Total length = 40 km	√	√	√	√	√						3.6, 3.9, 9.1, 11.2

NDC 9 - Promote Electric Mobility & Hybrid Vehicles

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
9.1: Increase tax concessions for electric & hybrid vehicles	MoF	MoT, SLC	1. Tax concessions for electric & hybrid vehicles 2. % of new registration of EVs 3. % of new	Gazette Records from MoF, SLC	1. No tax concession 2. EVs: 0.17% all vehicles categories; 0.37% of cars; 0.17% 2Ws, 0% 3Ws	Targets to be established	√	√	√								3.9, 7.3, 7.a, 11.6

			registration of hybrid vehicles		3. Hybrids: 0.82% all vehicles categories; 7.85% of cars; 0% 2Ws, 0% 3Ws												
9.2: Facilitate supportive infrastructure developments. Suh as charging stations, battery swapping & replacements	MoT	MoF, MoE, MoP&E, CEB, SLSEA, CEA, UDA, LAs	1. Number of charging stations 2. Number of battery swapping stations	Records of MoT	1. Changing stations: CEB – 7 and Private sector – 52 2. Battery swapping stations: None	1. CEB – Additional 10 by 2023 and SLSEA - 90 solar PV assisted charging stations by 2024 2. Target for battery swapping stations is to established	√	√	√								3.9, 7.3, 7.a, 11.6
9.3: Tax & Duty concessions for batteries used for electric and hybrid vehicles after introducing a specific HS code	MoF	MoT, MoE, SLC	Number of batteries import using new HS code	Records from MoF, SLC	HS Code was not established)	4,000 Electric car batteries by 2023	√	√	√								3.9, 7.3, 7.a, 11.6

NDC 10 - Improve Vehicle Fleet Efficiency

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
10.1: Improve efficiencies of existing vehicle fleet (e.g three-wheelers,	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

passenger cars, buses)																	
10.1.1: Inspection & Maintenance	DMT	MoT, SMoT, SLTrB, Academia and Vocational Training Institutions, Private Service Providers	1. % No of vehicles disqualified at the pre-testing stage on SLVET 2. % No of vehicles failed at the first test of SLVET	Records of DMT, SLVET project office	1. Baseline to be established 2. 17%	1. Target to be established 2. 10% by 2025	√	√	√	√	√						7.3, 7.a
10.1.2: Vehicle Emission Testing (improvement to be suggested with further random on-road testing)	DMT	MoF, MoT, MoE, CEA, SLVET Operators	1. Upgraded vehicle emission testing scheme 2. Percentage of vehicles out of total vehicle fleet inspected annually through random road tests annually	Records of DMT, SLVET project office	1. Conventional no-load test 2. 0.06% annual random road tests	1. Introduction of a new emissions testing methodology (VET 2.0) by 2025 2. 1 % annual random road tests by 2025	√	√	√	√	√						3.9, 7.3, 7.a, 11.6
10.1.3: Introduction of road worthiness test	DMT	MoT, IRCSL, AAC, Insurance Agencies	No of vehicle classes covered under mandatory road worthiness test	Records of SLP, DMT, Insurance Records.	Only commercial vehicles	All vehicle classes by 2030	√	√	√	√	√	√	√	√	√	√	3.9, 7.3, 7.a, 11.6
10.1.4: Introduction of garage improvement programme	DMT	CEA, Academia and Vocational Training	Percentage of Accredited garages out of registered garages	Data sources: CEA, LAs for EPL	No accreditation programme of garages	25% accredited garages Island wide under garage accreditation	√	√	√	√	√						7.3, 7.a, 8.3

		Institutions				programme by 2025											
10.1.5: Introduction of criteria for disposal of inefficient (unworthy) vehicles (Vehicle scrappage programme)	DMT	MoF, MoT, MoE, CEA, IRCSL, Insurance Agencies	Number of vehicle classes covered under the scrappage programme	Records of DMT, SLVET project office	No programme	All vehicle classes by 2030	√	√	√	√	√	√	√	√	√	√	3.9, 7.3, 7.a, 11.6
10.2: Promote the import of fuel-efficient vehicles (e.g. light duty vehicles)																	
10.2.1: Introduce emission standards for vehicle importation	MoE	MoF, MoT, DoI&EC, SLC, DMT, CEA, SLSEA, CPC, SLSI, Academia	Emission standards for vehicle importation	MoF gazettes, Records of DMT	Already gazetted (in 2018)	Updates in every 5-years (next update in 2023)	√	√	√	√	√	√	√	√	√	√	3.9, 7.3, 7.a, 11.6
10.2.2: Introduce fuel economy labelling programme	SLSEA	MoT, MoE, SLSI, DMT, CEA,	Number of fuel economy labels introduced.	Records of SLSEA, SLSI	A baseline study has been initiated by CleanAir SL with the assistance of UNEP and GFEI	Six by 2025 (LDVs, HDVs, and EVs)	√	√	√	√	√						3.9, 7.3, 7.a, 11.6
10.2.3: Introduction of tax concessions for fuel efficient vehicle imports	MoF	MoT, MoE, DoI&EC, SLC, IRD, DMT, SLSEA, CPC, SLSI, Academia	Number of vehicle classes covered under tax concession scheme based on fuel	MoF gazettes; Records of SLC	Conventional tax structure based on engine capacity (CC) and vehicle	All vehicle classes by 2025	√	√	√	√	√						3.9, 7.3, 7.a, 11.6

			economy.		class but not based on fuel economy. However differential tax system in favour of EVs and hybrid vehicle in place												
10.3: Introduce programmes to change driver behaviours	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10.3.1: Improve driving licensing mechanism	DMT	MoT, SLP	1. Improved driving licensing mechanism/test incorporating evaluation criteria related to eco-driving 2. No of districts where simulators/ tracks are installed	Records of DMT	1. to be initiated 2. None	1. Improved driving licensing mechanism by 2023 2. All the districts having simulators/ tracks by 2025	√	√	√	√	√						3.6, 7.3, 8.3
10.3.2: Implement demerit programme for driving license	DMT	MoT, SLP	1. Effective demerit programme /penalty scheme for driving license 2. Number of cases reported	Records of DMT, SLP, Court records.	No programme/scheme	1. Effective demerit programme /penalty scheme by 2024 2. Target for the number of			√	√							3.6, 7.3

			annually			cases to be established											
10.3.3: Introduce training on eco-driving	DMT	MoT, Driving license schools, SLP, Academia and Vocational Training Institutions	1. No. of awareness and training programmes for drivers and general public conducted per year 2. Module on eco-driving introduced to driver training institutions	Records of DMT	1, Some awarenes s program mes were conducte d, but not under a structure d plan 2. No module introduce d	1. 20 programme per year from 2024; 2. Module on eco-driving introduced by 2024	√	√	√	√	√	√	√	√	√	√	3.6, 7.3

NDC 11 - Road infrastructure development

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
11.1: Development of provincial and rural road infrastructure for improved mobility	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11.1.1: Resurface and modernize provincial and rural road network	RDA	Ministry in-Charge of RDA, Min in-Charge of Rural Roads, UDA, PCs, LAs, PDRAs,	Length of provincial and rural road network resurfaced and modernized	Records of RDA, PDRAs, PCs, LAs	None	iRoad – Rural Road - 6430km and 100,000 km developments by 2025; 7,411 km Road Lengths to be	√	√	√	√	√						3.9, 7.3, 9.1, 11.2, 11.6

						overlayed and 2,550 km of Road lengths to be widened & improved by 2030 and Inclusive connectivity and Development project (ICDP) 1200km										
11.2: Expansion of expressway network	Min in-charge of highways	MoT, RDA, Private Investors/Developers, Stakeholders of PPP Arrangements	Length of expressway roads developed	Records of Min in-charge of highways, RDA	272 km (Four expressways: Kottawa-Mattala (E01); Colombo-Katunayaka (E03); Outer Circular Highway (E02) Kottawa-Kelawarapitiya; Andarawewa – Hambanthota). Port Access Expressway (New kalani Bridge to	529.5 (additional 257.5 km through Central Expressway; Ruwanpura; Expressway and Extension of Colombo-Katunayake Expressway up to Kochchikade – to be commenced in 2025)	√	√	√	√	√	√	√	√	√	3.9, 7.3, 9.1, 11.2, 11.6

					church at port – 5.7km Elevated Expressway from New Kalani Bridge to Athurugiriya -16.4km Marine Drive Expressway from Port Access Expressway to Kollupitiya – 3.2km											

NDC 12 - Reduce GHG Emission from the Marine Sector

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
12.1: Ratification of Annex VI of MARPOL convention and promulgation of necessary legislation to enforce provisions of Annex VI in Sri Lanka	MEPA	Min in-charge of MEPA, MoPorts, MSS, SLPA	Annex VI of MARPOL convention ratified and regulations are implemented	Records of Ministries in-charge of Ports and Shipping, MEPA	Annex I to V of MARPOL Convention have been ratified, but Annex VI is not yet	Annex VI ratified	√	√	√	√	√						3.9, 7.3, 11.6

					(discussion in progress)												
12.2: Study the impact of shipping on GHG emission (coastal traffic and ports) depending on evidence-based information and introduce measures to address the issues	MEPA	MoE, MoPorts, Min in-charge of MEPA, SLPA, MSS, CEA, Academia	Impact of shipping on GHG emission studied/published	Records of Min in-charge of Ports and Shipping, MEPA & MoE	None (No study or programme started, lack of access to data and limited collaborations with other stakeholders are barriers)	GHG Emission estimates are published by 2025	√	√	√	√	√						3.9, 7.3, 11.6, 12.4
12.3: Promote sea transportation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12.3.1: Introduce and promote coastal shipping for freight and passenger transport	MoPorts	MoT, Min in-charge of MEPA, MoD, SLPA, MSS, CSC, MEPA SLN, SLCG	1. Number of containers (20 or 40ft) transported per year, 2. Tonnage transported 3. Number of passengers transported	Records of SLPA	Baselines to be established	Targets to be established	√	√	√	√	√	√	√	√	√	√	3.9, 7.3, 11.6
12.4: Introduction of energy efficiency measures and fuel quality improvement programmes to coastal shipping and fishing boats & vessels	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

12.4.1: Energy efficiency improvement programmes for Vessels & Boats	SLSEA	MoP&E, MoEn, MoPorts, MoFish, CPC, MEPA, SLPA, DoF, SLN, CC&CRMD, CSC, MSS, CEB, Academia	Number of awareness and training programmes conducted per year	Records of SLSEA, SLPA, MoFish, DoF, MSS	None	12 per year during 2023-2030	-	-	√	√	√	√	√	√	√	√	3.9, 7.3, 7.a, 11.6
12.4.2: Energy efficiency improvement programmes for ports/ port operations	SLSEA	MoP&E, MoE, MoFish, MoPorts, CPC, MEPA, SLPA,CSC, DoF, SLN, CC&CRMD, MSS, CEB, Academia	Number of awareness and training programmes conducted per year	Records of SLSEA, SLPA, MoFish, DoF, MSS	None	12 per year during 2023-2030			√	√	√	√	√	√	√	√	3.9, 7.3, 7.a, 11.6

NDC 13 - Supportive Policy Framework and Activities																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
13.1: Introduce new national policy or make amendments to relevant existing policies to promote electric mobility and hybrid vehicles	MoT	MoE, MoP&E, CPC, SLSEA, CEB, RDA, UDA, SLP, NTC, DMT, SLTrB, SLR, LAs, Private sector Transport	National Transport policy	Gazette	Draft Policy	Approved policy by 2023	√	√	√								3.9, 7.3, 7.a, 11.6

		Operators															
13.2: Introduce fuel-based carbon tax	MoF	MoT, MoE, CPC, SLSEA, NTC, DMT	Fuel-based carbon tax	MoF gazettes	None	Fuel-based carbon tax introduced from 2025	-	-	-	-	-	√	√	√	√	√	3.9, 7.3, 11.6
13.3: Include climate change measures (adaptation & mitigation) in maritime policy making	MoPorts	MoE, MoD, SLPA, MEPA, SLN, CEA, MSC, SLCG	Climate change measures incorporated in maritime policy	Ministry of Ports & Shipping	Baseline to be establishe d	Target to be established	√	√	√								11.6

3.4 Industry Sector

Industries play a pivotal role in economic growth, export drive, income generation, job creation, and poverty reduction. The industrial survey conducted in 2016 by the Department of Census and Statistics reported that there are 20,737 industrial establishments[24] in Sri Lanka, where manufacturing is the largest segment with 17,719 units. According to the Central Bank Annual Report 2019, industrial production is the second largest contributor to the GDP (26.4%) after the service sector (57.4%); it employs 27.6% of the country's workforce. Textile, apparel, and tea manufacturing are the most significant export-oriented sub-sectors.

As per the Energy Balance 2019 of Sri Lanka Sustainable Energy Authority, the energy required for the industry sector came from three key sources viz biomass (74.4%), fossil fuel - petroleum oil and coal (10.4%), and electricity (15.2%). Biomass is used in tea and rubber factories, bakeries, tile and brick industries, and other micro and small-scale industries. The primary use of fossil fuels is for operating boilers, ovens, and furnaces. The key industries contributing to GHG emissions include cement manufacturing, lime production (for the construction industry), and the industries using limestone and soda ash. However, compared to emissions from industrial energy consumption, industrial processes generate relatively low levels of GHG emissions.

As serious initiatives are underway by major economies to decarbonize their economies, integrating climate change and environmental considerations will be critical for Sri Lanka's industrial development strategy to be relevant and competitive in a rapidly changing global economy.

The GoSL is focusing on creating a globally competitive, high-value-added, innovative, technology- and knowledge-based industry with a minimal adverse impact on the environment that could boost investor confidence, ensure higher export revenues, and achieve sustainable development. Reflecting on this new direction, the Ministry of Industries is now formulating a National Policy for Industrial Development (NaPID) and a five-year Strategic Implementation Plan to operationalize the NaPID.

Alongside this, the Ministry of Industries is exploring the possibility of implementing the following industry sector NDCs (see *Table 3-4*) through the design and implementation of policy, as well as regulatory, technical & financial mechanisms, and tools to accelerate the deployment of RE, energy & resource-efficient technologies, and best practices.

These NDCs will enhance mitigation ambitions while embracing and incorporating resource efficiency, circular economy, and other internationally acclaimed concepts. It is noted that these NDCs are directly or indirectly addressing energy-consumption-based emissions as there are limited avenues and reliable data sources to account for Industrial Process and Product Use (IPPU) related actions.

Table 3-4 NDCs of Industry Sector

NDC #	NDC

[24] *Annual Survey of Industries (2018),Department of Census and Statistics.*

1	Continue fuel-switching to sustainable biomass energy and improve user efficiency
2	Enhance the application of "Resource Efficient Cleaner Production" (RECP) practices
3	Establish Eco-industrial parks
4	Introduce "Circular Economy" concept
5	Introduce "Tri-generation" facilities
6	Incentivize GHG reduction of clinker production in the cement industry
7	Introduce generic enabling activities

It is expected that these NDCs for 2021 to 2030 will reduce GHG emissions against the BAU scenario by 7% in the industry sector (4% unconditionally and 3% conditionally) equivalent to an estimated mitigation level of 2,088,000 MT unconditionally and 1,482,000 MT conditionally (total of 3,570,000 MT) of carbon dioxide equivalent during that period (Figure 3-5). It should be noted that there are additional emission reductions from various initiatives which are difficult to be accounted for as no systematic reporting/accounting arrangement is yet in place.

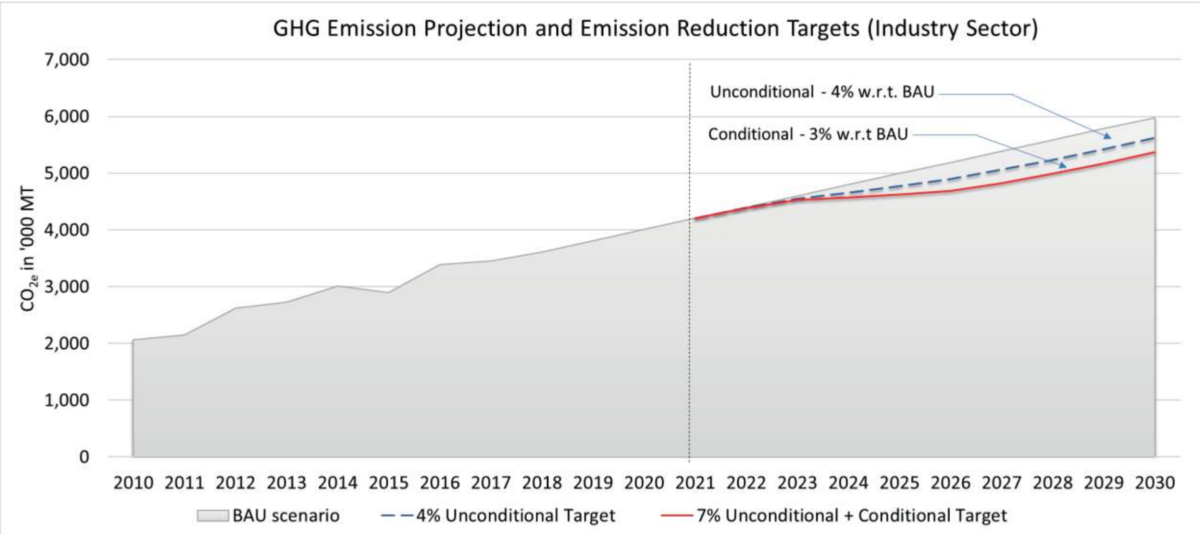


Figure 3-5 Industry Sector GHG Emission Projection and Emission Reduction Targets

3.4.1 Industry Sector NDC Implementation Plan

NDC 1 - Continue fuel switching to sustainable biomass energy & improve user efficiency in selected industrial subsectors such as tea, rubber, apparel, hotel & tourism, rice processing, etc.

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1: Conversion of industry furnaces to steam boilers and hot-water systems, and continued use of sustainable biomass energy in the industry	SLSEA	MoI MoP&E, SLTB, TRI, SLTDA, CIAs	Number of industrial boiler conversions	Through NEEA applications, ESCO & boiler supplier records	500	90	√	√	√	√	√	√	√	√	√	√	7.2
1.2: Biomass user efficiency improvement in industry (SMIs and Large) – Across industry sub sectors	SLSEA	MoI, MoP, SLTB, TRI, SLTDA, CIAs, SLSI	Number of improvements, Feed quality Standard	Through NEEA applications, ESCO & boiler supplier records	500	300	√	√	√	√	√	√	√	√	√	√	7.2 & 7.3
1.2.1: Improve biomass feedstock quality (type, size, dryness, storage, etc.) through standardization	Contributions of sub activities 1.2.1 to 1.2.3 are reflected in the main activity 1.2 and hence the details of sub activities are not provided in this implementation plan. However, stakeholder agency (in this case SLSEA) responsible for the implementation of these subactivities is expected to develop its own comprehensive action plans for the same in line with its institutional framework.-																
1.2.2: Energy efficiency improvement by O&M and system design improvements (Including flue gas recirculation, Air preheaters)																	
1.3: Introduce biomass co-generation (heating & cooling) in industries	SLSEA	MoI, SLTDA, CIAs	Number of systems installed	SLSEA records	4	25	√	√	√	√	√	√	√	√	√	√	7.2 & 7.3
1.4: Switching fossil fuel fired thermal energy generators to biomass energy in government institutions for thermal energy requirements – Biomass fired hot water heaters in hospitals, prisons, arm forces, hostels, universities, etc.	SLSEA	MoH, MoD, MoEd	Number of hot water systems installed	SLSEA records	25	192	√	√	√	√	√	√	√	√	√	√	7.2

NDC 2 - Enhance the application of Resource Efficient Cleaner Production (RECP) practices in selected industrial sub sectors																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Conduct RECP and energy audits and develop baselines based on industry classifications & importance	MoI	NCPC, SLSEA, SLEMA, BOI, Service providers of SCP & EE	Percentage and number of industries CP & energy audits conducted	Records of MoI	300 (Out of 3,000 to 5,000 industries , Source - NCPC and CEA)	25% relevant industries (Around 500)	√	√	√	√	√						9.4
2.2: Adopt RECP practices including low carbon technologies and processes	MoI	MoPC&LG, NCPC, IDB, CDA, RRI, ITI, Service providers of WM, CIAs	Number of industries adopting RECP practices and acquiring low carbon technologies and processes	Records of MoI	250	400 out of 500 above targets	√	√	√	√	√	√	√	√	√	√	6.2, 6.3, 6.4, 7.2, 7.3, 8.4, 8.8, 9.4, 12.2, 12.4 & 12.5
2.3: Improve water use efficiency in selected industrial subsectors	MoI	MoPC&LG, NCPC, SLSEA, IDB, CDA, RRI, CIAs	Percentage of relevant industries engaged	Records of MoI	100	50% relevant industries (such as Agro based industries: Food & Beverages, dairy, fish processing, Dessicated Coconut, textile finishing, etc.)	√	√	√	√	√	√	√	√	√	√	6.4
2.4: Promote energy efficient	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

appliances & technologies for selected industrial sub-sectors:																	
2.4.1: High-Efficient Motors (HEM) for water sector (focusing National Water Supply and Drainage Board)	NWSDB	SLSEA	Energy saving from High-Efficient Motors (HEM)	Records of NWSDB	775 GWh	18 GWh per year (2.25% reduction)	√	√	√	√	√	√	√	√	√	√	7.3
2.4.2: Variable Frequency Drives (VFD) for appropriate industries (focusing tea industry)	SLSEA	SLTB, TRI	Energy saving from Variable Frequency Drives (VFD)	ESCO records through SLSEA & MoI	590 GWh (Facilitated by Energy NAMA Project)	2,900 GWh	√	√	√	√	√	√	√	√	√	√	7.4
2.4.3: Efficient chillers & refrigeration technologies (replacement) for supermarkets, textile and apparel, hotel, dairy sectors	SLSEA	MoI, MoP&E, BOI, RISC, IDB, ISB, LINDEL, UDA, NCPC, NERDC, GBCSL, CIAs	Energy saving from efficient chillers & refrigeration technologies	ESCO records through SLSEA & MoI	1,300 GWh	170 GWh	√	√	√	√	√	√	√	√	√	√	7.5
2.5: Waste minimization, waste management, resource recovery & residual (sludge & sewage) processing while enhancing resource efficiency in selected industrial subsectors (such as coconut, food industry)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.5.1: Promote wastewater treatment with optimum water reuse possibilities for Food & Beverage, dairy, rice, and other water-based industries	MoI	MoPC&LG,, NCPC, IDB, CDA, RRI, ITI, Service providers of WM, Relevant CIAs	Percentage of relevant industries engaged	Industrial database of CEA	1,500	50% relevant industries	√	√	√	√	√	√	√	√	√	√	9.4
2.5.2: Promote sewage treatment (with optimum water reuse possibilities) facilities for hotel, apartment complex, garment and apparel and other potential industries (on-site and	MoI	MoPC&LG NCPC, IDB, CDA, RRI, ITI, Service providers of	Percentage of relevant industries engaged	Industrial database of CEA	Treatment plants including sewage	50% relevant industries	√	√	√	√	√	√	√	√	√	√	9.4

centralized)		WM, Relevant CIAs			Garment & Apparel – 715, Food & Beverage – 3,952, Hotels & Apartment complexes – 2,171 (From CEA EPL database)												
2.5.3: Encourage biodegradable waste treatments (composting and biogas) where applicable	MoI	MoPC&LG, NCPC, IDB, CDA, RRI, ITI, NSWMSC, Service providers of WM, Relevant CIAs	Percentage of relevant industries engaged	EPL database of CEA	According to CEA, as at May 2019, 119 composting projects were in operation out of 137 composting projects assisted by the Pilisaru programme in Local Authorities No data	60% relevant industries	√	√	√	√	√	√	√	√	√	√	7.2 & 9.4

					available in the industry sector and hence baseline to be established												
2.5.4: Minimizing packaging, raw material & rejections, etc.	MoI	NCPC, IDB, CDA, RRI, ITI, Service providers of WM, Relevant CIAs, SLIP	Percentage of relevant industries engaged	BOI, CEA, SLIP records	70% of BOI industries have already minimized packaging to the extent possible	70% relevant industries	√	√	√	√	√	√	√	√	√	√	9.4
2.5.5: Minimizing chemical use	MoI	NCPC, IDB, CDA, RRI, ITI, Service providers of WM, Relevant CIAs	Percentage of relevant industries engaged	CEA, BOI records	25% of BOI industries	70% relevant industries	√	√	√	√	√	√	√	√	√	√	12.4
2.5.6: Adopt low carbon technologies and processes for improved resource efficiency	MoI	Technology providers, Relevant CIAs	Percentage of relevant industries engaged	To be identified	Baseline to be established	70% relevant industries	√	√	√	√	√	√	√	√	√	√	9.4
2.5.7: Promote VOC emission controlling system for painting industry, tire factories & printing industries.	CEA	BOI, MoI, IDB, ISB, RISC, NCPC	Percentage of relevant industries engaged	CEA EPL database	No data available in the industry sector and hence baseline to be establishe	30% relevant industries	√	√	√	√	√	√	√	√	√	√	12.4

					d											
2.5.8: Introduce waste heat recovery systems for rice milling & textile finishing, ceramics	SLSEA	MoI, Service providers of Energy, Relevant CIAs	Number of systems installed	SLSEA records	Baseline to be established after carrying out a potential identification survey	Targets to be established after carrying out a potential identification survey	√	√	√	√	√	√	√	√	√	√	7.3

NDC 3 - Establish eco-industrial parks and eco-industrial villages

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1: Transform existing IPs, incorporating maximum possible green industrial concepts	BOI, MoI	RISC, IDB, ISB, LINDEL, UDA	Number of existing BOI EPZs transformed to eco IPs, Percentage of existing non-BOI IPs transformed to eco IPs	Records of IP operators	0	04 (BOI to upgrade existing infrastructure of waste water treatment plants in Seethawaka, Horana, Koggala & Mawathagama EPZs), 50% Non-BOI IPs	√	√	√	√	√	√	√	√	√	√	9.4
3.1.1: Conduct a survey of all existing IPs to assess the present level of resource efficiency and the adoption of SCP best practices	- - Contributions of sub activities 3.1.1 to 3.1.10 are reflected in the main activity 3.1 and hence the details of sub activities are not provided in this implementation plan. However, stakeholder agencies responsible for the implementation of these subactivities is expected to develop its						-	-	-	-	-	-	-	-	-	-	-
3.1.2: Establish criteria for eco-							-	-	-	-	-	-	-	-	-	-	-

industrial park establishment	own comprehensive action plans for the same in line with its institutional framework.--											
3.1.3: Review and improve the existing designs and optimize guidelines for IPs, including environmental, economic, and social standards	- - - -	-	-	-	-	-	-	-	-	-	-	-
3.1.4: Search & adapt innovative concepts of other countries (D4S, eco innovation, LCA, circular economy, eco-certification system and digital economy, etc.)	- - - - -	-	-	-	-	-	-	-	-	-	-	-
3.1.5: Design & implement improved energy, water and material efficiency, and circular economy measures for IPs which would engage SMIs	- - - -	-	-	-	-	-	-	-	-	-	-	-
3.1.6: Introduce holistic waste management (Solid, liquid and gaseous) approach including minimization of waste generation	- - - -	-	-	-	-	-	-	-	-	-	-	-
3.1.7: Retrofit existing infrastructures of SMIs & redesigning processes aligned with SCP and Green Concepts	- - -	-	-	-	-	-	-	-	-	-	-	-
3.1.8: Prepare SMIs for digital economy (networking between key stakeholders & SMIs through data sharing, self-certificate & monitoring)	- - - -	-	-	-	-	-	-	-	-	-	-	-
3.1.9: Assist the development of site-specific designing and planning based on experience of other countries for 1 or 2 Eco-IP sites earmarked by the government	- - - - -	-	-	-	-	-	-	-	-	-	-	-
3.1.10: Establish pilot Eco-IP at suitable locations under the Ministry in charge of Industries,	- - - - - - - - - - - -	-	-	-	-	-	-	-	-	-	-	-

	- - - - - - - - - - - - - - - -																
3.2: Introduce policy and regulatory regime, including guidelines to ensure all new IPs will be set up as Eco-IPs.																	
3.2.1: Develop standards and guidelines based on best international practices for setting up future Eco-IPS	MoI	MoE, CEA, BOI, RISC, IDB, ISB, UDA, LINDEL, CIAs	Policy package for Eco-IPs	Records of MoI	0	Policy package for Eco-IPs introduced	√	√	√	√							9.4

NDC 4 - Introduce Circular Economy concept to selected industrial subsectors or selected industrial zones																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	

4.1: Conduct a survey to identify and determine the potential subsectors to implement circular economy concept	MoI	BOI, RISC, IDB, NEDA, ISB, LINDEL, UDA, Service providers of SCP & WM, CIAs	Number of industries & sub sectors identified for circular economy	Records of MoI	No data available	All relevant industries	√	√									9.4, 12.4 & 12.5
4.2: introduce the life cycle approach for selected subsectors for greening the supply chain	MoI	NCPC, Service providers of SCP, CIAs	Percentage of sub sectors & industries engaged in greening the supply chain, Pilot demonstration project	Records of MoI, (NCPC, UoM, UoP, UoJP)	15 (Conducted by NCPC, UoM, UoP, UoJP)	100	√	√	√	√	√	√	√	√	√	√	12.4
4.3: Practice Industrial symbiosis concept in selected industrial parks or industrial subsectors (Agro-based, Apparel, Metal, etc.)	MoI	BOI, RISC, IDB, NEDA, ISB, UDA, LINDEL, Service provider of SCP & WM, Academia	Number of sub sectors & new IPs adopted industrial symbiosis	Records of MoI	Less than 10	All sub sectors & new IPs	√	√	√	√	√	√	√	√	√	√	9.4
4.4: Establish a pilot project on the zero-waste concept in selected industrial parks or industrial subsectors	MoI	BOI, RISC, IDB, NEDA, ISB, LINDEL, UDA, SCP & WM service providers, Academia	Number of zero waste pilots in sub sectors	Records of MoI	A few from apparel and hotel industries	10 industrial subsectors	√	√	√	√	√						9.4, 12.4 & 12.5
4.5: Adopt ISO standards for circular economy concept (ISO/TC 323)	SLSI	MoI, BOI, RISC, IDB, NEDA, ISB, LINDEL, UDA, Service providers of SCP & WM, CIAs	Percentage of industries adopted ISO/ITC 323	SLSI records	None	70% relevant industries	√	√	√	√	√	√	√	√	√	√	9.4, 12.4 & 12.5
4.6: Build industry capacity to adopt	MoI	NCPC, SCP	Percentage of	Records of	10% of	70%	√	√	√	√	√	√	√	√	√	√	9.4, 12.4

circular economy concept		& Service providers of WM, CIAs, Academia	industries adopted circular economy concept	MoI	industries	relevant industries											& 12.7

NDC 5 - Introduce Tri-generation facilities to selected industrial parks

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
5.1: Carry out a rapid assessment of tri-generation potential in 10 industrial parks	SLSEA	BOI, MoI, Academia	Number of rapid assessments completed	Records of SLSEA	1	9	√	√	√	√							7.2 & 7.3
5.2: Carry out a detailed assessment in one of the BoI industrial parks for piloting at Biyagama export processing zone - EPZ	SLSEA	BOI	Detailed assessment	Records of SLSEA	None	Detailed assessment completed	√	√									7.2 & 7.4
5.3: Develop business models and funding options	BOI	MoI, SLSEA	Business models and funding options	BOI records	None	3 Business models and funding options completed		√	√								7.2 & 7.5
5.4: Implement one tri-generation facility as a pilot project	BOI	SLSEA	Pilot tri-generation facility	BOI records	None	1 Pilot tri-generation facility established at Biyagama				√	√	√	√				7.2 & 7.6
5.5: Depending on the success of the pilot project, expand it into BoI and other industrial parks and other prospective applications	BOI	MoI, SLSEA, CIAs	Number of tri- generation facilities established	Records of MoI, SLSEA, CIAs	None	5								√	√	√	7.2 & 7.7
5.6: Make provisions through policy instruments to have tri-generation for new industrial zones	MoI	SLSEA, CIAs	Policy package	Records of MoI	None	Policy package introduced								√	√	√	7.2 & 7.8

NDC 6 - GHG reduction of clinker production in the Cement industry

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
6.1: Make necessary amendments to SLSI standards for cement production enabling the increase of ash and other similar materials as substitutes for clinker in line with industry standards / trends worldwide (GHG reduction through the avoided production of clinker)	SLSI	Relevant cement industry, MoI, MoE, CEA	Introduction of relevant standards, GHG reduction	Records of SLSI, Relevant cement industry	Existing SLSI standard	Two relevant standards already introduced but the awareness of prospective users needs to be created. Percentage and absolute amount of GHG reduction	√										9.4, 12.2, 12.4 & 12.5

NDC 7- Introduce NDC Support Policy Tools and Instruments (Enabling generic activities)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					20	20	20	20	20	20	20	20	20	20	

							21	22	23	24	25	26	27	28	29	30	
7.1: Facilitate industries in selected sub sectors to adopt relevant ISO systems having a focus on GHG emission reduction such as ISO 50001 & ISO 14064-1 (updated) (Subsectors: Tea, Garment and Apparel, Food processing, etc.)	MoI	SLSI, BOI, RISC, IDB, NEDA, ISB, UDA, LINDEL, NCPC, Service providers of EE, SCP & WM, CIAs	Percentage of industries adopting various ISO systems	NCPC records	100	25% relevant industries	√	√	√	√	√	√	√	√	√	√	7.3, 8.8, 9.4, 12.2, 12.4 & 12.5
7.2: Introduce and promote suitable tax incentives such as double deduction to promote the acquiring of sustainable technologies	MoI	MoF	Financial and non-financial incentives	MoI records	Baseline to be established	50% relevant industries	√	√	√	√							8.3 & 9.3
7.3: Facilitating the entry of environment related ISO certified companies to enter the Sustainable (Green) Public Procurement system of Sri Lanka	MoE (Env Planning & Economics Division)	MoI, MoF	Number & percentage of environment related ISO certified industries entering into Sustainable (Green) Public Procurement system	MoE & MoF records	None	Target to be established after introducing the Sustainable Public Procurement System	√	√	√	√	√	√	√	√	√	√	12.7
7.4: Facilitating transformational investment, favourable loans through financing institutions linking with green financing	MoI	MoF	Number & percentage of industries benefitting from green financing	MoI records	SMILE III Loan scheme – 2,997 projects and Rs 13,522.80 million from 2013 to 2020 E-Friends	SMILE III Loan scheme – Rs 1.5 billion per year E-Friends II Loan scheme – Rs 600 million per year	√	√	√	√	√	√	√	√	√	√	9.3

					II Loan scheme – 96 projects and Rs 935.75 million from 2018 to 2020												
7.5: Introduce a national policy to address siting of industrial parks and stand-alone industries, new concepts like circular economy, industry ecology, RECPs, digitalization, etc.	MoI	MoE, CEA, Relevant CIAs, Academia	Policy package	MoI records	None	Policy package strengthen	√	√	√	√							8.3 & 9.4
7.6 Ensure the availability of sustainable biomass for industry use																	
7.6.1: Ensure the availability of sustainable biomass for industry use through necessary facilitation and coordination with relevant policy making and regulatory authorities by adopting policy tools such as SLSI 1551	SLSEA	FD , MoP&E, MASL	Percentage of Industries having access to sustainable biomass	SLSEA records	Baseline to be established after introducing a mandatory reporting system	100% relevant industries	√	√	√	√	√	√	√	√	√	√	7.2
7.7: Promote National Green Reporting System (NGRS) as an encouragement for industries to embrace low carbon initiatives	MoE (Env Planning & Economics Division)	MoI, CEA, SLSEA, BOI, RISC, IDB, NEDA, ISB, LINDEL, UDA, NCPC, CCC, ITI, CIAs	Number of Green Reporters registered and reported	MoE records	Approximately 178 registered to date out of which less than 10 annual report submissions	20% annual increase of registrations and 50% annual report submissions	√	√	√	√	√	√	√	√	√	√	12.6

3.5 Waste Sector

People who live in urban areas are more directly and aggressively impacted by the waste sector's multifaceted impacts on human life. The efficiency of waste management directly impacts the environment, biodiversity, public health, society, and the economy. The waste sector plays an important role in several SDGs, including SDG 3 (Good health and well-being), SDG 11 (Sustainable Cities and Communities), and SDG 12. (Responsible Consumption and Production). Waste has long been a global problem, and by 2025, the amount of Municipal Solid Waste (MSW) produced daily per person is expected to reach 1.42 kg. Therefore, 2.2 billion tonnes of MSW will be produced annually by the 4.3 billion people who live in metropolitan areas[25].

It has estimated that Sri Lanka generates around 8,000 to 9,000 MT of Municipal Solid Waste (MSW) per day (equivalent to about 0.41 kg/capita/day) with the Western Province accounting for 3,500 MT (43%) of mass. Waste collection by local authorities is about 60% in the Western Province and 30% in other provinces[26]. With population growth, fast development of infrastructure, rapid urbanization, industrial growth, increase of per capita income, rise in living standards, changing lifestyle, and economic conditions, the generation of municipal solid waste is expected to increase in the decade from 2021 to 2030. However, due to the present downward global economic condition and temporary shrinking of the country's economy, significant changes in the waste generation and collection have been noted, which will reflect on the progress of the GHG mitigations estimated during 2021 and 2022. This situation may prevail during 2023 too. The limited coverage of proper waste collection mechanisms, inadequate infrastructure facility for waste collection, treatment, and final disposal, inadequate public awareness and commitment to waste management, and practical difficulties in the application of 3R principles are some of the underlying issues of the current waste management practices. Technologies and methods used for waste management are well accepted, however innovative technologies and strategies are yet to be introduced to streamline and modernize existing waste management practices.

At the national level, Sri Lanka has an institutional and regulatory framework with environment-related policies, strategies, and guidelines on waste management. Referring to the future outlook & GHG emissions reduction potential in the waste sector, the prioritized objectives of the recently approved National Policy on Waste Management (2019) are waste avoidance and reduction. The next level of management recommends the adoption of waste recycling and other forms of environmentally-sound disposal; re-use of unavoidable waste to the most acceptable extent possible; maintaining hazardous substances in waste at the lowest possible level and guaranteeing an environmentally sound residual waste treatment and disposal underlining the gradual shift from a waste generating socio-cultural regime to a new paradigm in which waste disposal is minimized in favor of reuse and reduced consumption. The National Action Plan for Plastic Waste Management 2021-2030 has identified the facilitation of collection of segregated plastic waste and recycling of plastic waste as a

[25] Bhada-Tata, P.H.; Daniel, A. What a Waste? A global review of solid waste management (English). In *Urban Development Series Knowledge Papers*; No. 15; World Bank Group: Washington, DC, USA, 2012.
[26] National Environment Action Plan 2022-2030 (NEAP)

profitable business to produce quality raw material for the plastic industry as a key activity of the plan.[27] The gazettes of 2006, 2017[28] and 2021[29] have highlighted the need to prohibit the use of polythene products less than 20microns, single-use-plastics, open-burning of polythene etc. Further, along with other measures, awareness through education and attitude change among the public is required to realize a sustainable waste management system. A long-term solution that addresses the issue of open dumping and creates economic/fiscal disincentives for waste generation is needed.

The Waste Management Authority of Western Province (WMA-WP) with the technical support of the JICA (Japan International Co-operation Agency) and with the consultation of other stakeholder institutes, the twenty-years (2022 to 2042) Master Plan for MSW management has been developed. In the MasterPlan, further reduction of waste generation by continually promoting the circular economy principles in waste management has been highlighted. Moreover, the targets have been fixed to optimize resource recovery by adopting technological options such as composting, recycling, and waste-to-energy. Hence, open burning and open dumping will be eliminated with the full implementation of the said master plan in the province.The guidelines for safe closure and rehabilitation of Municipal solid waste dumpsites in Sri Lanka (2021) further supports this effort[30].

In the Western Province, two private developers were granted permission for waste-to-energy generation projects with capacities of 700 and 500 MT/day. The first plant has been established at Kerawalapitity and it is in commercial operation at present, while the other project has been cancelled. Due to the operation of the first plant, 45% of collected burnable waste is used for energy recovery. However, there have been operational issues related to the quantity of waste available and electricity feed-in tariff that is not tagged to USD. Further, there are concerns on the impact of waste segregation and recycling, as the plant accept mixed waste.

In addition to three large-scale compost facilities which are operated by the WMA-WP, there are 27 composting facilities in operation and their total design capacity is 300 MT/day. Presently, about 12% of collected waste is composted through the above facilities, and out of the total waste collection, the percentage recycled by the Local Authorities (formal sector) is around 2%. Further, the amount recycled by the informal sector is four or five-fold higher than that of the formal sector. However, still, 40% of collected waste is openly dumped at 21 open dumpsites in the province.

In other provinces, recycling and composting are the main technologies adopted for material recovery in the daily waste stream. Among the composting facilities, there are nine (09) KAWASHIMA composting facilities with a capacity of 50 MT/day in each which are established by the Ministry of Local government.

The country faces challenges to management of several other major waste streams such as

[27] https://ccet.jp/sites/default/files/2021-08/srilanka_report_web_fin_pw.pdf
[28] Gazette No.2034/34 to 38 -2017.09.01
[29] Gazette No.2211/51 of 2021.01.21
[30] https://ccet.jp/publications/guidelines-safe-closure-and-rehabilitation-municipal-solid-waste-dumpsites-sri-lanka

electrical and electronic waste (e-waste), healthcare waste, construction and demolished waste, chemical and other hazardous waste due to lack of proper storage, treatment and disposal facilities. In case of e-waste, CEA maintains a list of licensed E-waste collectors. Yet the processing capabilities to ensure complete management and safe disposal of E-waste is limited. INSEE Ecocycle Lanka (Private) Limited (formally M/s Holcim Geocycle), possesses the only facility in the country capable for safe management of hazardous waste, through cement kiln co-processing. However, it cannot meet the country's total demand for hazardous waste disposal. The facility has been used for the disposal of part of the obsolete POPs accumulated over the last few decades, pesticides and contaminated products, and PCBs containing oil. Further, many local authorities send their segregated burnable waste to INSEE for co-processing. In case of healthcare waste, considerable efforts have been taken in the sector in promoting holistic waste management concepts. Though considerable progress is achieved in segregation of waste in majority of healthcare facilities, and introduction of treatment technologies (such as incineration and hybrid autoclave), there are issues related to proper operation of treatment facilities and disposal of residues/treated waste. Ministry of Health, with the assistance of international development partners, has initiated healthcare waste management programmes to address these issues.

The NDCs of the waste sector (given in *Table 3-5*) will enhance mitigation ambitions while embracing circular economy concepts spelled out in the national policies for Waste Management and Sustainable Consumption and Production (SCP).

Table 3-5 NDCs of Waste Sector

NDC #	NDC
1	Improve "Circular Economy" practices in all MSW generation sources
2	Manage biodegradable waste components through treatments
3	Introduce energy recovery using non-compostable non-recyclable waste which cannot be managed by other means
4	Use of sanitary landfill for the disposal of residues (non-compostable, non-recyclable, non-recoverable, and residues from waste to energy plants) will be increased from the current level of 5% to 100% on weight basis
5	Generic enabling activities

It is expected that the implementation of NDCs during the period of 2021 to 2030 will result in GHG emission reduction against the BAU scenario by 11% reduction in the waste sector (8.5% unconditionally and 2.5% conditionally) equivalent to an estimated GHG emissions reduction of 2,549,000 MT (1,969,000 MT unconditionally and 580,000 MT conditionally) of carbon dioxide equivalent during that period (see Figure 3-6).

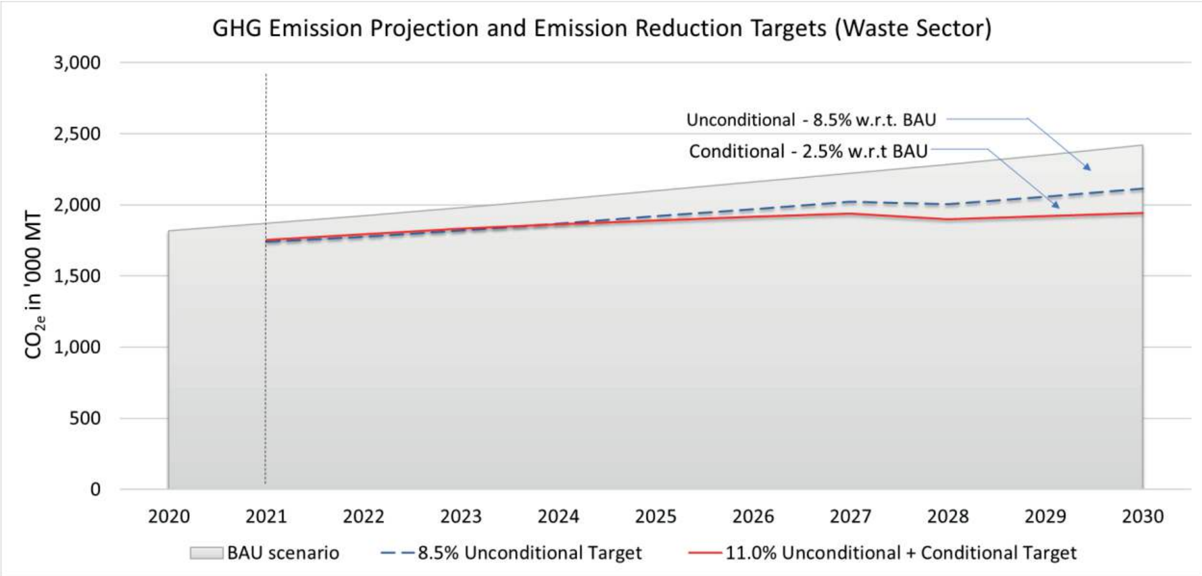


Figure 3-6 Waste Sector GHG Emission Projection and Reduction Targets

3.5.1 Waste Sector NDC Implementation Plan

NDC 1: Improve "Circular economy'' practices in all MSW generation sources

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1: Prevent, avoid or reduce MSW generation by reducing the growth rate by 10% and also total coverage for treatment and disposal of industry solid waste and effluents	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.1.1: Reduce MSW generation growth rate by 10 %	Ministry in Charge of PCs, and LAs	LAs, WP-WMA, NSWMSC, MoE, PCs	Reduction of waste generation growth rate	Derived from annual waste auditing - WP-WMA for WP, NSWMSC for other provinces	2% (The estimated MSW generation rate is around 7000MT/ day and the estimated annual generation growth rate is 2%)	1.8%	√	√	√	√	√	√	√	√	√	√	1.6, 3.9, 8.4, 12.2, 12.3, 12.5
1.1.2: Total coverage for treatment and disposal of industrial solid waste & effluent (Major industries; BOI Zones, non-BOI Industrial Parks, BOI approved standalone industries, other standalone industries and other SMEs)	MoI	MoE, BOI, IDB, RISC, UDA, ISB, LINDEL, CCC, CEA, LAs, NWPEA	The percentage covered of industrial solid waste & effluent treatment and disposal	Data Collection from CEA, BOI and other industry zone operator	**BOI** Solid waste generation rate in BOI zones are around 269 MT/day	100% coverage of Solid waste and industrial effluent generated.	√	√	√	√	√	√	√	√	√	√	3.9, 8.4, 9.4, 11.6, 12.2, 12.3,12.5

					and effluent generation is around 48,110 M^3/day **Others** Baseline to be identified												
1.2: Improve the segregation of MSW at source and increase number of segregation categories	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.2.1: Increase the level of waste segregation (perishable, non-perishables)	MoPC&LG	NSWMSC, LAs, PCs, WP-WMA	Percentage of waste segregation	Data source for WP - WP-WMA, Other Provinces NSWMSC	In the WP = 60% Other Provinces = 30% (average)	By 2025, WP=75% Other Provinces - 60% (average)	√	√	√	√	√						11.6, 12.3, 12.5
1.2.2: Increase number of waste segregation categories from 2 to 3 (perishable, potential recyclable, residual) at source	MoPC&LG	NSWMSC, WP-WMA, LAs,	Number of LAs those who have increased their waste segregation categories from 2 to 3	Data source for WP - WP-WMA Other Provinces - NSWMSC	In the WP = 30 number of LAs in 2020 In other Provinces = 60 number of LAs in 2020	All LAs by 2027	√	√	√	√	√	√	√				11.6, 12.4, 12.6
1.3: Improve MSW collection & transportation systems (With appropriate infrastructure facilities through investments in: Vehicles, Transfer stations, Collection centers, Technology: Route-planning, GPS monitoring,	MoPC&LG	NSWMSC, LAs, PCs, WP-WMA, UDA	Percentage of Population covered by the waste collection services	WP – WP-WMA Other provinces - NSWMSC	WP = 60% (MC = 65%, UC = 72%, PS = 32%)	WP = 75% Other Provinces = 60%	√	√	√	√	√	√	√	√	√	√	9.a, 11.6, 12.5

Capacity Building)					Other provinces = 30%											
1.4: Improve waste recycling of LAs on collection basis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.4.1: Increase current recycling percentage in Western Province (Trash reverse vending machines, New tech separators, etc. Streamline collections. Waste collection, segregation centers, etc.)	MoPC&LG	NSWMSC, Private Sector recyclers and collectors, Brand owners	Percentage of formal waste recycled by LAs (on collection basis) and the amount of recycling through the informal sector MT/day	Data bases of WP-WMA and CEA, CCC	Formal Recycling % =2% (32 MT/day) (LAs on-collection basis) Informal Recycling 40MT/day	Formal Recycling % = 7% (116 MT/day) Informal Recycling 150MT/day	√	√	√	√	√	√	√	√	√	√	3.9, 8.4, 12.2,12.5 ,
1.4.2: Increase recycling percentage of the rest of the country	MoPC&LG	MoE, CEA, NSWMSC, NWPEA, Private Sector recyclers and collectors, Brand owners	Percentage of formal waste recycled by LAs (on collection basis) and the amount of recycling through the informal sector in MT/day	Data bases of WP-WMA and CEA, CCC	Formal Recycling % = 1.0% (LAs on-collection basis) and the Informal Recycling 20 MT/day	Formal Recycling % = 5% (LAs on-collection basis) and the target for the Informal Recycling minimum 100MT/day	√	√	√	√	√	√	√	√	√	√	3.9, 8.4, 12.2,12.5
1.4.3: Ensure recycling of Polyethylene Terephthalate (**PET**) bottles	CEA	MoPC&LG, MoE, CCC, WP-WMA, NSWMSC, NWPEA	% of PET recovery by weight	CCC/CEA data bases	30% by weight	80% by weight	√	√	√	√	√	√	√	√	√	√	3.9, 8.4, 12.2,12.5
1.4.4: Ensure recycling of High Impact Polystyrene (**HIPS**) cups - (Collection of 960 MT per year)	CEA	MoPC&LG, MoE, CCC, WP-WMA, NSWMSC, NWPEA	% of HIPS recovery by weight	CCC/CEA data bases	3% by weight	15% by weight	√	√	√	√	√	√	√	√	√	√	3.9, 8.4, 12.2,12.5
1.4.5: Ensure recycling of Tetra packs,	CEA	MoPC&LG,	% of recovery	CCC/CEA	0.01% by	15% by	√	√	√	√	√	√	√	√	√	√	3.9, 8.4,

metallized films and other recyclable packaging materials		MoE, CCC, WP-WMA, NSWMSC, NWPEA	by weight	data bases	weight	weight											12.2,12.5
1.5: Implement regulatory framework to control high waste generating products	CEA	MoE, MoI, MoH, LAs, CCC, CAASL, SLSI,SLIP, I TI, Environment Police	Number of Products regulated	CEA	Number of products already regulated 7	By 2023 total number of products regulated 15	√	√	√								9.4,12.5

NDC 2: Manage Biodegradable waste components through biological treatments

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Apply composting as a priority treatment for the management of biodegradable wastes (increase the present level of compost preparation from 15% to 30% in WP and from 3% to 30% in other provinces by 2030)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.1.1: Rehabilitate / restore or improve existing composting facilities for capacity & quality enhancement and for the adoption of new technologies	MoPC&LG, SLLDC	MoA, UDA, Fertilizer secretariat, NSWMSC, WP-WMA	Percentage of existing compost plants rehabilitated/restored, and the capacity enhanced in MT/day	WP – WP-WMA Other provinces - NSWMSC	Total number of existing composting facilities 195	10% of the existing composting facilities rehabilitated/restored	√	√	√	√	√	√	√	√	√	√	2.4, 12.2, 12.3,12.5
2.1.2: Introduce new composting facilities for potential/prospective Local Authorities.	MoPC&LG	MoE, UDA, NSWMSC, WP-WMA	All LAs covered for composting	WP - WP-WMA Other	Existing composting facilities	By 2025 add ten numbers (10) of new	√	√	√	√	√						2.4, 12.2, 12.3,12.5

				provinces - NSWMSC	= 195 and capacity is around 1,000 MT/day	facilities and the total capacity to be added to the existing capacity is 100MT/day											
2.1.3: Adopt new technologies to enhance the productivity of composting facilities	MoPC&LG, SLLDC	MoST, LAs, PCs, Academia, WP-WMA, NSWMSC	Productivity of composting facilities	WP – WP-WMA Other provinces - NSWMSC	WP = 53%, Other provinces = 5%	WP = 75% Other provinces = above 25%	√	√	√	√	√	√	√	√	√	√	3.9, 8.4, 12.2,12.5
2.1.4: Improve quality / maintenance and gradually upgrade them to SLSI standards	MoPC&LG, SLLDC	MoA, DoA, SLSI, Fertilizer secretariat, WP-WMA, NSWMSC, LAs, CEA	Number and percentage of compost plants registered in the Fertilizer Secretariat Number of plants that have received SLSI standard	WP- WP-WMA Other provinces - NSWMSC	WP= 0, (0%) Other Provinces = 01, (0.6%) SLSI standards = 0	WP =20 (80%) Other Provinces = 33 (20%) SLSI standards = 10%	√	√	√	√	√						12.2, 12.3, 12.4, 12.5
2.1.5: Compost yards complying with the Environment Regulations	MoPC&LG, SLLDC	WP-WMA, NSWMSC, LAs, PCs, CEA	Number and percentage of compost plants that have received EPL	Reports from CEA, WP-WMA, NSWMSC, LAs	WP = 11, (40%) Other Provinces = 8 (5%)	WP = 21 (80%) Other Provinces = 42 (25%)	√	√	√	√	√	√	√	√	√	√	2.4, 12.2, 12.3, 12.5
2.1.6: Promote household-level composting	MoPC&LG	LAs, PCs, WP-WMA, NSWMSC, NGOs, INGOs	Percentage of the households that do not depend on degradable waste disposal service offered by	WP – WP-WMA Other provinces - NSWMSC	WP = 5% Other provinces 10%	WP = 10% Other provinces 30%	√	√	√	√	√	√	√	√	√	√	2.4, 12.2, 12.3, 12.5

			their respective LA														
2.2: Apply suitable treatment facilities for liquid waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.2.1: Introduce central (networked) sewage and wastewater treatment facilities for selected local authorities	NWSDB	MoPC&LG, MoE.MoWS, , CEA, LAs	Percentage of population covered by sewer networks	NWSDB Progress reports	Population connected to sewer networks 2.1%	Population connected to sewer networks increased to 4.4%	√	√	√	√	√	√	√	√	√	√	3.9, 6.2, 6.3, 9.4, 12.2, 12.4, 12.5
2.2.2: Introduce night soil treatment facilities for disposal of fecal sludge from septic tanks	MoPC&LG, NWSDB	LAs, WP-WMA, PCs	Percentage of safe sanitation coverage by facilitating safe disposal of fecal sludge from septic tanks	Reports from LAs, CEA - Database / receiving EPL	11.1%	57.4%	√	√	√	√	√	√	√	√	√	√	3.9, 6.2, 6.3, 9.4, 12.2, 12.4, 12.5,
2.2.3: Improvements for the treatment and appropriate disposal of industrial wastewater	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.2.3.1: BOI Zones	BOI	MoI, NWSDB	Number of BOI zones subjected to improvement of their treatment and disposal facilities for industrial waste water	Reports form BOI	Total numbers of BOI Zones covered 01 (Total number of BOI zones = 16)	Total numbers of BOI Zones to be covered 05	√	√	√	√	√	√	√	√	√	√	3.9, 6.2, 6.3, 9.4, 12.2, 12.4, 12.5
2.2.3.2: Non-BOI Industrial Parks	MoI	CEA, NWSDB, Industry park operators, RISC, IDB, LINDEL, ISB, UDA	Percentage of non- BOI zones subjected to improvement of their treatment and	CEA-Database, MoI and records of other industry parks operators	10% Around 3 (Ratmalana, Bataatha, LINDEL)	At least 20% of those that have no treatment and disposal				√	√	√	√	√	√	√	3.9, 6.2, 6.3, 9.4, ,12.4, 12.5, 12.2

			disposal facilities for industrial waste water			facilities											
2.2.3.2.1: Establishing a data base for Non-BOI Industrial Parks for data gathering including industrial waste water generation and treatment	MoI,	BOI, UDA, LAs, CEA, NWPEA	Data base covering all industries	Report form CEA, NWPEA	Stand alone data bases	Live data base established	√	√	√								3.9, 6.2, 6.3, 9.4, 12.2, 12.4, 12.5
2.2.3.3: Standalone industries acquiring EPL license	CEA	MoI, LAs, NWPEA	Percentage of BOI and standalone industries requiring EPL license	Data base on MoI and CEA & NWPEA	Over 80% of BOI approved enterprises have EPL (BOI – Total Licensed Enterprises - 2,407 Out of witch 361 are within the Zones) Around 70% of non-BOI enterprises have EPL	100% of enterprises obtained EPL license (that are required to obtain EPL)				√	√	√	√	√	√	√	3.9, 6.2, 6.3, ,9.4, 12.2, 12.4, 12.5
2.2.4: Enhance capacities of existing treatment plants or apply new technologies	Authority of respective Industry trial parks or respective operators	MoI, CEA, WM service providers	Percentage of treatment facilities enhanced their capacity with new technologies	Data from LAs, NSWMSC, CEA Database	BOI – Completed 01 (Koggala – 1,000 m^3/day) Non BOI -	All existing treatment plants	√	√	√	√	√	√	√	√	√	√	3.9, 6.2, 6.3, 9.4, 12.2, 12.4, 12.5,

					Baseline to be identified												
2.2.5: Establish treatment facilities with disposal for industrial sludge	Authority of respective Industry trial parks or respective operators	CEA, NWSDB, WM service providers	Numbers of treatment facilities enhanced to treat industrial sludge	Data from LAs, NSWMSC, CEA Database	BOI Zones = 04	All BOI zones	√	√	√	√	√	√	√	√	√	√	3.9, 6.2, 6.3, 9.4, 12.2, 12.4, 12.5,
2.2.6: Introduce pollution load-based pricing system for liquid waste	MoE, CEA	MoI, MoUD&H, NWSDB, CC&CRMD, BOI, ITI	Percentage of BOI zones introducing Pollution Load Based / Volume Based pricing system (gazetted and implemented)	Relevant gazette notification and CEA reports	0 (Act amendment is in progress)	At least 25% of Zones (Live and operate)	√	√	√	√	√	√	√	√	√	√	3.9, 6.2, 6.3, 9.4, 12.2, 12.4, 12.5
2.3: Where compositing is not practical, use biogas technology for the management and treatment of biodegradable solid waste with triple benefits (Methane management, energy recovery option and organic nutrients)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.3.1: Facilitate biogas technology in selected sectors (mass scale commercial——establishments and households)	In charge of respective selected sector	WP-WMA, CEA, SLSEA, Service providers	Number of institutions /establishments with biogas systems	Data sources from CEA. Private institution	20,000 number of individual units	40,000 number of individual units	√	√	√	√	√	√	√	√	√	√	3.9, 6.3, 7.2, 9.4, 12.2
2.3.2: Biogas cluster system for selected LAs	In charge of respective LAs, Private sector	CEA, SLSEA, Service providers/Developers	Number of centralized biogas system in operation	Data sources from CEA, WP-WMA, NSWMSC	No cluster-based biogas system established for LAs	Target to be set	√	√	√	√	√	√	√	√	√	√	3.9, 6.3, 7.2, 9.4, 12.2

NDC 3: Introduce energy recovery using non-compostable non-recyclable waste which cannot be managed by other means																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1: Establishment of already committed 2 waste-to-energy generation facilities for major/prospective municipalities. (Capacities 750MT/day and 500MT/day)	MoUD&H, Respective Developers	MoP&E, SLSEA, CEB, WP-WMA, CEA, CMC and LAs	Number of Waste-to-energy facilities in operation and the total capacity	Data sources from WP-WMA, CEA	One facility 750 MT/day	Add one more facility to the baseline (500MT/day) (Two plants with 1250 MT/day)	√	√	√	√	√	√	√	√	√	√	3.9, 6.3, 7.2, 9.4, 12.2
3.2: Make policy instrument to clearly define the purpose of waste-to-energy and plan the phasing out of preferential feed-in-tariffs	MoUD&H, MoE	MoP&E, CEB,	Policy instrument	Records of MoUD&H	No policy instrument	By 2024 relevant Policy is in place	√	√	√	√							3.9, 6.3, 7.2, 9.4, 12.2
3.3: Formulation of regulations on controlling the disposal of non-compostable and non-recyclable waste trough waste to energy facility	CEA	MoUD&H, MoE	Regulation in place	Data sources from MoE, CEA	No regulations	By 2025 relevant regulations are in place	√	√	√	√	√						7.2, 3.9, 6.3, 9.4, 12.2
3.4: Introduce other thermal treatment technologies particularly Pyrolysis technology	WP-WMA & NSWMSC	MoUD&H, Service providers, CEA, CPC	Total number other thermal treatment facilities (Pyrolysis, Gasification) are in operation and their capacity in MT/day	Data sources from WP-WMA and NSWMSC	Total numbers of plants - 05 (Tire pyrolysis = 4, total capacity 600MT/day, Mixed plastic co-processing =1,	Total numbers of plants - 7 By 2025 add two more plants for mixed plastic pyrolysis plants and total added capacity is 200 MT/day	√	√	√	√	√						7.2, 3.9, 6.3, 9.4, 12.2

					capacity 150 MT/day)											

NDC 4: Use of sanitary landfill for the disposal of residues (non-compostable, non- recyclable, non-recoverable, and residues from waste to Energy plants) will be increased from the current level of 5% to 100% on weight basis

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4.1: Operationalize policy & regulation for siting (locating) and implementation of sanitary landfills (with Methane capturing) according to the waste generation and management forecasts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.1.1: Identifying potential sites for new sanitary landfills	UDA	MoUD&H, MoE, MoPC&LG, CEA, WP-WMA, NSWMSC	Number of new site(s) identified and their design capacity	Site identification report by UDA, CEA (EIA/ER)	Identified – 09 sites for 09 Provinces by the UDA	Acquiring of all identified sites	√	√	√	√	√	√	√	√	√	√	9.a, 11.6, 12.5
4.1.2: Optimize the supply-chain utilization and management of available sanitary landfills	MoUD&H	LAs, WP-WMA, CEA, NSWMSC	Number of LAs connected with the supply chain and the total amount of Waste diverted	Data sources from NSWSC, WP-WMA, Facility operators	Aruwakkalu = 1,200MT /day & no LAs using the facility Dompe = 90MT/day & Two LAs + Industries	Aruwakkalu = 400MT/day & number of LAs could vary and Industries Dompe = 90 MT/day & one LA + Industries	√	√	√	√	√	√	√				9.a, 11.6, 12.5
4.1.3: Introduce transfer stations and transport infrastructure	MoUD&H	LAs, NSWMSC,	Total No of transfer	Record of MoUD&H	No properly	By 2026 two transfer		√	√	√	√						-

		WMA- WP, CEA	stations in operation and their total capacity		develope d transfer stations are in operation	stations and the capacity 450MT/day establshed (Kalaniya 400 MT/day, Pohorawath a, Kalutara 50 MT/day)										
4.1.4: Introduce cluster-based sanitary landfill sites to unserved local authorities	MoUD&H	CEA, LAs, WP-WMA, NSWMSC, Donor agencies	Numbers of LAs connected to Aruwakkalu and Dompe sanitary landfills	Records of MoUD&H	Aruwakk alu - 0 (Total number of LAs serviced is zero) Dompe – 02 LAs served	Aruwakkal u - 50 (Introduced the facility for minimum 50 numbers of LAs including WP and Other potential Provinces) Dompe – 10 LAs (50MT/day)	√	√	√	√	√	√	√	√	√	√	9.a,11.6, 12.5
4.2: Rehabilitate (active and abandoned) existing waste dump sites (50% of 340 sites by 2030)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.2.1: Preparation of technical manual for rehabilitation of dumpsite by 2021	MoE	WP-WMA, NSWMSC, CEA, Academia	Published Technical manual	MoE records	Draft manual for dumpsite managem ent	Technical manual was published in 2021	√										9.a, 11.6, 12.5
4.2.2: Safe closure of dump sites by 2030	UDA	LAs, WP-WMA, NSWMSC, CEA	Number of dumpsites closed	Data source of WP-WMA and NSWMSC	WP = around 20	All open dumps closed		√	√	√	√	√	√	√	√	√	9.a, 11.6, 12.5

					Other provinces 1 (Badulla dump site) (Total no of existing dump sites 339)												
4.2.3: Reduce open dump burning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.2.3.1: Develop Disaster contingency plans/ Preparedness plan for Disaster Management	NSWNSC, WP-WMA	MoUD&H, DMC, CEA, NBRO	Numbers of high-risk dumps sites having contingency plans	Data source of NSWMSC, WP-WMA	Three Dump sites (Karadiyana dump site, Meethotamulla dump site and Seethwaka dump site)	By 2026 all high-risk dump sites have contingency plans	√	√	√	√	√	√					9.a, 11.6, 12.5
4.2.3.2: Develop & introduce proper management plan with a monitoring mechanism for open dumps	NSWMSC, WP-WMA	LAs, CEA, DMC, NBRO, UDA	No of open dumps having a management plan with a monitoring system	Data source of NSWMSC, WP-WMA	Three open dumps (Karadiyana dump site, Meethotamulla dump site and Seethawaka dump site)	By 2026 all high-risk dump sites have management plan with a monitoring mechanism	√	√	√	√	√	√					9.a, 11.6, 12.5
4.3: Introduce Gas measurement and recovery systems for potential open	MoUD&H	WP-WMA, NSWMSC,	Number of dump	Data sources from	Potential sites to	All potential	√	√	√	√	√	√	√	√	√	√	3.9, 6.3, 7.2,

dump sites (abandoned and existing)		CEA, Service providers,	sites rehabilit ated with Gas measurement and recovery systems	MoUD&H, WP-WMA, NSWMSC	be identified	dump sites											9.4, 12.2

NDC 5: Generic enabling activities

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
5.1: Update or introduce the required legislations to facilitate and enforce the implementation of NDCs	CEA and all respective lead agencies	MoUD&H, MoE, MoPC&LG, MoI	Number of Legislations enforced	Data sources from CEA	CEA – 11 Legislati ons (by 2020 11 Regulatio ns have been published for solid waste managem ent)	CEA – 18 Legislation s (By 2026 Seven more Legislation to be published and total legislation will be 18)	√	√	√	√	√	√					3.9, 6.3, 9.4, 11.6, 12.4, 12.5, 13.2
5.2: Introduce a mechanism for waste generation forecasting and a tracking system to monitor collection and disposal	MoPC&LG	MoE, NSWMSC, WP-WMA, CEA, ICT Service Providers	Number of LAs having tracking systems	Data sources from MoE WP-WMA NSWMSC	04 LAs have systems	By 2030 all MCs and UCs have tracking systems	√	√	√	√	√	√	√	√	√	√	9.c, 3.9, 6.3, 9.4, 17.18, 11.6, 12.4, 12.5
5.3: Introduce legislation to make segregation of waste at household level mandatory	CEA	MoPC&LG, MoE, NSWMSC, WP-WMA	Legislation	Data source of CEA	Western Province Waste Mgt Rules no 01 of	By 2024, regulation enforced for waste segregation	√	√	√	√							3.9, 6.3, 9.4, 11.6,13.2 , 12.4, 12.5

					2008 and Directive given by the MoPC&LG												
5.4: Introduce or amend necessary legal framework and instruments to initiate Market-Based Instruments (MBIs) and non-market-based instruments to incentivize and promote sustainable production and consumption patterns	MoE	MoPC&LG , MoI, CEA, WP-WMA, NSWMSC	Market based instrument and non-market-based instruments	MoE records	EPR and PPP system are included to the amended waste management policy (2019)	Amending of existing market-based instrument on requirement basis	√	√	√	√	√	√	√	√	√	√	3.9, 6.3, 9.4, 11.6, 12.4, 12.5,13.2
5.5: Implement “Polluter Pays Principle” for mixed waste generators	MoPC&LG	MoE, CEA, LAs, PCs, WP-WMA, NSWMSC	Percentage of Local authorities introducing service charge systemS for commercial sector	WP-WMA, NSWMSC	WP: execution of Service charging system for commercial places = 70% Other Provinces : 5%	WP = by 2025 all commercial places Other provinces - Target to be established	√	√	√	√	√						3.9, 6.3, 9.4, 11.6, 12.4, 12.5,13.2
5.6: Conduct awareness programmers for behavioral changes of waste generators and capacity building programs for waste management personnel	MoPC&LG	WP-WMA, NSWMSC, LAs, MoE	Number of capacity building and awareness programs conducted annually	Western Province - WP-WMA, Other provinces - NSWMSC	Annual average capacity building programs = 150 and awareness	Target to be established	√	√	√	√	√	√	√	√	√	√	3.9, 6.3, 9.4, 11.6, 12.4, 12.5,17.9

					programs = 500												
5.7: Introduce public-private-partnerships to finance waste management projects facilitating NDCs	MoE, MoPC&LG	LAs, WP-WMA, NSWMSC	Number of PPPs	WP- WP-WMA, Other provinces NSWMSC	In the Western Province: 03 PPPs in Waste to Energy	Target to be established	√	√	√	√	√	√	√	√	√	√	3.9, 6.3, 9.4, 11.6, 12.4, 12.5,17.17

3.6 Forestry Sector

Sri Lanka's forest cover includes savanna, mangroves, open, sparse, and dense forests, and it exhibits diversity and dispersion across the wet, dry, and intermediate climate zones of the country.The forest cover of the country decreased from 84% in 1881 to 29.2% in 2015. The total land area declared under the Forest Conservation Act in accordance with the FAO definition is 1.3 million ha (FSMP, 2023 draft obtained from ESCAMP).

The forestry sector in Sri Lanka plays a crucial role in providing various resources for the population as well as ensuring environmental balance. Some of these benefits include assisting agriculture, providing timber and non- timber resources, providing and regulating water, protecting soils and coastlines from erosion, and reducing GHG emissions

A key document that supported the sector is the Forestry Sector Master Plan (FSMP) 1995-2020, a comprehensive long-term development framework, which provided the guidance to the forestry sector in sustainable management of forest resource of the country, while ensuring provision for eco-system services to the society. This had its foundation the National Forestry Policy 1995. Based on this, many forestry related investment programmes were formulated and several actions were successfully implemented. In order to further the initiatives taken, development of a new FSMP 2021-2030 has been initiated in 2021. This is expected to build on national policies, laws and regulations and international commitments and obligations to reflect new issues as well as trends.

The draft FSMP has incorporated to address climate change adaptation and mitigation in the Action Plan it has further highlighted the importance of promoting Trees Outside Forests (TROF) for carbon sequestration. Further, the Outputs and Activities Plan has captured the progress of activities with global goals and commitments such as the NDCs and SDGs.

However, the sector faces numerous threats such as deforestation, land degradation, soil erosion, illegal logging, poaching, mining, forest fires, and the deterioration of coastal forests which cause the sector to contribute significantly to the country's greenhouse gas emissions.

To mitigate climate change and increase the country's forest cover, Sri Lanka's NDCs in forestry sector as listed in Table 3-5, focus on conserving existing forests, restoring degraded forests, establishing new forest plantations, and working with the business sector to improve commercial and utility forests. Encouraging home gardens and promoting the "tree outside forests" (TROF) with support from state and non-state actors can also help increase the forest cover.

Sri Lanka also leads the Action Group on Mangrove Ecosystems and Livelihoods under the Commonwealth Blue Charter initiative for ocean protection and economic development. Studies are being carried out to assess the blue carbon stocks in mangrove ecosystems, seagrass meadows and salt marshes and their potential in climate change mitigation[31] and also as

[31] Gunathilaka et al, *Blue Carbon Stocks; Distribution, Threats, and Conservation in Sri Lanka; Insight Towards Climate Change Mitigation*, Rajarata University Journal, (2022), Vol 7 (1).

investment potential as natural capital. However, contradictory policies and gazettes in other sectors are barriers in securing carbon sequestration.

Table 3-6 NDCs of Forestry Sector

NDC #	NDC
1	Increase forest cover of Sri Lanka up to 32% by 2030
2	Improve the quality of growing stock of natural forest and plantations
3	Strengthen catchment protection of major rivers and cascade systems
4	Improve and increase of Trees Outside Forests (TROF)
5	Generic enabling activities

Figure 3-7 provides a graphical representation of this increase in carbon sequestration. These estimates are based on the conservation of existing forests, the enrichment and restoration of degraded forests, and the establishment of new forest plantations, as well as the promotion of the "tree outside forests" (TROF) and home gardens. The business sector will also be involved in improving commercial and utility forests.

It's worth noting that these estimates are subject to various uncertainties and assumptions, including the implementation of NDCs, land-use changes, and climate variability. However, achieving the anticipated increase in carbon sequestration through the forestry sector's NDCs can contribute to Sri Lanka's climate change mitigation efforts, while providing numerous benefits, such as protecting biodiversity, improving ecosystem services, and supporting rural livelihoods.

It is expected that the implementation of Sri Lanka's forestry sector's NDCs from 2021-2030 will improve the country's carbon sequestration capacity by 7% compared to the BAU scenario. This translates to an anticipated increase in the sequestration of carbon dioxide equivalent to 2,357,000 MT (705,000 MT unconditionally and 1,652,000 MT conditionally) during this period.

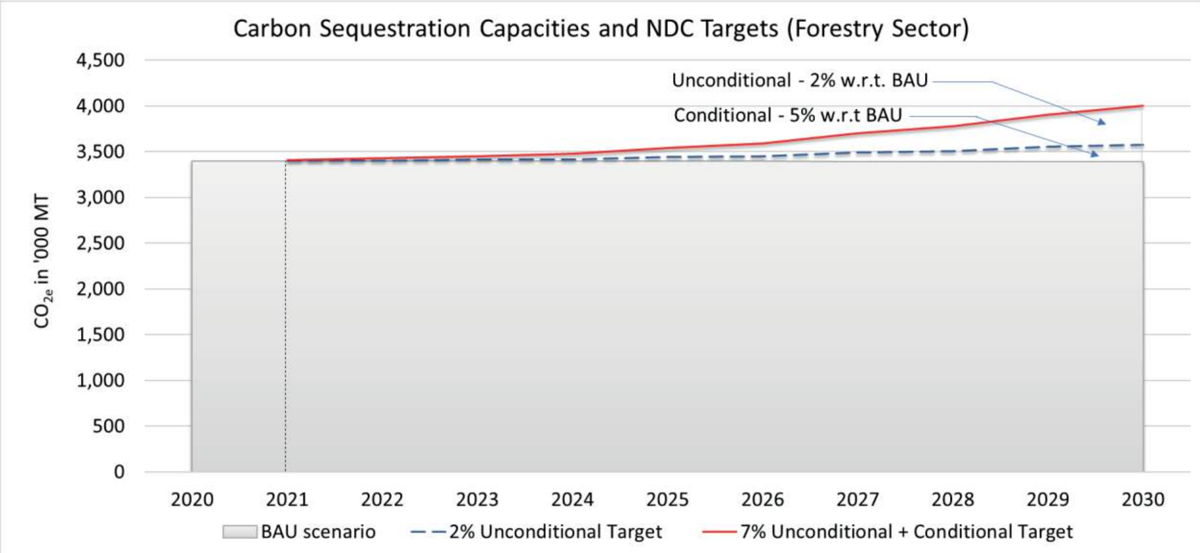


Figure 3-7 Carbon sequestration capacity projections in the forestry sector

3.6.1 Forestry Sector NDC Implementation Plan

NDC 1: Increase forest cover of Sri Lanka up to 32% by 2030																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1: Identify land for reforestation/forestation	FD	Ministry of Wildlife and Forest Conservation, MoPlant, RRI, Rubber Development Authority, LUPPD, MASL, Private sector, NGOs	Land area suitable for reforestation/forest restoration Land use plan for DS Divisions	Maps of FD	From the Government funds FD annually, plants 2,000 ha of forests. Similarly, MASL plants 273 ha yearly while MoPlant have not planted on a regime	18,000 ha land coming under FD (2,000 ha per year from 2021 to 2029). 315 ha outside FD from MoPlant 2,735 ha from the MASL Land use plans prepared for all DS Divisions.	√	√	√	√	√	√	√	√	√		15.1
1.2: Develop forest management plans for natural forests to ensure sustainable management	FD	Ministry of Wildlife and Forest Conservation	Number of management plans prepared	Approved management plans of FD	70	500 (60 to 76 plans per year from 2021 to 2026)	√	√	√	√	√	√					15.2
1.3: Implement forest restoration programme (18,000+ ha of non-forest	FD	CBOs, NGOs,	Number of ha restored/plant	Reports of the FD	0	18,000 +	√	√	√	√	√	√	√	√	√	√	15.2

lands will be Reforested/Afforested including mangroves)		Private sector organizations	ed														
1.3.1: Reforestation/restoration of degraded state forest/lands. 1.3.1.1: Reforestation/restoration using government and external funds 1.3.1.2: Promote private and public sector companies to investment in environmental conservation projects through CSR programs. 1.3.2: Conversion of marginal tea lands in to forests with the participation of the Ministry responsible for the subject of plantation (315 ha - to be planted annually) 1.3.3: Reforestation of unproductive private lands (land extent above 0.5 ha @100 ha/year) 1.3.4: Mangroves restoration by Wildlife Department through PPP	MoPlant, FD, DWC, MASL, Private Sector, Individuals	CEA, SLLDC	Land area/extent reforested	Forest cover maps & 'plantation journal' of FD MoPlant's records including annual reports	From the Government funds FD annually, plants 2,000 ha of forests. Similarly, MASL plants 273 ha yearly while MoPlant have not planted on a regime 2059237 ha (FD)	18,000 ha (mangrove) land coming under FD 3,049 ha outside FD from MoPlant (273-316 ha per year from 2021 to 2030) 2,735 ha from the MASL 200 ha (100 ha In Anavilundawa and 100 ha in Vankalai in 2025) by DWC 1,000 ha by the private sector 2077237 ha (FD)	√	√	√	√	√	√	√	√	√	√	14, 15.1, 15.2

NDC 2 - Improve quality of growing stock of natural forests and plantations

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Improve quality of growing stock of natural forests (200,000 ha)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.1.1: Preparation of a Degradation Index	FD		Degradation Index	FD Report	0	Degradation Index prepared	√	√	√								15.2
2.1.2: Identification of degraded forests	FD	Ministry of Wildlife and Forest Conservation, Academia	Extent of Degraded land areas (according to degree of DI)	FD Maps	0	200,000 ha (100,000 ha per year from 2023 to 2024)			√	√							15.2
2.1.3: Preparation restoration plans covering 200,000 ha including FD and DWC areas	FD, DWC	Ministry of Wildlife and Forest Conservation, Academia	Land extent covered by the restoration plans	Restoration plans	0	25 plans to cover 200,000 ha (25plans of FD + 105 DWC=200,000) (This includes 105 Wildlife Management plans of Wildlife Department (which includes Habitat maintenance)			√	√	√						15.2

2.1.4: Implementation of restoration plans for identified 200,000 ha (25 plans)	FD, DWC	Ministry of Wildlife and Forest Conservation, Divisional Secretaries, Academia	Land extent/area covered by restoration plans	FD's progress reports (Annual)	0	200,000 ha (Around 30,000 ha per year from 2024 to 2030)				√	√	√	√	√	√	√	15.2
2.1.5: Completion of boundary demarcation of state-owned natural forests	FD, DWC	Ministry of Wildlife and Forest Conservation	Extent of natural forest land demarcated	FD's progress/administrative reports (Annual)	500 km	9,840 km to cover 500,000 ha	√	√	√	√	√	√	√	√	√	√	15.2
2.1.6: Conservation to increase non-carbon benefits (to be reported as a co-benefit)	FD, DWC	MoE, CEA, Academia	Research to assess the savings from improvement of ecosystem services from forest conservation	Research reports of FD, DWC and Academia	Some studies have been carried out in areas like valuation	At least 1 research to be conducted	√	√	√	√	√	√	√	√	√	√	15.2
2.1.7: Declare all forests as protected areas (PAs) under the Forest Ordinance and flora and fauna ordinance	FD	Ministry of Wildlife and Forest Conservation	Area declared (ha)	Records of FD, DWC	The existing protected area extent (14.2% of the land area of the country)	200,000 ha (Around 40,000 Ha per year from 2021 to 2027) (Subjective to the concurrence of Divisional Secretaries with the GOSL new directive)	√	√	√	√	√	√	√				15.2
2.1.8: Sensitive areas that cannot be declared as PAs will be managed as Environmental Sensitive areas (ESA) under ESA policy	MoE	CEA, FD	Area declared (ha)	Annual reports of CEA	The existing extent of the ESAs under MoE (	All sensitive Areas No target but would	√	√	√	√	√	√	√				15.2

					116.833 km^2 – in 10 EPAs)	declare based on the need											
2.2: Improve quality of forest plantations (78,000 ha)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.2.1: Demarcation of boundaries of state-owned plantation forests (5,000 km)	FD	MoE, MoPlant, Ministry of Wildlife and Forest Conservation	Area demarcated	FD maps	0	5,000 km	√	√	√	√	√	√					15.2
2.2.2: Develop plantation management plans to bring them in to sustainable management & implementation (four management plans – Teak, pine, Eucalyptus and Khaya) (Khaya species management plan to be developed. Others need to be updated)	FD	Ministry of Wildlife and Forest Conservation, MoPlant	Number of plans developed	FD's species management plan	1 (teak)	4 plans	√	√	√	√							15.2

NDC 3 - Strengthen catchment protection of major rivers and cascade systems of Sri Lanka																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3: Strengthen catchment protection of major rivers and cascade systems of Sri Lanka	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.1: Multi hazard prioritization of catchment/ river basins	MASL, ID	FD, DWC	Number of catchments in which multi hazards had been prioritized	MASL annual reports	0	4 plans			√	√	√	√	√				15.5
3.2: Strengthen lower catchment management / protection of 10 major rivers through tree planting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

3.2.1: Preparation of catchment management plan/s (demarcation and protection of riverine vegetation, etc.)	MASL, ID	DoA, FD, DWC	No of catchment management plans prepared /demarcated extent in ha	Records of MASL, ID	0	10			√	√	√	√	√	√			6.6, 15.4, 15.5
3.2.2: Implementation of protective measures through community-based tree planting campaigns at selected locations of rivers	MASL, ID	DoA, DAD, FD, DWC	Number of plants	Records of MASL, ID	3,410 ha and 3.4 million trees from 2015 to 2020 (on the basis of 1 ha – 1,000 trees used by MASL)	1 million plants in 1,000 ha (Around 100 ha per year - 100,000 trees)	√	√	√	√	√	√	√	√	√	√	6.6, 15.4, 15.5
3.3: Strengthen upper catchment management / protection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3..3.1: Mahaweli (Upper catchment) - tree planting – tree planting	MASL	DoA, FD, DWC	Extent in ha, Number of plants	Records of MASL, ID	3,211 ha and 3.2 million trees from 2015 to 2020 (on the basis of 1 ha – 1,000 trees used by MASL)	2 million plants in 2,000 ha (Around 200 ha per year - 200,000 trees)	√	√	√	√	√	√	√	√	√	√	6.6, 15.4, 15.5
3.3.2: Other major rivers (Upper catchment) - tree planting	ID	DoA, FD, DWC	Extent in ha, Number of plants	Records of ID	0	Target need to be set	√	√	√	√	√	√	√	√	√	√	6.6, 15.4, 15.5
3.3.3: Water streams running through plantations - tree planting	MoPlant	MoE, RPCs, DWC, FD,	Number of ha developed	Annual progress	0	Target need to be set	√	√	√	√	√	√	√	√	√	√	6.6, 15.4, 15.5

		MASL		reports of MoPlant													
3.3.4: Tree planting in riverine areas of all rivers	MASL	MoIrri, CEA, ID, RPCs, DWC, FD, LAs	1 Identification of riverine areas for tree planting (ha) 2 Areas planted in identified rivers	Annual progress reports of MASL	1 Tree planting in degraded areas and event-based planting program mes according to annual plans 2 Around 500,000 trees per year	1 Riverine areas identified for tree planting (2025) (ha) 2 Tree planted in all identified areas of 10 major rivers	√	√	√	√	√	√	√	√	√	√	6.6, 15.4, 15.5
3.4: Strengthen catchment management / protection of cascade systems & isolated tanks through tree planting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.4.1: Preparation of catchment management plan/s (demarcation and protection of cascade systems & isolated tanks, etc.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.3.4.1.1: Major tanks (Mahaweli - 19 excluding those in PAs, Other under ID - Major 73 & Medium - 160)	MoIrri,	ID, MASL, DWC, FD, DAD	Number of Plans	Records of MoIrri	3	4	√	√	√	√	√	√	√	√	√	√	6.6, 15.4, 15.5
3.4.1.2: Major & minor tanks under CEB (Kothmale, Kukulu, Samanala Wewa, Nillamba, /Castle ree, Canyon tanks) & NWSDB (3 tanks)	CEB, NWSDB	FD, DWC, MASL	Number of trees planted	Records of CEB and NWSDB	10,000	1,000,000 plants	√	√	√	√	√	√	√	√	√	√	6.6, 15.4, 15.5
3.4.1.3: Preparation of catchment management plan/s within PAs	FD, DWC, CEA	ID, MASL, DAD	Number of Plans	Records of FD, DWC, CEA	3 plans available	4 (excluding the target in 3.4.1.1)	√	√	√								6.6, 15.4, 15.5
3.4.2: Implementation of protective	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

measures																	
3.4.2.1: Major & minor tanks under CEB (6 tanks) & NWSDB (3 tanks)	CEB, NWSDB	FD, DWC, MASL	Number of trees planted	Records of CEB and NWSDB	22,000 trees in 6 tanks by CEB	1 million trees by CEB	√	√	√	√	√	√	√	√	√	√	6.6, 15.4, 15.5
3.4.2.2: Implementation of catchment management plan/s within PAs	FD, DWC, CEA	ID, MASL, DAD	Number of Plans	Records of FD, DWC, CEA	0	3					√	√	√	√	√	√	6.6, 15.4, 15.5
3.5 Continue the "Climate Resilience Multi-Phase Programmatic Approach" Project in lower Kelani river basin	ID				The project has been discontinued. May commence at a later date												

NDC 4 - Improvement and increase of Trees Outside Forests [TROF]

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4: Improve and increase of Trees Outside Forests (TROF) (tree planting along roadside, Urban forestry, religious lands, schools and other government lands, home gardens)	FD (District Secretaries and Divisional Secretaries will have to play a major role)	RDA, UDA, MASL, LAs, DoA, CBOs, NGOs, Individuals	The number of trees planted outside forests	Records of FD, RDA, UDA and other relevant organizations	100,000	1,000,000	√	√	√	√	√	√	√	√	√	√	9.4, 12.4 & 12.5
4.1: Adopt policy instruments and regulations supporting TROF (urban forestry, tree planting along roadside,	Ministry of Wildlife and Forest	MoE, MoPlant, FD, Provincial	Policy instruments & regulations	Annual records of the stakeholder	Forestry Master Plan In	Policy instruments and			√	√							11.6, 11.7

religious premises, schools and other Government lands, home gardens)	Conservation	councils, LAs, RDA, UDA, MASL, RPC, DoA, DAD		institutions	progress	regulations supporting TROF established										
4.2: Establish an institutional setup and a mechanism to implement such programmes	Ministry of Wildlife and Forest Conservation	MoE, MoPlant, FD, Provincial councils, LAs, RDA, UDA, MASL, RPC, DoA, DAD	Institutional setup and a mechanism	Ministry in charge of Forestry and Wildlife	0	Institutional setup and a mechanism to implement such programme established			√							15.2
4.3: Conduct carbon stock assessment for TROF	FD	MoWL&FC, SLCF, Academia	The number of carbon stock evaluations conducted in TROF	The records of the evaluations done by the agencies, SLCF	Studies carried out and published by academics on selected areas including home gardens, mangroves, coconut plantations, tea lands, etc.	Carbon stock evaluations done in all the home gardens and other TROF	√	√	√	√	√	√	√	√	√	√	15.2
4.4: Implementation of TROF Programmes 4.4.1: Mobilizing public sector agencies to implement TROF Programmes. 4.4.2: Promote private companies to investment in TROF programmes through CSR programs.	FD, MoI	NCPC, SCP & WM Service providers of, CIAs, Academia	Percentage of industries invested in tree planting and the extent of trees planted by private sector	Records of MoI and other private sector companies who had invested in tree planting	500 ha/yr	At least 50% from public sector agencies to adopt tree planting 70% relevant	√	√	√	√	√	√	√	√	√	√	15.2

						industries adopting tree planting										

NDC 5 - Generic enabling activities

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
5.1: Develop and implement a MRV system for forestry NDCs	MoE (CCS)	MoPlant, FD, DWC	MRV system	Records of MoE	0	MRV system developed and established		√	√								15.1

3.7 Agriculture Sector

Since gaining independence in 1948, Sri Lanka has continued to grapple with the creation of a sustainable agriculture sector to generate healthy income levels while ensuring food security and efficient ecosystem management. The GDP contribution of the agriculture sector (primary production) in the years 2019, 2020, and 2021 was 7.3%, 8.1%, and 8.7%, respectively[32]. Further, the agriculture sector has considerably contributed to employment engaging about 27.3% of the country's workforce, particularly in rural areas. Figure 3-8 depicts the export revenue for the agricultural sector from 2009 to 2021, where the sector's average share of all foreign earnings was 23.7%[33]

The food crop segment dominates the agriculture sector of Sri Lanka, with rice being the major staple contributing to about 10% of the agricultural GDP[34]. Enhancing resource-productivity per unit area is considered as the main path for agricultural production to meet the major part of the food demand woth limited availability of resource, and in a changing and variable climate. The food crop sector involves smallholders with an average extent of less than one hectare, but contributes heavily in achieving the overall food security of Sri Lanka. Due to the small-scale operations, there are problems with diseconomies of scale and difficulty

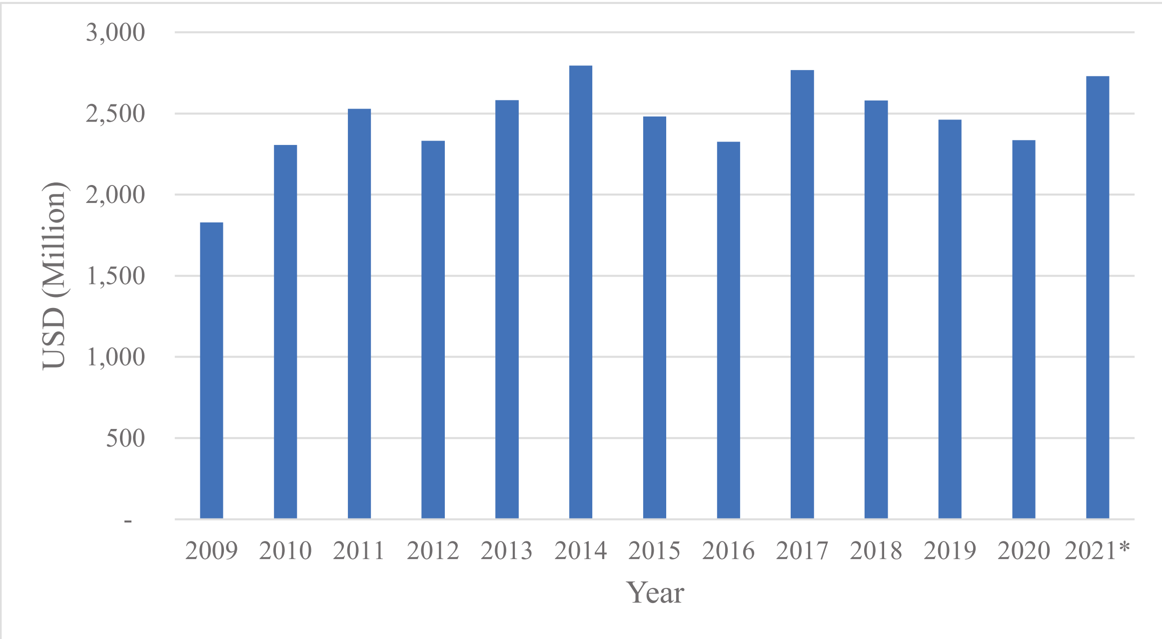


Figure 3-8 Export earnings by the agriculture sector (provisional) [Adopted from CBSL[33]]*

of mechanization in light of rising wages and a labour shortage. Major obstacles include a high reliance on agriculture that is rain-fed, inadequacy of diversification into high-value marketable products, high production costs and low profitability, limited technology adoption and unfavorable market conditions, poor information dissemination, and poor value addition.

---

[32] World Bank, https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=LK

[33] Central Bank of Sri Lanka; https://www.cbsl.gov.lk/en/statistics/statistical-tables/external-sector

[34] Central Bank of Sri Lanka https://www.cbsl.gov.lk/sites/default/files/cbslweb_documents/publications/annual_report/2019/en/8_Chapter_04.pdf

In 2021, the GDP contribution of the livestock sector (including poultry) was about 1%. With 1.6 million cattle and production of 412 million liters of milkor approx. 38-40% of the country's milk requirement, cattle accounts for a significant portion of the livestock sector in Sri Lanka. The dairy sector possesses an enormous potential which is still to be tapped effectively in meeting the demands of the country. The livestock sector is nonetheless constrained by poor breeding efforts and low productivity, limited technological adoption, limited grazing places, and excessive feed prices. Poor feeding practices, unproductive herds of cattle or buffalo, unsatisfactory animal welfare practices, and other factors have significantly increased the sector's GHG emissions. Biogas from livestock waste and residues is one of the main options available for mitigating GHG emissions in the sector. Though limited, this technology has been in practice for several decades. As biogas provides a renewable and environmentally friendly process that supports sustainable livestock industry, further interventions are needed to deploy modern and more efficient technologies and systems. In addition, these are other opportunities for the livestock sector to gain from the technology development in other RE sources, particularly biomass and solar. Biomass fired hot water generators and air dryers, solar-powered refrigerators and freezers, solar pumping for livestock watering, and solar lighting are some examples.

The post-harvest losses reported in Sri Lanka due to poor transport and storage/packing conditions of food crops is a serious concern. This has negatively affected the reach of high quality agricultural produce to the consumers. The food crops of perishable nature such as fruits have reported about 20-40%, post-harvest losses with the highest recorded for papaya, while it ranged between 20-46% for vegetables[35].

The NDCs, given in *Table 3-7*, focus on reducing the post-harvest losses, increasing productivity of the sector, adoption of RE through various activities spanned over a decade from 2021 to 2030.

Table 3-7 NDCs of Agriculture Sector

NDC #	NDC
1	Reduce post-harvest losses and value addition of fruits and vegetables
2	Increase crop productivity
3	Improve adoption of renewable energy for crop farming/value addition
4	Improve dairy sector productivity by managing herd, herd health, feed and by improving animal comfort and welfare
5	Improve productivity of Monogastrics by improving genetic, feed efficiency, animal health, comfort and welfare
6	Adopt renewable energy for livestock applications

In the agriculture and livestock sector, it is anticipated that the implementation of NDCs between 2021 and 2030 will reduce GHG emissions compared to the BAU scenario by 7% (4% unconditionally and 3% conditionally), which equates to an estimated mitigation level of 2,477,400 MT CO_2 unconditionally and 1,858,000 MT CO_2 conditionally (totaling 4,335,400

[35] http://www.harti.gov.lk/images/download/reasearch_report/2018/217.pdf

MT CO_2) of carbon dioxide equivalent during that period (Figure 3-9).

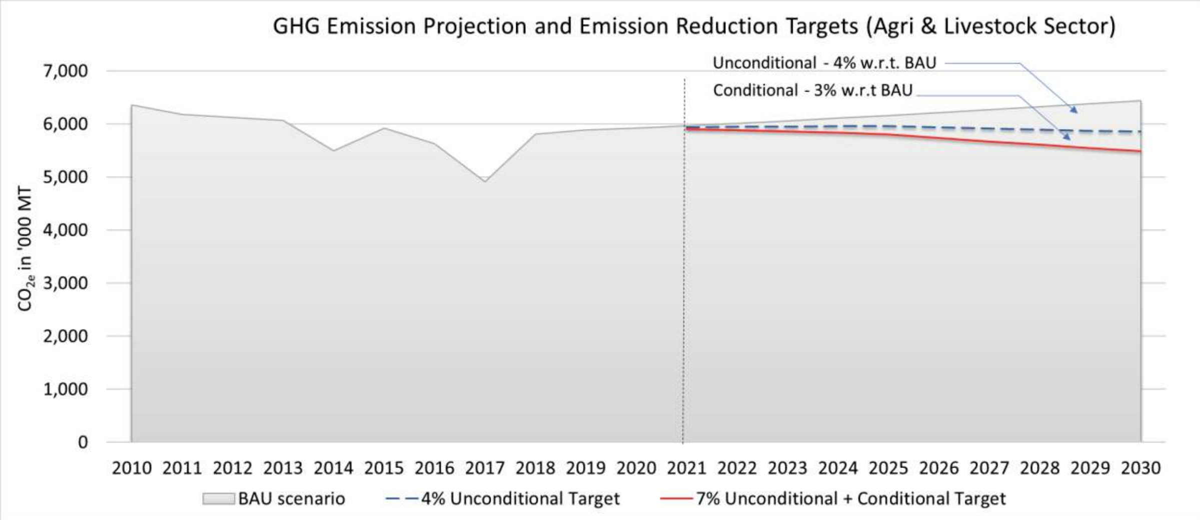


Figure 3-9 Agriculture Sector GHG Emission Projection and Emission reduction Targets

3.7.1 Agriculture Sector NDC Implementation Plan

NDC 1 - Reduction of postharvest losses of fruits & vegetables and value addition																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1: Planning of cultivation management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.1.1: Strengthen the existing planning processes in agricultural operations to avoid seasonal gluts in production	MoA	DoA, DAD, ID, MD, PDoA, MASL, DS	Planning process to avoid seasonal gluts in production	Records of MoA, DoA, MASL, DAD, DAC meeting agenda and minutes	Existing planning process, but with limited emphasis on seasonal gluts in production	Process is adopted and implemented with frequent updated	√	√	√	√	√	√	√	√	√	√	2.a, 12.5
1.2: Improve post-harvest management	NIPHM	MoA, DoA. PDoAs, MASL, DAD, Academia	1. Percentage of Postharvest losses 2. Segregated estimates for fruits and vegs 3. Database for PH stats 4. Number of technologies disseminated through research	Records of MoA, DoA, NIPHM, MASL, Private sector	1. On average 35% 2. No segregated data 3. Un-compiled data 4. To be identified 5. To be identified	1. 20% 2. Segregated data by 2024 3. Database established by 2025 4. At least 10 5. At least 10,000	√	√	√	√	√	√	√	√	√	√	2.a, 12.3, 12.5

			5. Number of beneficiaries of the technology transferred annually		(approximately 5,000)												
1.2.1: Recommend and implement improved post-harvest operations at all levels	DOA	PDoAs, HASL, MASL NIPHM	Percentage reduction of Postharvest losses relative to the baseline	Records of NIPHM	Baseline to be estimated	Postharvest losses reduced to less than 20%	√	√	√	√	√	√	√	√	√	√	2.a, 12.3, 12.5
1.3: Managing the excess production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.3.1: Improve value additions and repurposing of excess productions	MoA	EDB, ITI, IDB, Private sector, NIPHM, Food Promotion Board, DoA	1. % excess production with value addition/repurposing 2. No of new technologies and processes popularized/adopted 3. No. of private/public sector businesses / entrepreneurs established	Records of EDB, IDB, NIPHM, DoA	1. To be quantified 2. There are improved technologies developed, but the level of popularization to be identified 3. Same as above	1. 50% 2. To be established 3. To be established	√	√	√	√	√	-	-	-	-	-	2.3, 2.4, 2.a, 8.2, 12.3, 12.5
1.4: Product innovation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.4.1: Introduce innovation for food processing industries	MoA	EDB, ITI, IDB, Private sector, NERDC, NIPHM DoA, Academia	1. Number of innovative technologies developed 2. % No. of innovations transferred	Records of MoA, DoA, NIPHM, EDB, ITI, IDB, NERDC, NIPO	1. To be identified 2. To be identified	1. To be identified 2. To be identified	√	√	√	√	√	√	√	√	√	√	2.a, 12.3, 12.5
1.5: Monitoring of post-harvest	MoA	MoTrad,	1. Mechanism	Records of	1. Present	1.Mechanis	√	√	√	√	√	√	√	√	√	√	12.3

management process		ICTA, SLT, DAD Economic centres, DCS, DSS, Economic centres, Private Communication systems	to measure PH losses 2. Digitized supply & value chain	MoA	mechanism with limited scope 2. Main supermarket chains	m in place 2. Extended to major supply/value chains											
1.6: Introduce policy and other support instruments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.6.1: Operationalize the existing national policy elements related to minimizing post-harvest losses	MoA	MoE, MoTrad, DoA, NIPHM, CARP, MASL	National Agriculture Policy	Policy, Records of MoA	Draft developed	Policy enacted by 2023, and operationalized	√	√	√	√	√	√	√	√	√	√	2.4
1.6.2: Build awareness and capacity of value-chain actors	MoA	NIPHM, MoTrad	Number of personnel trained	Records of MoA, NIPHM, MoTrad	Baseline number trained to be obtained	Target to be established	√	√	√	√	√	√	√	√	√	√	2.4
1.6.3: Set and implement strategies to reduce postharvest losses in line with the national obligation to fulfil SDG target 12.3	MoA	MoE, Ministry of Trade, CARP NIPHM	Percentage of Reduction of PH losses	CARP, Records of NIPHM, HARTI	40%	Reduce up to 15%	√	√	√	√	√	√	√	√	√	√	2.4

NDC 2 - Increase agriculture productivity of crops

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Identify crops with high productivity improvement	DoA	MoA, MoPlant,	List of crop-species and	DoA data sources	Available list	Continuously updated	√	√	√	√	√	√	√	√	√	√	2.3, 12.2

potentials		PMoA	varieties with high productivity identified and promoted			list (Annually)											
2.2: Adopt Good Agricultural Practices as a mandatory requirement in productivity enhancement programs of food crops	MoA	DoA, MoPlant, MASL, PDoA	1. Production per unit area 2. No of farmers certified for GAP 3. Land extend under GAP 4. No of programmes	Annual performance reports and other records of MoA, DoA, PDoA, DSC, AGSTAT	1. Present productivity levels (AGSTAT 2020) 2. Present certified farmers 3. Present land extent 4. Present programmes	1. To be established 2. 5% of the farmer community 3. To be established 4. At least 25 programmes per year	√	√	√	√	√	√	√	√	√	√	2.3, 12.2
2.3: Increase rice / paddy sector land-productivity (national average paddy yield tons/ha) by 15% unconditionally and 5% conditionally	DoA	MoA, ID, MASL, PDoA, RRDI, DAD	Average paddy productivity/yield (tons/ha sown)	DoA data sources	4,670 kg/ha	20% increase (5,604 kg/ha)	√	√	√	√	√	√	√	√	√	√	2.3, 2.a
2.4: Improve fertilizer use-efficiency by 10% unconditionally and 5% conditionally	MoA	DoA, National Fertilizer Sec (NFS), ID, PDoA, Private sector, MASL	1. No. of farmers adapt site-specific fertilizer applications 2. Percentage improvement in Fertilizer usage efficiencies (Production per kg of fertilizer use)	DoA data source	1. To be identified 2. To be identified	1. To be establised 2. 15%	√	√	√	√	√	√	√	√	√	√	2.3, 2.a
2.5: Improvement of water use efficiency	DoA	MoA, MoIrri (IMD), ID, PDoA, MASL	Increase water productivity in all crops	Data sources of DoA, ID. MoIrri (IMD),	To be identified	To be established	√	√	√	√	√	√	√	√	√	√	6.4

		Private sector	(ton/m3)	PDoA, MASL													
2.5.1 Adopt water-saving techniques (Timely cultivation, shared cultivation, cultivation of drought tolerant varieties without significantly compromising the yield, use of drip & other micro irrigation practices, rainwater harvesting)	DoA	MoA, MASL, ID, PDoA, DADS	% of the Extent with technologies	Data sources of DoA, ID	40%	80%	√	√	√	√	√	√	√	√	√	√	6.4
2.5.2: Reduce conveyance losses of irrigation water in major & minor tanks systems	Major: ID, Minor: DADS	MoA, DoA, MASL, PDoA	Percentage reduction of conveyance losses	Data sources of ID, DADS	40%	75%	√	√	√	√	√	√	√	√	√	√	6.4
2.6: Promote precision agriculture	DoA	MoA, PDOAs MASL, Academia, Private sector	1. Promotional programmes conducted 2. No of capacity building progammes conducted 3. Characterization of technologies 4. Introduce the concepts into formal educational programmes 5. Number of pilot demonstration projects implemented	Data sources of DoA, MoA, DAD, MASL	Baselines to be identified	Targets to be established	√	√	√	√	√	√	√	√	√	√	2.3, 2.4, 2.a, 6.4, 8.2, 12.2, 12.4, 12.5, 14.1
2.6.1: Adopt labour saving and/or cost effective agricultural	DoA	MoA, PDoA	% number of farmers with	Data records of MoA, DoA	15%	60%	√	√	√	√	√	√	√	√	√	√	2.3, 2.4, 2.a, 6.4,

practices/techniques for selected crops (hydroponics, green houses, poly tunnels, rain shelters, etc.)			hydroponics tech at commercial scale													8.2, 12.2, 12.4, 14.1
2.6.2: Popularize farm mechanization in paddy (land preparation, pesticides & fertilizer application, harvesting)	DoA	MoA, DAD, MASL, Private sector	% Land extends cultivated with mechanizatio ns	Data sources of DoA, MoA, DAD, MASL	70%	100%	√	√	√	√	√	√	√	√	√	√	2.3, 2.a, 6.4, 12.4, 12.5

NDC 3 - Improve adoption of renewable energy for crop farming/value addition

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1- Application of solar and wind energy (or hybrid) for agriculture practices	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.1.1 Promote water pumping applications (solar and/or wind)	MoA	DoA, SLSEA, CEB, MASL, DAD, PDoA, Private sector	Percentage of solar PV powered water pumps	SLSEA, DoA data sources	2% of farmers	20% of farmers	√	√	√	√	√	√	√	√	√	√	7.2
3.1.2 : Promote solar & wind power use in place of fossil fuel driven engine powered pumps	MoA	DoA, SLSEA, CEB, MASL, DAD, PDoA, Private sector	Percentage of farms converted to CEB grid applications	CEB data sources	1% of farmers	10% of farmers	√	√	√	√	√	√	√	√	√	√	7.2, 7.3
3.2: Renewable energy powered mini-grid for clustered agriculture farming in vulnerable areas (as a pilot)	SLSEA	MoA, PDoA	Pilot scale study	SLSEA data sources	None	One pilot scale study completed	√	√	√	√	√						7.2
3.3: Explore the potential to develop small hydro power potential (low flow high head) in irrigation water canals for agriculture purposes	ID	MoA, SLSEA, CEB, DoA, MASL	Report on potential with recommendati ons	SLSEA data sources	None	Report on potential with recommend ations	√	√	√	√	√						7.2

						completed											
NDC 4 - Improve the productivity of dairy sector (Target: 40% increase of milk yield per cattle from 3.2 to 4.5 Ltrs/day by 2030 and further improve up to 5 Ltrs/day (55%) on conditional basis. Increase productive milking cow percentage of the herd up to 60% on conditional basis)																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4.1: Improve herd management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.1.1: Rational management of non-productive animals to increase the percentage of productive animals (In-milk and dry animals divided by total animal population)	DAPH	PDAPHs, NLDB, LAs, MASL, Academia, Private Sector	Percentage increase of productive animals	Records of DAPH	45% productive animals (end 2020)	Above 60% productive animals	√	√	√	√	√	√	√	√	√	√	2.3, 8.2, 8,3, 8.4, 12.2
4.1.2: Genetic improvement (Breeding)	DAPH	PDAPHs, NLDB, MASL, Academia, Private Sector	Increase of milk production per animal Decrease number of AI per conception	Records of DAPH	3.2 litre 3.5 AI rate	5 Litre 2.5 AI rate	√	√	√	√	√	√	√	√	√	√	2.3, 8.2, 8,3, 8.4, 12.2
4.1.3: Introduce heat resistance breeds	DAPH	PDAPHs, NLDB, MASL, Academia, Private Sector	Number of new breeds introduced	Records of DAPH	1 new breed (Sahiwal)	3 new breeds introduced	√	√	√	√	√	√	√	√	√	√	2.3, 8.2, 8,3, 8.4, 12.2
4.2: Improve feed management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.2.1: Introduce improved good quality forages varieties	DAPH	PDAPHs, NLDB, MASL, Academia, Private Sector	Extent (ha) with improved varieties Number of varieties	Records of DAPH	10,000 ha 3-4 varieties	20,000 ha 3 new varieties	√	√	√	√	√	√	√	√	√	√	2.3, 8.2
4.2.2: Improve feeding systems (well balanced ration)	DAPH	PDAPHs, NLDB, MASL, Academia, Private Sector	Percentage increase of farmers adopting improved	Records of DAPH	Baseline to be established in 2023	Double the percentage of farmers adopting improved	√	√	√	√	√	√	√	√	√	√	2.3, 8.2

			feeding systems (TMR - Total mixed ration)			feeding systems											
4.2.3: Preservation/conservation of forages	DAPH	PDAPHs, NLDB, MASL, Academia, Private Sector	Quantity of preserved forages Number of farmers engaged	Records of DAPH	Baseline to be establishe d in 2023	Double the baseline values	√	√	√	√	√	√	√	√	√	√	2.3, 8.2
4.3: Herd health management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.3.1: Improve udder health management	DAPH	PDAPHs, NLDB, MASL, Academia, Private Sector	Percentage reduction of incidences of Mastitis reported	Records of DAPH	Percentag e of incidence s reported - 25%	Reduction of incidences from 25% to 10 %	√	√	√	√	√	√	√	√	√	√	2.3, 8.2
4.3.2: Prevention and control of contagious diseases	DAPH	PDAPHs, VRI, NLDB, Academia, Private Sector	Reduction of number of cases of contagious diseases (FMD - Foot & Mouth, HS, BQ) Reduction of mortality rate for contagious disease Number of vaccinations done	Records of DAPH	Number of cases; **FMD** – 4,975, **HS** – 147, **BQ** – 25 Mortality rate; **FMD** – 133, **HS** – 79, **BQ** – 21 Vaccinati ons (Annual average of 10 years) **FMD** – 614,136, **HS** – 223,324,	Number of cases; FMD - 0, HS - 0, BQ – 0 Mortality rate; FMD - 0, HS - 0, BQ – 0	√	√	√	√	√	√	√	√	√	√	2.3, 8.2

					BQ – 163,995												
4.4: Improve animal comfort and animal welfare	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.4.1: Improve micro environment quality of housing (ventilation, heat stress management, etc.)	DAPH	PDAPHs, NLDB, Academia, Private Sector	Increase of number of improved sheds	Records of DAPH	Baseline to be established in 2023	Double the baseline value	√	√	√	√	√	√	√	√	√	√	2.3, 8.2

NDC 5 - Improve the productivity of Monogastrics (Responsibility: DAPH)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
5.1: Genetic improvement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.1.1: Introduce improved genetic (pigs and poultry – broilers and layers)	DAPH	PDAPHs, NLDB, MASL, Academia, Private Sector	Increase of carcass weight Increase of hen house (egg) production Increase of feed conversion efficiency	Records of DAPH	Carcass weight; Broilers - 1.2 kg, Pig - 60 kg Hen house production; 60% Feed conversion efficiency; Broilers – 1.85	Carcass weight; Broilers - 1.5 kg, Pig - 70 kg Hen house production; 70% Feed conversion efficiency; Broilers – 1.7	√	√	√	√	√	√	√	√	√	√	2.3, 8.2
5.2: Improve feed quality	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.2.1: Improve feed conversion efficiency through feed quality improvement	DAPH	PDAPHs, NLDB, MASL,	Percentage of Registered Feed	Through field level sample surveys under	Baseline to be establishe	Number of Registered Feed	√	√	√	√	√	√	√	√	√	√	2.3, 8.2

		Academia, Private Sector	manufactures Percentage of registered animal feed quantity from the total	the animal feed Act	d	manufactures – 90% Percentage of registered animal feed quantity from the total - 95%										
5.3: Animal health management	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.3.1: Disease control	DAPH	PDAPHs, VRI, Academia, Private sector	Reduction of number of cases (ND & IBD for poultry, Pasturellosis for Swine) Reduction of mortality rate for major disease Number of vaccinations done (with local NDV)	Records of DAPH	**ND** cases – 90,356 Mortality - 5,418 Vaccination - 4,052,769 **IBD** cases – 54,192 Mortality - 2,069 Pasturellosis - cases – 1,065 Mortality - 120	Zero Targets for ND, IBD and Pasturellosis by 2030	√	√	√	√	√	√	√	√	√	√	2.3, 8.2
5.3.2: Improve bio-security	DAPH	PDAPHs, NLDB, Private sector	Reduction of number of disease outbreaks (over 5% mortality per week per batch in poultry breeder farms)	Records of DAPH	Zero	Maintain at zero	√	√	√	√	√	√	√	√	√	√	2.3, 8.2

5.4: Improve animal comfort and animal welfare	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.4.1: Improve micro environment quality of housing (ventilation, heat stress management, etc.)	DAPH	PDAPHs, NLDB, Academia, Private sector	Percentage increase of birds under environmentally controlled housing	Records of DAPH	60%	90%	√	√	√	√	√	√	√	√	√	√	2.3, 8.2

NDC 6 - Adoption of renewable energy for livestock applications – (Responsibility: Min of Agriculture & the relevant State ministry)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
6.1: Introduce small-scale solar-powered refrigeration facilities to increase the milk storage facilities. Introduce Solar PV Powered Can Coolers for Milk Producers [already commenced by MILCO]	DAPH	DAPH, PDAPHs, SLSEA, Private sector,	Adoptive rate of the intervention Increase of milk quality and quantity collected	Records of DAPH, SLSEA, CEB	Baseline to be established in 2023 in consultation with SLSEA	Target to be set in 2023 in consultation with SLSEA	√	√	√	√	√	√	√	√	√	√	2.3, 7.2, 8.2, 8,3, 8.4, 12.2
6.2: Introduce Solar PV energy for milk collection & chilling centres	SLSEA	DAPH, PDAPHs, CEB, Milk processors, Solar power suppliers, Financiers	kW of solar PV installed Number of installations Number of installations with full grid independence Increase of milk collection	Records of SLSEA	Baseline to be established in 2023 in consultation with SLSEA	Target to be set in 2023 in consultation with SLSEA	√	√	√	√	√	√	√	√	√	√	2.3, 7.2, 8.2, 8,3, 8.4, 12.2
6.3: Introducing solar energy for farm operation and processing	SLSEA	DAPH, PDAPHs,	kW of solar PV installed	Records of SLSEA	Baseline to be	Target to be set in 2023	√	√	√	√	√	√	√	√	√	√	2.3, 7.2, 8.2, 8,3,

		CEB, Milk processors, Solar power suppliers, Financiers	Number of installations Increase of milk collection		established in 2023 in consultation with SLSEA	in consultation with SLSEA											8.4, 12.2
6.4: Introduce generation of biogas in large scale livestock & poultry, dairy processing, and abattoirs	SLSEA	DAPH, PDAPHs, CEB, CEA, LAs, Private sector (Livestock & poultry producers & processors, Biogas service providers), Financiers	Capacity (m3) of biogas plants established Number of installations	Records of SLSEA	Baseline to be established in 2023 in consultation with SLSEA	Target to be set in 2023 in consultation with SLSEA	√	√	√	√	√	√	√	√	√	√	7.2
6.4.1: Methane emission management from livestock/dairy manure	DAPH	MoE, VRI, Academia,	Methane generation in livestock sector	Records of DAPH	Isolated initiatives	Methane generation assessment in 2023-2025 and periodic update in different systems and in different climatic zones			√	√	√	√	√	√	√	√	12.4
6.4.2: On-site manure to energy conversions (biogas for thermal heating or electricity generation)	SLSEA	DAPH, PDAPHs, CEB, CEA, LAs, Private sector (Livestock & poultry producers & processors,	Biogas generation (utilization and potential) kWh electricity generated per year	Records of SLSEA, CEB	Baseline to be established in 2023 in consultation with SLSEA	Biogas generation (utilization and potential) assessment in 2023 kWh			√	√	√	√	√	√	√	√	7.2

		Biogas service providers), Financiers				electricity generation per year target to be set in consultatio n with SLSEA											

4 NDC IMPLEMENTATION – ADAPTATION

4.1 Overview

Climate change poses a serious threat to economic growth and erodes development gains. Sri Lanka ranks 100th in terms of readiness for climate change adaptation and 60th in terms of climate change vulnerability[36]. Sri Lanka's ND-GAIN index (1995-2020) has varied around an average value of 103, with the index for 2020 being 104[37], proving the nation's vulnerability to climate change and emphasizing the urgent need for climate adaptation. As seen in Figure 4-1, Sri Lanka has been witnessing the negative effects of climate change for several decades in the form of yearly natural catastrophes that affect hundreds of thousands of people[38]. Although floods have been the most common natural disaster, the overall damage has also been severely impacted by droughts, landslides, and storms. Additionally, analysis has revealed probable long-term adjustments in ecological limits and rainfall distribution, adding to already noticeable changes in the bimodal monsoon pattern, rainfall intensities, dry periods, temperature rise, increased exposure to climate changes, and sea level rise.

Agriculture, biodiversity, coastal and marine environments, fisheries, health, livestock, tourism, and recreation, urban planning and human settlements, and water are the most crucial sectors impacted by these changes. As a result, these nine sectors have been recognized in NDCs to prioritize adaptation measures by related governmental agencies, specialists, and other stakeholders in each vulnerable sector.

[36] University of Notre Dame, USA, Notre Dame Global Adaptation Initiative https://gain-new.crc.nd.edu/country/sri-lanka (this initiative ranks the climate adaptation performance for 177 countries)
[37] https://gain-new.crc.nd.edu/country/sri-lanka
[38] World Bank, Climate Change Knowledge Portal, https://climateknowledgeportal.worldbank.org/country/sri-lanka/vulnerability

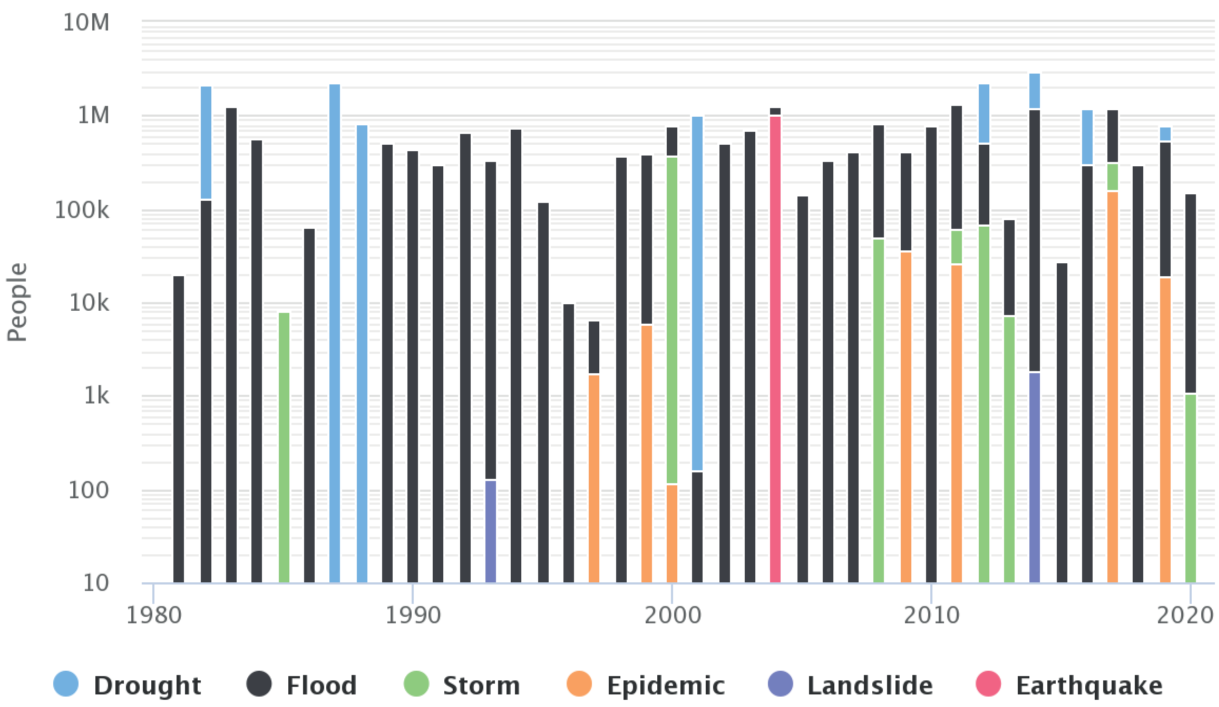


Figure 4-1Number of people affected by key natural hazards statistics between 1980 and 2020 (Data [41])

Sri Lanka's long-term policy objective is to safeguard the nation against the harmful effects of climate change. The goal is to promote sustainable development in each sector while safeguarding the natural resource base on which many of these livelihoods depend. This will support ongoing economic growth and high levels of human development.

There are many GCF, FAO, ADB funded adaptation projects such as the being implemented in Sri Lanka. Nevertheless, the monitoring of project activities and the long term sustainability after the project is terminated needs to be ensured.

Priorities for adaptation share underlying conditions that must be met for implementation to be successful. In this respect, the active engagement of local government stakeholders becomes essential. The absence of data and the lack of accessible localized modeling tools for decision-making are two major obstacles that adaptation measures must overcome. In order to make precise, risk-aware investments, many industries and regions do in fact need more readily available data at a local level. An example is the level of accuracy of the information available to make predictions on sea-level rise in Sri Lanka. Risk assessments for developing sectoral strategies (e.g. tourism) and for spatial development (e.g. urban centers) are currently unavailable at the required resolution, therefore, have been mentioned as priority adaptation actions. The availability of risk and vulnerability data at the province, river-basin, or divisional levels to support decision-making is currently limited. However, the GCF funded National Adaptation Plan Readiness Support Project implemented by the Global Green Growth Institute is in the process of revising the National Adaptation Plan and preparing Provincial Adaptation

Plans (PAPs). One priority activity is the deployment of a downscaled model for meteorological forecasting.

4.2 Agriculture Sector

Approximately 38% of the world's land is agriculture of which one-third is used for crops while the rest used for grazing livestock. Agriculture and forestry are responsible for 23% of global GHG s emissions[39]. Changes are needed to manage the land while safeguarding the food and farmers' livelihoods. Poor policy decisions, exploitation of natural resources and negative impacts of climate change have threatened the food security of Sri Lanka. For a sizeable portion of Sri Lanka's population, especially in rural areas, the agriculture sector provides prospects for a living. Some farmers are abstaining agriculture in favour of alternative sources of income due to climate concerns and low revenue. This downfall occurred over the decades as evident from International Labour Organization (ILO) data[40] (4-2). However, it also noteworthy that Sri Lanka's employment share in the agriculture sector has declined below the world average but with an increase in productivity of many crops such as rice and maize, signaling a potential shift to mechanization and adoption of other new technologies due to the efforts made by Sri Lanka to modernize the agriculture sector.

[39] Organisation for Economic Co-operation and Development (OECD): https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=COM/TAD/CA/ENV/EPOC(2020)3/FINAL&docLanguage=En#:~:text=Executive%20summary-,The%20Agriculture%2C%20Forestry%20and%20Other%20Land%20Use%20(AFOLU)%20sector,share%20is%20likely%20to%20grow.

[40] International Labour Organization. "ILO modelled estimates database" ILOSTAT

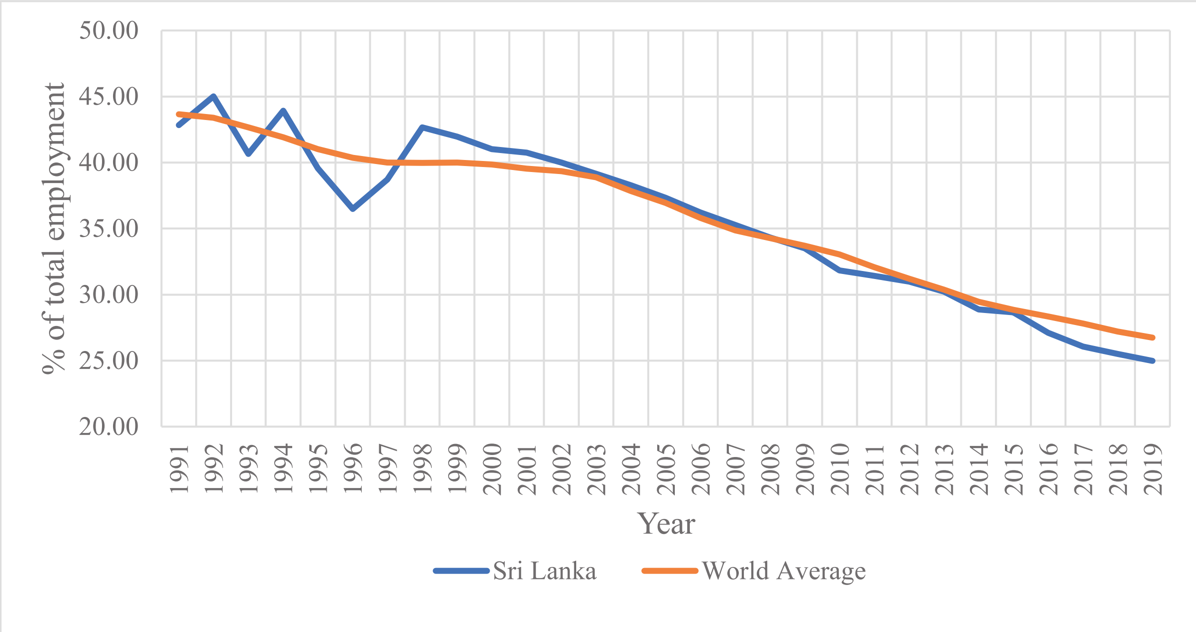


Figure 4-2 Variation of agriculture sector employment over the years in Sri Lanka and global average (Adopted from ILO[40])

Agriculture sector in Sri Lanka is among the most vulnerable to climate change because of its reliance on weather patterns and natural resources. Farmers and other important players in the sector are faced with a completely new set of issues as a result of climate change. It will affect the nation's food and nutritional security, economy, sustainable development initiatives, and many other elements if farmers, who are the primary food producers, lack resilience and adaptive capacities. Sri Lanka has pledged to help the agriculture sector to strengthen its resilience and adapt to the effects of climate change. Ample evidence for this point is provided by the National Climate Change Policy of 2012 (currently being updated), the National Adaptation Plan for Climate Change Impacts of 2016–2025, National Action Programme for Combatting Land degradation in Sri Lanka (2015-2024), and Soil Conservation Act No. 25 of 1951 and subsequent amendments.

The active participation and effective contribution of all the stakeholders are important for adaptation. Therefore, to comprehend the effects of a changing climate and manage the main dangers, the GoSL is collaborating with communities and enterprises. As the scientific understanding of the effects and consequences of climate variability and change improves, agricultural producers are searching for ways to apply this information to planning and decision making and put it into action.

The diversity of the 46 Agro-ecological Regions (AERs) in the nation, both in terms of climate and the agricultural products produced, suggests that different locations and commodities will have different reactions to climate change and variability. Agricultural producers need to continuously adjust to changing conditions (i.e. market price fluctuations, increasing input costs, new neighbors, labor shortages, pest invasions, and adverse weather conditions). Climate change adaptation can help to reduce the risks from climate variability and change, increase the resilience of systems to potential disruptions, and even alter systems to be better able to take advantage of future conditions. The adaptation measures often provide co-benefits towards a number of objectives, such as improving soil health, safeguarding water quality, managing wildlife habitats, or reducing GHG emissions. For example, one notable initiative taken with the leadership of Sri Lanka is the Colombo Declaration for Sustainable Nitrogen Management in 2019 (and the related UN resolutions) to tackle the global nitrogen challenge by significantly reducing its wastage. It is apparent that the transformative adaptation processes in response to climate change could generate more resilient agricultural systems together with improvements in sector governance.

In order to reduce the climate change risks and enhance disaster risk resilience of farmers, the GoSL has implemented number of programmes, including installation of early warning systems for the sector and launching of the Agro-met Advisory Service and a centralized online database 'GeoGoviya'. The Agro-met Advisory, which provides information on weather and guidance for crop cultivation, is compiled by DoA on the basis of the seasonal climate forecast issued by the Department of Meteorology (MD), in consultation with experts and other stakeholder institutions, The GeoGoviya is a cloud-based smart farming platform that facilitates the idea of advancing digital solutions using a cost-effective ICT tool to monitor and track crop performance. It enables larger system capabilities for the GoSL to measure, monitor and report on farm-level data, which can also be used for better coordination among different agencies to facilitate larger agricultural reforms such as providing bundled insurance solutions to farmers.

Another effective intervention could be attributed to the series of progammes and activities conducted by the Extension Division of the Extension & Training Center in the DoA. This division continuously disseminates the agricultural technologies to all stakeholders related to agriculture through different extension approaches in major irrigation schemes. There are sub units in extension division for coordinating extension and development activities covering paddy, other field crops, fruits & vegetables, plant protection, women agriculture extension, young farmers club, plant nutrition & organic fertilizer, climate sustainable agriculture and irrigation management.

The NDCs present in *Table 4-1* presents an opportunity for Sri Lanka to consider and communicate its acknowledgment of the need to plan for more significant changes over the long term with the particular emphasis on climate smart agriculture while supporting near-term changes needed to address urgent issues. Significantly enhanced support across the entire agriculture sector will be essential to improve resilience and protect the lives and livelihoods of farmers and their communities.

Table 4-1 NDCs of Agriculture Sector in Adaptation

NDC #	NDC
1	Climate change considerations mainstreamed into agriculture in Sri Lanka
2	Promote Integrated Pest Management (IPM) and Integrated Plant and Nutrition Systems (IPNS) in most vulnerable areas/districts/crops

3	Develop/introduce varieties resistant/tolerant to biotic and abiotic stresses targeting most vulnerable agricultural crops to climate change
4	Revisit the Agro Ecological Regions (AERs) maps of Sri Lanka with current and future climate scenarios and recommend appropriate crops for different regions to reduce vulnerability to climate change impacts
5	Enhance sustainable land and water management practices in areas where anticipated climate vulnerability is severe
6	Enhanced early warning and risk management mechanisms introduced to reduce climate change vulnerability

4.2.1 Agriculture Sector NDC Implementation Plan

NDC 1 - Climate change considerations mainstreamed into Agriculture in Sri Lanka (2022)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1 Enhance Adaptation of Climate Smart Agriculture (CSA) Technologies in Sri Lanka	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.1.1 Develop National Guidelines on Climate Smart Agriculture (CSA) Technologies and promote implementation.	DoA	MoIrri, LUPPD, MASL, DAD, TSHDA, PDoA, ID & TRI, RRI, CRI, CCB, SRI, PRI	KPI: National Guideline on CSA published, Implementation - Launched	Data Sources of DoA and other state agencies. DoA and other state agencies.	Guideline on CSA available	100%	√	√	√								2, 7, 12,13 (SDG targets to be identified)
1.1.2 Develop and publish inventory of CSA Technologies for Sri Lanka	DoA	MoIrri, LUPPD, MASL, DAD, TSHDA, PDoA, ID & TRI, RRI, CRI, CCB, SRI, PRI	Inventory of CSA Technologies developed and published	Annual Reports,	Information on CSA Technologies available with different agencies	100%		√	√	√							2, 7, 12,13 (SDG targets to be identified)
1.1.3 Mainstream CSA technologies through Good Agriculture Practices (SL GAP) program.	DoA	PDoA, DEA, MASL	KPI: updated SL GAP including CR.	DoA and other state agencies.	LGAP Guidelines available SLGAP standards established	100%	√	√	√	√	√	√	√	√	√	√	2, 7, 12,13 (SDG targets to be identified)
1.2 Minimize climate (change) impact/risk in agriculture through climate forecast based agro-advisories	MET	DoA PDoA, DEA, MASL, Plantation	Upgraded climate based agri-advisory	Annual Reports,	Spatial/ temporal accuracy	100%	√	√	√	√	√	√	√	√	√	√	2, 7, 12,1, 13 (SDG

			system exists, No of advisories issued		and resolution of available system need to be further improved												targets to be identified)3
1.3 Promote appropriate crop-livestock integrated farming systems in climate vulnerable regions (2022).	DoA & DAPH	PoDA, PDAPH, DAD, MASL, NLDB, Private Sector including RPCs, Academia	KPI: (I) Extents covered (ha) or % increase. (II) Number of farmers covered; (II) Number of integrated farming systems/models introduced	Data Sources: DoA, DAPH and other state agencies.	10%	40%	√	√	√	√	√						2, 7, 12,13 (SDG targets to be identified)
1.4 Promote home gardens as small-scale production systems with value addition and establishment of market channels (2022).	DoA & DAPH	DEA, MASL, DAD, DAPH, PDAPH, PDoA, Private sector entities and farmer organizations UDA	(i) Number of farmer markets established (ii) Number of forward contracts established (iii) Number of home garden models identified	Data Sources: DoA, DAPH and other state agencies, project evaluations	Home gardening guide books available	75%	√	√	√	√	√						2, 13 (SDG targets to be identified)

NDC 2 - Promote Integrated Pest Management (IPM) and Integrated Plant and Nutrition Systems (IPNS) in agricultural areas of most vulnerable area/districts/crops (2025)																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1 Develop approaches for rapid Identification of areas vulnerable to resurgence and emergence of pests/disease, weeds and wild animal attacks due to climate change.	DoA	DAD, DWC, MET, DoMC, PDoA, Academia, MASL, DEA, HARTI, HBASL '	KPI: Priority areas are identified (ii) Survey and data analysis reports (iii) Indicators for vulnerabilities	Data sources and survey reports of state agencies	To a certain extent analysis and vulnerable site identification is done	50%	√	√	√	√							13 (SDG targets to be identified)
2.2 Develop and introduce appropriate IPM and IPNS programmes for selected crops in vulnerable areas	DoA,	DAD, DWC, MET, DoMC, PDoA, Academia, HARTI, MASL, DEA, HBASL '	KPI: (i) Number of IPMs (ii) IPNS packages introduced, (iii) Number of farmers adopting these packages	Data sources of DoA and state agencies.	IPM packages are already implemented for rice and vegetables	40%	√	√	√	√	√						2, 13 (SDG targets to be identified)
2.3 Increase SL GAP Certified products by 25% from areas which are highly vulnerable to climate change (2025).	DoA	DAD, DWC, MET,DodMC, PDoA, Academia, HARTI, MASL, DEA, Trade agencies such as supermarket chains,	(i) Number of GAP certified farmers, (ii) Number of markets for GAP certified products, (iii) Quantities s of GAP certified	Data sources of DoA and state agencies.	5%	Achieve expected KPI levels for each	√	√	√	√	√						2, 13 (SDG targets to be identified)

		dedicated economic centers, and private sector, farmer markets, 'Hadhabima'	products marketed (iv) Number of promotional materials developed													

NDC 3 - Develop/introduce varieties resistant/tolerant to biotic and abiotic stresses targeting most vulnerable agricultural crops to climate change

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1 Develop, introduce/promote heat tolerant varieties (2030).	DoA	PDoA, MASL, DAD Academia	% number of heat tolerant varieties introduced from those developed	Variety release committee reports, reports of the socio-economic and planning centre, performance reports of state agencies	30%	100%		√	√	√	√	√	√	√	√	√	2, 12 (SDG targets to be identified)
3.2 Develop, introduce/promote drought tolerant/escape varieties (2030).	DoA	PDoA, MASL, DAD Academia	% number of drought tolerant/escape varieties introduced from those developed		25%	100%		√	√	√	√	√	√	√	√	√	2, 7, 12 (SDG targets to be identified)
3.3 Develop, introduce/promote excess soil moisture/flood tolerant varieties (2030).	DoA	PDoA, MASL, DAD Academia	% number of excess soil moisture/flood tolerant		10%	100%		√	√	√	√	√	√	√	√	√	2, 7, 12 (SDG targets to be

			varieties introduced from those developed													identified)
3.4 Develop, introduce /promote salt tolerant varieties (2030).	DoA	PDoA, MASL, DAD Academia	% number of salt tolerant varieties introduced from those developed		30%	100%		√	√	√	√	√	√	√	√	√	2, 7, 12 (SDG targets to be identified)
3.5 Develop and promote pest and disease resistance /tolerant varieties (2030).	DoA	PDoA, MASL, DAD Academia	% number of pest and disease resistance /tolerant introduced from those developed		80%	100%		√	√	√	√	√	√	√	√	√	2, 7, 12, 13 (SDG targets to be identified)
3.6 Develop, introduce fodder varieties that withstand extreme climatic conditions (2030)	DoA, DAPH	PDoA, PDAPH, Academia	% number of fodder varieties that withstand extreme climatic conditions introduced from those developed		Baseline to be identified	Target to be established		√	√	√	√	√	√	√	√	√	SDG targets to be identified

NDC 4 - Revisit the Agro Ecological Regions (AERs) maps of Sri Lanka with current and future climate scenarios and recommend appropriate crops for different regions to reduce vulnerability to climate change impacts (2030)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4.1 Expanding the Argo-met observation network to cover the most	DoA	MET, PDoA, MASL, ID,	AER zones covered	Performance reports	40%	100%		√	√	√	√	√	√	√	√	√	2, 7, 12, 13

vulnerable AER to climate change (2025).		DAD														(SDG targets to be identified)
4.2 Conduct studies related to soil moisture regimes covering most vulnerable AER to climate change (2028).	DoA	DAD, MASL, ID, MET, WRB	5 studies	Study reports, performance reports	25%	100%		√	√	√	√	√	√	√			2, 7, 12, 13 (SDG targets to be identified)
4.3 Most vulnerable AERs are re-demarcated into sub zones to make recommendations for specific crops (2030).	DoA, MET	PDoA, MASL, ID, DAD	AER Map	Available reports	25%	100%		√	√	√	√	√	√	√	√	√	2, 7, 12, 13 (SDG targets to be identified)

NDC 5 - Enhance sustainable land and water management practices in areas where anticipated climate vulnerability is severe (2030																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
5.1 Promote input efficient farming methods / systems covering the target area by 50% in 2025 and 100% by 2030.	DoA	MASL, PDoA, DAD, ID, HASL, TRI, DoEA, CCB	Input efficient farming systems established	Performance reports	30%	100%	√	√	√	√	√	√	√	√	√	√	2, 12, 13 (SDG targets to be identified)
5.2 Promote farm rainwater harvesting to cover the target area by 75% (2025).	DoA	FCRDI, HORDI, FRDI	Rainwater harvesting mechanisms established	Performance reports	30%	75%	√	√	√	√	√						2, 12, 13 (SDG targets to be

																identified)
5.3 Promote storm water management in 25% of the target area (2025).	DoA	LUPPD, PDoAs, HADABIMA , MASL	Area covered	Performance reports	5%	25%	√	√	√	√	√					2, 12, 13 (SDG targets to be identified)
5.4 Promote crop diversification with input efficient and climate change tolerant varieties in 50% of the target area (2030).	DoA	PDoA, MASL	Crop divarication packages established under irrigation schemes	Performance reports	25%	50%	√	√	√	√	√	√	√	√	√	√	2, 12, 13 (SDG targets to be identified)
5.5 Restoration of small tank cascades and individual tanks to cover the entire target area (links to water sector (2030).	DAD	DoA, PDoA, ID	Small tank irrigation systems restored	Performance reports	30%	70%	√	√	√	√	√	√	√	√	√	√	2, 12, 13 (SDG targets to be identified)
5.6 Promote and apply soil conservation measures in 50% of the target area (2028).	DoA	PDoA, HBASL, , MASL, TSHDA	Soil conservation measures established	Performance reports	25%	50%	√	√	√	√	√	√	√	√			2, 12, 13 (SDG targets to be identified)

NDC6: Enhanced early warning and risk management mechanisms introduced to reduce climate change vulnerability																
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)									Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
6.1 Improved seasonal climate forecasting for Maha and Yala (2024).	MET	NRMC	Improved Seasonal	Performance reports	25%	75%	√	√	√	√							2, 12, 13 (SDG

			Forecast Launched														targets to be identified)
6.2 Promote provision of simplified and timely climate forecast-base advisory communication to farmers and field-level officials in agriculture (2025).	DoA	NAICC, PDoAs MET, NRMC	Communication network established and operational	Performance reports	40%	75%		√	√	√	√						2, 12, 13 (SDG targets to be identified)
6.3 Strengthen risk management and risk transfer mechanisms in agriculture (2025).	AAIB	SEPC, NRMC	Agriculture Insurance mechanism in place and operational; Increased number of farmers enrolled in the process	Performance reports	40%	100%		√	√	√	√						2, 12, 13 (SDG targets to be identified)
6.4 Strengthen early warning systems/advisory for climate hazards and pest and disease risks (2025).	DoA	NRMC MET, RRDI, HORDI, FCRDI, PDOA	Mechanism in place and operational; Number of farmers using early warning advisory	Performance reports	25%	50%		√	√	√	√						2, 12, 13 (SDG targets to be identified)
6.5 Introduce climate related crop forecasting to reduce post-harvest losses (2025).	DoA	SEPC, NRMC, RRDI, MASL, PDoA	MOSAICC based Crop forecasting done	Performance reports	15%	100%		√	√	√	√						2, 12, 13 (SDG targets to be identified)
6.6 Promote protected agriculture and other technologies for climate risk management (2025).	FMRC, HORDI	;PAEA Other Private Sector entities, Academia	Area under protected agriculture	Performance reports	20%	50%			√	√	√	√	√				2, 12, 13 (SDG targets to be identified)

4.3 Fisheries Sector

The nation's fisheries resource base includes a 517,000 sq km exclusive economic zone (EEZ), a 21,500 sq km territorial sea, 1,580 sq km of internal waters made up of lagoons and estuaries, and 5,200 sq km of artificial reservoirs. The resource foundation for the growth of aquaculture is made up of bays, lagoons, reservoirs, and certain lands situated in coastal and reservoir areas[41].

Fisheries play a key role in the nation's economy and food security. Fish provides over 50% of the animal protein consumed in Sri Lanka, which is three times the average for the world. According to the "Industry Capacity Report of the Export Development Board (EDB) for the Fisheries Sector", around 8,500,000 people were actively engaged in the seafood and aquaculture industry in 2019. The key stakeholders are fisherman, breeders, processors, logistics, cold chain, packing and other service suppliers. Each and every step in the Seafood and Aquaculture industry generates more and more employment opportunities while uplifting livelihood of fisheries communities' mainly in coastal area. Furthermore, the fishing sector earned 1.5% of the foreign revenue in 2019 while making direct, indirect, and induced contributions totaling 1.9% to the GDP.

The production of fish in the country is heavily influenced by the coastal and marine sectors. The major contribution to the nation's fish production is made by marine fish production, which includes both coastal and deep-sea fisheries (Figure 4-3). From the years 2014 to 2021, the percentage of marine fish output in the total fish production was 86%, 87%, 86%, 85%, 83%, 82%, 76%, and 76%, respectively[42].

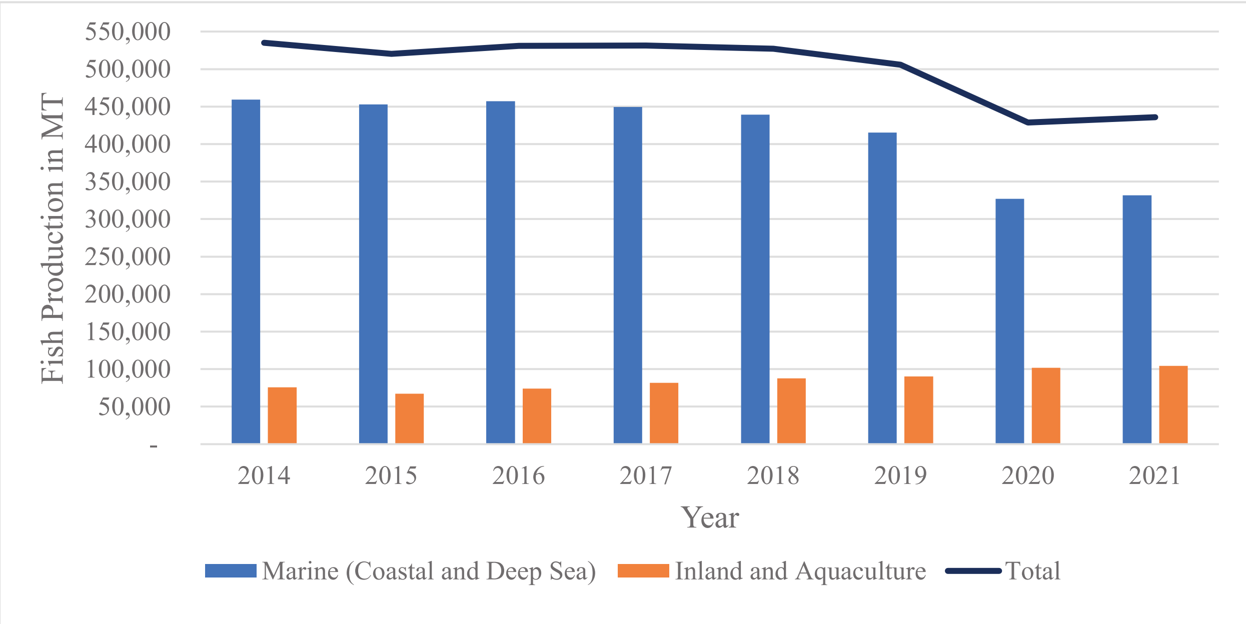


Figure 4-3 National fish production (Data: Department of Census and Statistics[42])

[41] The National Fisheries and Aquaculture Policy, Sri Lanka (2018)
[42] Statistical Pocket Handbook of Sri Lanka, 2022 Available at http://www.statistics.gov.lk/Publication/PocketBook

However, the sector has recently seen a decline in catch for every unit of labor and has been exposed to extreme weather events. Additionally, the COVID-19 pandemic has caused a 20% decline in fish catch and a 26% decline in exports by 2020, significantly affecting the lives of already vulnerable coastal fishing communities[43]. Aggravating the situation, present economic crisis has crippled the livelihoods of the fishermen due to the shortages and high prices of fuel and electricity creating difficulties in operating fishing boats, making ice for preservation of fish catch and transporting to market places from fishing harbours.

Under SDG 14 - Life Under Water, the sector had set three targets for 2021 viz 372,472 Mt of marine fish production, 109,500 Mt of inland and aquaculture fish production, and 48 g per day per capita fish consumption, and 89%, 94.8%, and 77.3%, respectively, of these targets, have been achieved by the year 2021 [44]. Despite the successful achievement of targets, the sector faces major challenges to fully exploit its potential in a sustainable manner; the challenges include (i) unlawful fishing operation by South Indian fishers in Sri Lankan waters using harmful bottom trawling methods, (ii) growth of illegal, unreported, and unregulated fishing operations, and (iii) increasing marine pollution and increase in invasive alien species due to increase in marine traffic in sea lanes around Sri Lanka. GoSL has developed a comprehensive legal, policy and institutional framework for managing coastal and marine resource and has made significant efforts to increase the fish supply from marine sources as evident from the sector performance in the year 2021 as indicated above. These legal interventions are undertaken by the Department of Fisheries Aquatic Resources (DFAR) under the provisions of Fisheries and Aquatic Resources Act 2 of 1996. The draft National Fisheries and Aquaculture Policy (2018)[45] has included a section on Environment, Climate and Natural Disasters. It highlights the need to develop a strategy to address the environmental and climate change challenges and impact of natural disasters. It further hghlights steps needed to be taken to prevent marine pollution, assistance to communities impacted by climatic impacts and development of coping capacity.

Furthermore, the mangrove and seagrass habitats, which serve as spawning sites for fish species with commercial viability, will be impacted by climate change. Additional effects of climate change on the fisheries industry include the loss of wetlands in coastal areas and changes in the salinity of lagoons and estuaries that influence fish and shellfish. Temperature variations, droughts, precipitation, runoff, and floods on freshwater ecosystems are threats to inland fisheries. Reduced rainfall anticipated during the North-East Monsoon would increase the risk to inland fisheries. An increase in natural catastrophes including storm surges, strong winds, and cyclones will harm the reef, aggravating coastal erosion, increasing soil salinity, and contaminating freshwater sources. Aggressive adaptation strategies are necessary due to the

[43] World Bank, Priorities for Sustainably Managing Sri Lanka's Marine Fisheries, Coastal Aquaculture, and the Ecosystems that Support Them (2021).

[44] State Ministry of Ornamental Fish, Inland Fish & Prawn Farming, Fishery Harbour Development, Multiday Fishing Activities and Fish Exports, Annual Performance Report, 2021

[45] Ministry of Fisheries and Aquatic Resources Development and Rural Economy (2018) National Fishereis and Aquaculture Policy

many detrimental effects of climate change on the fishing sector.

The seven NDCs (*Table 4-2*) that comprise the adaptation strategy include adopting ecosystem-based approaches to fisheries management, increasing aquaculture and culture-based fisheries for improved food security, breeding species for aquaculture to withstand adverse climatic conditions, improving safety at sea, better early warning for managing climate risk, diversifying livelihoods, and specialised research on the effects of climate change on fisheries.

Table 4-2 NDCs of Fisheries Sector

NDC #	NDC
1	Ecosystem-based approach to fisheries management (EAFM) adopted in areas of high climate vulnerability to enhance resilience
2	Expand aquaculture and culture-based fisheries to address food security issues relating to climate change
3	Breeding of climate change resilient and commercially important aquatic resources
4	Increase the production capabilities of fisheries, aquatic resources in 30 lagoons that are highly vulnerable to climate change
5	Enhanced safety at sea against climate change influenced extreme conditions
6	Diversification of livelihoods of fisherfolk to build resilience to climate change
7	Conduct fisheries and aquatic resources research to build resilience to climate change

4.3.1 Key Gender Aspects and Challenges in the Fisheries Sector

The Fisheries Statistics (2020) documents that there were 224,610 active fisher women and men in the marince fisheries sector and 70,715 active fisher wmen and men in the inland fisheries sector in 2019. Out of this, 4,371 women are employed in the inland fisheries and aquaculture trade. The draft Fisheries and Aquaculture Policy (2018) has identified the need to promote equal opportunities for women's participation in the activities of the sector. It has recognized the need to mainstream gender in small scale fisheries development strategies; create conditions for both male and females to have equal access to resources and benefits and encourage both men and women to participate jointly in finding solutions to problems.

In general, fish catching is male dominated. In artisanal fishing communities, women often manage smaller boats and canoes. Women are mostly responsible for onshore tasks such as making and mending nets, processing and marketing catches, and collecting molluscs such as clams, oysters and mussels.

Fisheries practices and fish availability is dependant on weather patterns. Hence, fishing is seasonal and fishing communities have diversified their livelihoods. Climate change impacts trigger vulnerabilities in coastal communities and temporaray migration is seen by both men and women who travel inland for jobs as construction workers, domestic help and labourers.

4.3.2 Recommendations for Gender Responsive NDC Planning and Implementation

In consideration of the above detailed status of women engaged in the fisheries sector, it is important to facilitate, support and upgrade their role through the NDCs, for more efficient and effective overall NDC outcomes. The following recommendations are suggested for consideration:

(a) NDC activity planning and implementation in the sector need to take into account the division of labour and the significant contribution women provide to the fisheries sector, which is a resource to the sector, and complementary to the role of men.

(b) NDC activity planning and implementation in the sector need to take a gender responsive approach to ensure due recognition of the activities carried out by women in the sector (currently invisible due to lack of disaggregated data, policy gaps and stereotypes). This will lead to overall benefits and improved productivity in the sector.

(c) Incorporate activities to encourage and promote women's engagement and potential in the fisheries sector, to be active in community activities (through the fisheries cooperatives and rural development organisations, and through training and capacity building programmes implemented under the NDC actions).

(d) Identify main baseline criteria for the role and functions carried out by women, include targets and KPIs into the NDC monitoring plan of the fisheries sector.

(e) Incorporate programmes into the NDC activity plans to enhance and upgrade the activities that come under women's responsibilities (such as lagoon fishing, fish gutting, cleaning and drying).

(f) Use specific strategies to include/target female-headed households Ex. Government owned land can be leased for aquaculture activities.

(g) Include and target women in providing training for value addition, technology and machinery, credit, subsidies, places for fish drying, and in finding high value markets to enhance their position in the fish value chain.

(h) Include and target women and the specific functions they carry out in the sector in the programmes for diversification of livelihoods of the vulnerable fisherfolk.

(i) Ensure equitable access to programmes conducted under the NDC action plan for upgrading skills related to technology, management, marketing, transport and developing networks.

(j) Introduce improved technologies and methods to ease women's burdens and increase their efficiency.

(k) Provide income-generating opportunities such microfinance services, credit facilities to the needs of different clients.

(l) Design projects to support women's work within their households (e.g providing water, wood supplies, day-care, etc).

(m) Set targets to reach and maintain the share of women scientists, officials, technical officers, and those in the local level committees.

(n) Include collection of sex disaggregated data, develop KPIs, to review gender responsive activities, and outcomes, in the progress review and monitoring of the NDC plans.

4.3.3 Fisheries Sector NDC Implementation Plan

NDC 1 - Ecosystem-based Approach to Fisheries Management (EAFM) adopted in areas of high climate vulnerability to enhance resilience (2030)																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1 Identify priority limits and define fisheries management areas based on ecological principals	DFAR	NARA, CC&CRMD, MEPA	Number of fisheries management units identified	Records of the DFAR	Not Commenced	05 priority areas selected			√								5.c, 14.2, 14.b, 14.c
1.2: Develop 5 EAFM plans	DFAR	MoFish, NARA, CC&CRMD, MEPA	Number of EAFM plans developed in gender responsive manner as appropriate	Published plans of DFAR	Not Commenced	5 EAFM Plans developed			√	√	√						5.c, 14.2, 14.b, 14.c
1.3: Conduct survey/s to estimate women's participation / contribution in the Fishery sector	MoFish (Statistical unit)	MoWCSD, NARA, CC&CRMD MEPA, NAQDA, DFAR, Academia	1. Initial Surveys 2. Number of updates of the surveys	Survey reports	Not Commenced	1. Initial surveys conducted by 2023 2. two updated per year			√	√	√	√	√	√	√	√	5.1, 5.2, 5.5, 5.a, 5.c, 14.2
1.4: Incorporate EAFM into 5 prioritized existing fisheries management areas declared under Fisheries and Aquatic Resources Act	DFAR	NARA, CC&CRMD, MEPA, MoPC&LG, NAQDA, FD, SLCG, DS	Number of EAFM incorporated fisheries management areas	Records of the DFAR including sex disaggregated data	Not Commenced	05 existing fisheries management areas incorporated with EAFM		√	√	√	√	√	√	√	√	√	5.c, 14.2, 14.b, 14.c
1.5: Build awareness and capacities of all key stakeholder agencies on gender issues in the sector	DFAR	MoWCSD, International agencies	1. Number of awareness rogrammes conducted	Reports on the awareness and training programmes	Some work initiated, but	Targets of the two indicators to be			√	√	√	√	√	√	√	√	5.5, 14.2

			2. Number of participants received awareness training	on gender issues, gender responsive planning & implementation for climate resilience	awareness programme not conducted	established											
1.6: Amend existing legislative framework, where necessary to enable gender integration	MoFish, DFAR	All relevant institutions	Legislative framework enabling gender inclusion	Approved policy and amended legislative framework	Draft policy pending Cabinet approval Pension scheme established to include fisher spouses & dependents	Amended legislative framework where necessary			√	√	√	√	√	√	√	√	5.5
1.7: Implement 5 EAFM plans	DFAR	MoPC&LG, NARA, CC&CRMD, MEPA, DS	Number of EAFM Plans Implementated	Minutes of Progress review meetings, with sex disaggregated data	Not commenced	05 EAFM Plans implemented			√	√	√	√	√	√	√	√	14.2
1.8: Target an appropriate percentage of women in introducing climate change responsive new technologies and systems	DFAR	MoE, MoWCSD, NARA, ITI, NERDC, NGOs, INGOs	% of the women participation Programmes for the introduction of climate change responsive new technologies and systems	DFAR Progress reports with sex disaggregated data	Above 10%	Not less than 25% of women reached out/included in promoting climate resilient programmes			√	√	√	√	√	√	√	√	5.1, 5.2, 5.5, 5.a, 5.c, 14.2

NDC 2 - Expand aquaculture and culture-based fisheries to address food security issues relating to climate change (2025)																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Promote an appropriate fish fingerling stocking programme for enhancement of culture-based inland fisheries	NAQDA	MoFish, DFAR, DAD, NARA, MASL, CC&CRMD, ID, DWC, CEA, Chambers of Commerce, Academia	1. No of fingerling stock 2. Annual inland fish production	Records of MoFish, NAQDA	1. 110 million fingerling stock 2. 104,000 MT	1. 500 million fingerling stock 2. Target for inland fish production to be established	√	√	√	√	√						8.1, 8.4, 13.b, 14.2, 14.7
2.2: Establish fish barricade devices for 50 perennial reservoirs impacted with frequent floods to prevent fish escape, in consultation with Irrigation Department	NAQDA	ID, MASL, NARA, DWC, Farmer Organizations	No of tanks covered	Records of MoFish, NAQDA	None	Target to be established	√	√									2.4, 13.1, 14.2, 14.7
2.3: Promote culture of species appropriate for changing climate	NAQDA	DFAR, NARA, CC&CRMD, CEA, Private Sector (for promotion and applications), Academia	Number of species of fish	Records of NAQDA	01	At least 2 new fish species by 2030	√	√	√	√	√	√	√	√	√	√	2.4, 13.1, 14.2, 14.
2.4: Conduct survey/s to estimate women's participation/contribution in the aquiculture Fishery sector	NAQDA	MoWCSD, NARA, CC&CRMD, MEPA, DFAR, Academia	1. Initial Surveys 2. Number of updates of the surveys	Survey reports	Not Commenced	1. Initial surveys conducted by 2023 2. two updated per year			√	√	√	√	√	√	√	√	5.5

NDC 3 - Breeding of climate change resilient and commercially important aquatic resources (2025)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1: Cryopreservation facility in Dambulla expanded for stocking fish sperms for artificial breeding of species where effective spawning affected due to climate induced changes	NAQDA	NARA, Academia, Private sector for PPP to promote facilities	Number of samples preserved	Records of NAQDA	300 samples preserved	Annually 300 samples	√	√	√	√	√	√	√	√	√	√	8.2, 13.1, 14.2, 14.4, 14.7
3.2: Convert 52 number of existing open breeding facilities into indoor facilities and design constructions enabling controlling temperature and salinity for breeding tolerant strains of selected species	NAQDA	NARA, Academia, Private sector	Number of hatcheries developed/im proved	Records of NAQDA	5	52	√	√	√	√	√	√	√	√	√	√	8.2, 13.1, 14.2, 14.4, 14.7

NDC 4 - Increase the production capabilities of fisheries, aquatic resources in 30 lagoons which are highly vulnerable to climate change (2030)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4.1: Identify vulnerable lagoons (by 2022) and prepare lagoon profiles for 30 lagoons	NARA	MoFish, DFAR	1. Number of vulnerable lagoons identified 2. Number of lagoon profiles developed	Records of MoFish, DFAR, NARA	5 lagoon profiles up to 2020 Data collected for 07 lagoons (05 in 2017 and	30 lagoon profiles developed	√	√	√	√	√	√	√	√	√	√	14.2, 14.7

					02 in 2019)												
4.2: Carrying capacity assessment of 30 lagoons	NARA	MoFish, DFAR, NAQDA, CC&CRMD, MEPA, SLTDA, CEA, Academia	No of carrying capacity assessments completed	Records of NARA	None	15			√	√	√	√	√	√	√	√	14.2, 14.7
4.3: Declaring and managing 10 lagoons as Co-managed Fishery Management Areas (FMAs)	DFAR	SD, NARA, CC&CRMD, DS, Approximately 23 agencies including fisheries committees at divisional level	1. No of Lagoons gazetted/ declared 2. No of co-management groups established 3. No of management and development plans prepared and implemented	Records of DFAR (Management Plans)	1. 36 Gazetted (by 2017) 2. None 3. None	1. Additional 10 lagoons 2. Target to be established 3. Target to be established		√	√	√	√	√	√	√	√	√	13.2 14.2
4.4: Minimize aquatic pollution in above 10 lagoons mentioned in 4.3	MoFish	NARA, DFAR, CC&CRMD, NGO, MEPA, CEA, LAs	No of lagoons where aquatic pollution minimized	Records of DFAR & NARA (for water quality)	Feasibility studies in 4 lagoons in progress (Arugam bay, Nandikadal, Nayaru, Lanka Patuna)	10	√	√	√	√	√	√	√	√	√	√	14.1
4.5 Promoting aquaculture of selected climate change resilient, high value	NAQDA	NARA, DFAR, CEA,	No of species identified as	Records of NAQDA and	Feasibility studies	5	√	√	√	√	√	√	√	√	√	√	14.2

food species in selected lagoons		LAs	climate resilient	DFAR	being conducte d											

NDC 5 - Enhanced safety at sea against climate change influenced extreme conditions (2025)																
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)									Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
5.1: Promote applicable measures to enhance safety at sea	DFAR	MoFish, DMC, MoD, MED	1. Number of applicable measures identified 2. Number of incidents reported	1. List of applicable measures in DFAR records (Communication equipment for multi-day fishing vessels) 2. MCS records	1. Some guidance on applicable measures are provided in the Act. 2, Number of incidences to be identified	1. Identify the exact applicable measures at least by 2023 2. Target to be established (% reduction of incidences)	√	√	√	√	√	√	√	√	√	√	8.8, 13.1, 14
5.2: Enhance effective early warning transmission systems for fishers (including small boats and traditional crafts) and insurance schemes	DFAR	MoFish, MD,DMC, MoD, SLN, MRCC Telecom service providers, Private & Government Insurance Companies	50% of the coastal fishers using effective early warning transmitting system such as CDMA	MOU between MoFish and Telecom service provider	Current systems are not effective	At least 50% of the coastal fishers use effective early warning transmission systems	√	√	√	√	√	√	√	√	√	√	8.3, 8.8

5.3: Establishment of an efficient weather information management and communication system (WIMS) including satellite-based vessel monitoring system to ensure safety at sea	DFAR	SLPA, SLN, DMC, SLCG	1. % of multiday boats equipped with VMS 2. % of multiday boats equipped with AIS	Amended regulation; Records of DFAR	1. WIMS older version 2. Few boats with AIS	1. Establishment of an efficient weather information management and communication system including satellite-based vessel monitoring system to ensure safety at sea. 2. 100% by 2025			√	√	√	√	√	√	√	√	8.8

NDC 6 - Diversification of livelihoods of fisherfolk to build resilience to climate change (2030)																
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)									Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
6.1: Enhance access to credit, inputs training for diversification of livelihoods of the vulnerable fisherfolk	DFAR	MoFish, MoSD&VT, NARA, ITI, Banks, Insurance companies	1. Number of schemes for livelihood diversification 2. Number of fisherfolk who had diversified	Progress reports of relevant agencies	1. None 2. None	1. Target to be set 2. Target to be set	√	√	√	√	√	√	√	√	√	√	8.2, 8.3, 14.b

			their livelihoods														
6.2: Allocate a percentage for women fisherfolk in carrying out knowledge transfer activities, training sessions, extension programmes, providing credit facilities, production inputs, etc.	DFAR	MoSD&VT, MoWCSD, Women's Bureau, NARA, ITI, Banks, Insurance companies	1. Percentage of women fisherfolk included in carrying out knowledge transfer activities, training sessions, extension programmes, providing credit facilities, production inputs, etc s 2. Number of women accessing credit, production inputs	DFAR progress reports with information on women fisherfolk reached, accessing the facilities	1. Not recorded 2. Not recorded	Activities have been conducted but gender disagrregated data not recorded			√	√	√	√	√	√	√	√	1.4, 5.5, 5.a, 5.b, 8.5, 14.b
6.3: Assist finding high value markets to deal with reduced yields	DFAR	MoFish, MoSD&VT, NARA, Banks, Insurance companies	Number of high-value markets established	Records of DFAR	None	Target to be established			√	√	√	√	√	√	√	√	2.3, 9.3, 14.b
6.4: Facilitate value additions through diversification of fisheries related products (fish oil, fish sauce and other value-added products)	DFAR	NARA, ITI, BOI, EDB	Number of value-added products introduced annually	Progress reports of relevant agencies	No specific products introduced	Target to be established			√	√	√	√	√	√	√	√	2.3, 9.3, 14.b

NDC 7- Conduct fisheries and aquatic resources research targeting building resilience to climate change (2030)																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
7.1: Assess climate impacts on fisheries and aquatic resources	NARA	Academia	1. Number of assessments conducted annually 2. Number of areas covered in Climate impact assessments (Fisheries - Marine, Aquaculture & Inland fisheries, Aquatic resources - Habitats, Coral reefs, Mangroves, Sea grass, Salt marsh)	Records of relevant agencies	Research and data collection have been done, but not specifically focus on CC impact and data is not comprehensive enough to do the assessments. Two proposals particularly related to CC have been	Targets to be established	√	√	√	√	√	√	√	√	√	√	14.2, 14.3

					developed but could not implemented due to non-availability of funding.											
7.2: Develop reef monitoring systems to provide early warning alerts of bleaching events	NARA	Academia	Number of Reef monitoring systems	NARA records	Monitored 02 reefs annually for the reef status Four data loggers are available (but not real-time monitoring, which is essential for a reef monitoring systems)	04 automated real-time data monitoring systems (02 each for West coast and East coast). 02 by 2025 and 04 by 2030	√	√	√	√	√	√	√	√	√	√	14.2, 14.3
7.3: Identify adaptation measures in fisheries for ocean acidification related impacts	NARA	Academia	1. Number of Automated monitoring systems for ocean acidification measurements 2. Number of Adaptation	NARA records	Ocean acidification measurement is done in two selected locations (East coast and	04 Automated monitoring	√	√	√	√	√	√	√	√	√	√	14.2, 14.3

			measure/s for ocean pacification		west coast), but the measurement process is manual												
7.4: Installation of artificial reefs where substrate for settlement of corals larvae is minimal	NARA	CWC, CC&CRMD	Number of artificial reefs installed	NARA records	Small-scale artificial reefs were piloted in 04 locations (Polhena, Galle, Sinnapadu and Weligama)	At least four locations	√	√	√	√	√	√	√	√	√	√	14.2, 14.3, 14.5
7.5: Deployment of fish aggregating devices in identified areas	NARA	CWC, CC&CRMD D	1. Studies to identify number of locations 2. Deployment NAQDA	NARA records	1. Studies conducted in four locations to identify the feasibility for deployment 2. None	1. Comprehensive assessment by 2025 2. 05	√	√	√	√	√						14.4
7.6: Reduce capital, operation and other costs in fisheries and aquaculture by introducing and promoting fuel efficient technologies in response to declining yield and productivity in a changing climate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.6.1: Introduce solar panel systems to multiday fishing vessels and fish	DFAR	CEB, SLSEA	Number of multiday	NAQDA and DoF records	None	All multiday			√	√	√	√	√	√	√	√	2.4

processing factories			fishing vessels installed with solar panels			fishing vessels installed with solar panels (approximately 5,500)											

4.4 Livestock Sector

The livestock sector plays a significant role in agricultural development that supports poverty reduction and food security. With more than 600,000 registered livestock farms, the majority of which are small-scale, the livestock sector (including poultry) is crucial to the food systems and livelihoods of rural communities in Sri Lanka. However, one of the nation's economic sectors that is most susceptible to the effects of climate change is livestock. Developing the livestock industry is a must for ensuring the nation's food security. This is true not only for improved soil fertility for higher crop output but also for enhanced availability of livestock produce.

In Sri Lanka, livestock husbandry is often maintained on a small scale while giving rural agricultural households additional revenue and support for their way of life by utilizing extra labor, underutilized agricultural byproducts, and marginal lands. As depicted in Figure 4-4, the livestock with the largest population, next to poultry, is cattle. The cattle population remains almost steady over the past 5-year period averaging around 1.1 million[46]. The number of goats and buffaloes remains nearly the same yet substantially small compared to cattle, while sheep are the lowest in number. There is a sharp increase in poultry numbers between 2019 and 2020, as shown in *Table 4-3*. Meanwhile, egg production fluctuated around 2 billion eggs during the period concerned.

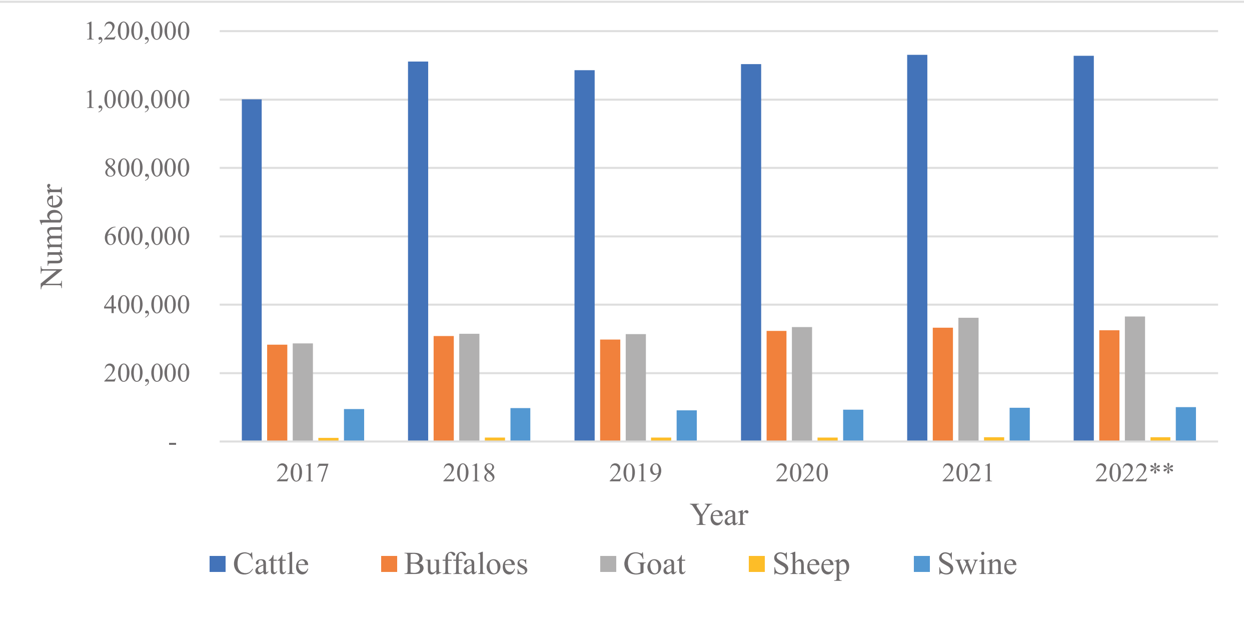


*Figure 4-4 Livestock numbers (excluding poultry[46]) (** provisional)*

[46] National Livestock Statistics 2017 – 2022; www.statistics.gov.lk/Agriculture/StaticalInformation/rubb4

*Table 4-3 Poultry, milk, and egg production[47] (**provisional)*

Year	Poultry (numbers)	Milk (million Liters)	Eggs (millions)
2017	21,275,820	397.92	2072.87
2018	20,531,000	467.69	1972.21
2019	20,411,050	447.58	2084.21
2020	24,277,830	491.54	1869.69
2021	24,310,690	513.31	1953.71
2022**	22,766,750	506.45	1848.60

The livestock sector is seen to be seriously threatened by climate change. Droughts, floods, and heat stress are just a few examples of the extreme weather occurrences and climate variabilities that are predicted to be brought on by the unpredictable rainfall and warming temperatures caused by global climate change. For instance, the Northern province suffered greatly because of the cold wave that swept across the country in December 2022, which killed over a thousand livestock. In addition to these direct consequences, there are also significant secondary effects, such as implications on forage crop growth, pasture availability, waterlogging, disease risk from emerging infections, and reduced production and quality of feed crops.

Policy direction for the industry is provided by the National Livestock Development Policy (NLDP) (2007) and the Livestock Master Plan - A Strategy for Livestock Development Toward Self-sufficiency (2011). NLDP focuses on four sub sectors viz (i) dairy, (ii) poultry, (iii) meat, and (iv) animal feed resources. It aims to serve three objectives namely, (i) Spell out clearly the development goals of the livestock sector and the role of the public sector in livestock development activities in the country, (ii) facilitate the private sector and other interested agents to identify the scope and possibilities for their activities in production, processing and marketing of livestock and livestock produce, and (iii) rationalise investments on livestock sector provided from the consolidated fund through the national budget and avoid crowding-out of private sector investment[47].

Draft National Agriculture Policy which is to be submitted soon for Cabinet approval has the vision of achieving "sustainable food security to achieve national prosperity" and the mission to create a "socially-acceptable and sustainable food system in Sri Lanka through a globally competitive agricultural production, processing and marketing mechanism". The draft policy has 10 thematic areas; Crop Production and Productivity, Input Management, Advanced Technologies, Food Safety and Quality Management, Eco-friendly Operations, Agri-Entrepreneurship and Markets, Producer Empowerment, Climate resilience and other risk management, Knowledge Management and Agricultural Extension, and Governance and Operations Management. This policy is also expected to provide the policy framework for all key agriculture sector institutions; including crop, livestock, inland fishery, crop processing, and allied services such as irrigation, agrarian development and environment.

With the other agencies under the Ministry of Agriculture, (MoA) the Department of Animal

[47] http://www.vri.lk/nnn3/ldp.php

Production and Health (DAPH) takes the lead in improving the livestock sector development in Sri Lanka. National Livestock Breeding Policy Guidelines and Strategy for Sri Lanka, (2010) has been the main guidance for livestock breeding.

Priorities for the livestock sector's adaptation are included under three NDCs (*Table 4-4*), which address strengthening climate resilience in ruminant livestock farming techniques, managing swine and poultry farms, and sector-wide research and development, training, and capacity building.

Table 4-4 NDCs of Livestock Sector

NDC #	NDC
1	Introduce adaptation measures to address adverse impacts of climate change on ruminant livestock
2	Introduce technological innovations and interventions to build resilience in poultry and swine farming
3	Improve research, education, awareness and, capacity building for climate change adaptation

4.4.1 Gender Aspects in the Livestock Sector

Most rural communities manage livestock as an income generating scheme. In general, men are responsible for larger animals (mainly cattle), while women tend to engage in animal care and milking. Women are responsible for managing smaller animals such as goats and poultry. Heat stress, drought, floods create more hardship for women who have to provide food and water to maintain the livestock. Maintenance of animal pens and coops in the face of floods and droughts is also a challenge. International organizations in collaboration with the Ministry of Agriculture has taken several initiatives to provide training and involve women in micro entrepreneurships. Several banks in Sri Lanka have taken steps to provide loan schemes to women entrepreneurs who are engaged in animal husbandry, and market dairy products.

4.4.2 Recommendations for NDC Planning and Implementation

As the analysis of the secondary sources indicate, despite many constraints, women make a significant contribution to the livestock sector. It is therefore important to facilitate, support, and enhance their role through the NDCs, for more efficient and effective overall NDC outcomes. The following recommendations are suggested for consideration:

(a) NDC activity planning and implementation in the sector need to take into account the division of labour and the significant contribution women provide to the livestock sector, which is a resource to the sector, and complementary to the role men play in the sector.

(b) Incorporate activities to encourage and promote women's engagement and potential in the livestock sector, to be active in community activities (through dairy cooperatives, Rural Development Organisations, and through training and capacity building programmes implemented under the NDC actions).

(c) Include and target women in providing training for adaptation measures, technological innovations and resilient farming systems, machinery, subsidies, to enhance their position in the value chains.

(d) Include collection of sex disaggregated data to review gender responsive activities, and outcomes in the progress review and monitoring of the NDC plans.(Please see Table 4.4.3 for specific actions for gender and socially inclusive implementation)

4.4.3 Livestock Sector NDC Implementation Plan

NDC 1 - Introduce adaptation measures to address adverse impacts of climate change on ruminant livestock (2025)																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1: Identify and promote appropriate adaptation measures, technological innovations and resilient farming systems including heat stress management	DAPH	MoA, PDAPHs, NLDB, VRI, Academia, Milk Processing agencies, Related NGOs	Recommended adaptation measures Number of technological innovations adopted	Reports of DAPH	0 (for all the activities)	In 50% of the existing farms having adaptation measures using technological innovations			√	√	√	√	√	√	√	√	2.3, 2.4, 8.2, 12.2, 13
1.2: Promote integration of rainwater harvesting ponds into medium and large farms	DAPH	PDAPHs, MASL, Milk collecting agencies	Number of ponds adapted by medium and large-scale farms	Quarterly progress reports, Annual reports of the DAPH	0	Established in 50% of the farms in the dry zone			√	√	√	√					2.3, 2.4, 6.b, 12.2, 13.3
1.3: Introduce adaptation measures such as forage conservation, modification of feeding systems to respond to early warnings on extreme weather events	DAPH	MoA, PDAPHs, NLDB, VRI, Academia, Milk Processing agencies, Related NGOs	Number of farmers adapting these technologies, by sex disaggregated data	Records of DAPH, VRI and Feed Registrar's office records	0	Number of farmers – 50%			√	√	√						2.3, 2.4, 13.3
1.4: Introduce/ develop high yielding and climate adaptable new forage and feed resources	DAPH, VRI	MoA, PDAPHs, NLDB, MASL, Academia, Milk	Number of varieties & feed resources promoted and adopted	Reports of DAPH and VRI	3	2 new varieties	√	√	√	√	√						2.3, 2.4, 12.2, 13.3

		Processing agencies, Related NGOs														
1.5: Continuous monitoring/ improved surveillance by veterinary services to detect and respond to new/re-emerging (Leptospirosis, Tick-borne, etc.) climate related diseases	DAPH	PDAPHs, VRI, VICs	Surveillance of new and re-emerging diseases or outbreaks	Reports of DAPH	0	Annual surveillanc e			√	√	√	√	√	√	√	√	2.3, 2.4, 13.3

NDC 2 - Introduce technological innovations and interventions to build resilience in poultry and swine farming (2025)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Facilitate small-scale operators to adopt climate-resilient housing and management practices to reduce heat stress	DAPH	PDAPHs, VRI, Academia, Related NGOs, Private sector	Number of training sessions conducted Sex disaggregated data of participants Facilitation of uptake recommended adaptation measures Number of improved animal housing	Annual reports and statistical bulletin, indicating women farmers included in training	Awarene ss program mes being carried out but not in a planned manner	Target need to be set for the number of training sessions 50% of existing farms adopting adaptation measures to reduce heat stress % of women farmers adopting (out of the above 50%)			√	√	√	√					2.3, 2.4, 8.2, 12.2, 13
2.2: Continuous monitoring/	DAPH	VRI, VIC,	Surveillance	Epidemiologi	0	In all the			√	√	√	√					2.3, 2.4,

improved surveillance by veterinary services to detect and respond to new/re-emerging climate related diseases in poultry and swine		PDAPHs	of new and re-emerging diseases or outbreaks	cal bulletin of DAPH		farms											13.3
2.3: Promote expansion of existing adaptation measures such as modification of feeding systems to manage available feed in responding to early warning systems on extreme conditions	DAPH	VRI, Academia, Private sector	Number of modifications / formulations	VRI reports DAPH Annual report, Feed Registrar's Office records	0	2				√	√	√	√				2.3, 2.4, 13.3

NDC 3 - Improve research, education awareness, and capacity building for climate change adaptation (2030)																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1: Technology and knowledge transfer to implement adaptation measures, considering gender sensitivity in livestock sector	DAPH	PDAPHs, VRI, NLDB, Academia	Technology and transfer assessment Knowledge and technology transfer packages are developed & delivered for relevant target groups (with gender and youth components) Sex	Finalized Assessment report of DAPH Research papers	0	Overall technology and transfer assessment conducted (by 2024) Knowledge transferred to not less than 50% livestock farmers				√	√	√	√	√	√	√	5.b, 13.3

			disaggregated data indicating numbers of women farmers reached with technology and knowledge transfer													
3.1.1: Conduct a gender assessment and analysis for the livestock sector to identify main gender issues in the sector relevant for adaptation, and to set a baseline	DAPH, HARTI	MoA, MoWCSD, PDAPH, Academia, Processing agencies	Sector gender assessment (Women's involvement in the sector, related gender issues, barriers and challenges)	DAPH reports	Some studies available, scattered information	~~Updated~~ sector gender assessment		√	√								5.b, 13.3, 13.b
3.1.2: Incorporate gender issues identified in activity 3.1.1 in identifying, developing and promoting technological innovations, adaptation measures, resilient farming systems	DAPH	MoA, MoWCSD, PDAPH, VRI NLDB, Academia, Processing agencies	Gender responsive adaptation measures, technological innovations	Progress reports/Bulletins of DAPH	Gender issues not emphasised	Gender issues incorporated			√	√	√	√	√	√	√	√	2.3, 2.4, 5.b,13.3, 13.b
3.1.3: Plan and implement activities to engage and target women livestock producers in the promotion of all adaptation measures in the NDC action plan (technological developments, resilient farming systems, forage conservation, feeding systems, processing and marketing mechanisms etc.)	DAPH	MoA, PDAPHs, NLDB, VRI, Academia, Milk Processing agencies, related NGOs,	Women livestock producer engagement	Reports/records of DAPH	Not emphasised	Not less than 30 % of women livestock producers engaged			√	√	√	√	√	√	√	√	2.3, 2.4, 5.b,13.3, 13.b
3.1.4: Encourage women scientists/researchers/technicians/Extension Officers, in developing and introducing adaptation measures recommended in the NDC action plan for the livestock sector in planning and	DAPH, PDAPHs	NLDB, VRI, Implementing partner organisations	Percentage of women scientists/researchers/technicians in planning/deci	DAPH reports include sex disaggregated data	Not emphasised	Not less than 40%			√	√	√	√	√	√	√	√	2.3, 2.4, 5.5, 5.a, 5.b,13.3, 13.b

decision-making positions			sion making														
3.2: Conduct awareness and educational programmes on climate resilience in livestock activities	DAPH	PDAPHs, NGOs, Farmer Organizations, DAD, Private sector	Number of local level extension Officers trained by DAPH (ToT) No of livestock farmers trained by PDAPHs	Records of the P DAPHs. Attendance with sex disaggregated data indicating women livestock farmers/extension officers participation	Not emphasised	25 per year 800 per year				√	√	√	√	√	√	√	2.3, 2.4, 13.3
3.3: Capacity building of all service providing institutions in the livestock sector to promote resilience building measures discussed in NDC 1 and 2	DAPH	PDAPHs, DAD, NLDB, VRI, MASL, Private sector, Processing agencies	No of trainings received by each institution Capacity building material/modules incorporate gender issues No of women participants attended	DAPH reports	Not emphasised	One training per institution per year			√	√	√	√	√	√	√	√	2.3, 2.4, 12.8, 13.3
3.4: Access to risk management and financing to support adaptation to climate risks and changes	Agriculture and Agrarian Insurance Development Board(,AAIB) and other insurance companies	VRI, DAPH, PDAPHs, DMC, Farmer Managed Societies, Private sector	Number of farmers registered for insurance Number of women farmers registered	Annual reports of, AAIB, Farmer Managed Societies, DAPH reports with sex disaggregated information	Less than 10%	Over 60% livestock farmers have access to insurance schemes	√	√	√	√	√	√	√	√	√	√	13.1, 13.3,13.a
3.5: Review and revise existing training curricular in universities offering veterinary and animal	UGC, Academia, DAPH	VRI, PDAPHs, Private sector	Number of modules/courses	Curriculum/modules	0	The integration of climate			√	√	√	√	√	√	√	√	4.7, 13.3

production-related degree programmes and in the Department of Animal Production and Health in addressing climate vulnerability			addressing climate vulnerabilities Number of modules/courses addressing gender issues in climate vulnerabilities on adaptations in the livestock sector			change into all the curricula in veterinary medicine and animal production											
3.5.1: Collect sex disaggregated data for all relevant activities in the adaptations NDCs	DAPH	PDAPHs, NLDB, Milk processing companies	Formats for collection and analysis of sex disaggregated data developed and introduced	DAPH reports, bulletins reporting with sex disaggregated information	0	Practice of collection and analysis of sex disaggregated information enabling gender responsive NDC implementation			√	√	√	√	√	√	√	√	2,5,13
3.6: Research and development to identify climate-resilient breeds/varieties and new technologies for livestock management	DAPH	VRI, PDAPHs, NLDB, Academia, Private sector breeder farms	Climate resilient breeds and fodder varieties identified Technologies developed	Number of communications regarding the research and technologies	Work in progress	2 new breeds 3 new fodder varieties 3 New Technologies	√	√	√	√	√	√	√	√	√	√	2.3, 2.4, 12.2, 13.3

4.5 Water Sector

Southwest and Northeastern winds can bring heavy rain to Sri Lanka. The island's water resources in the South-central region are primarily determined by the topography (the highland massif), as well as by its location across the path of monsoonal winds. The central region's hills block these moisture-laden monsoonal winds, resulting in a distinctive pattern of rainfall. Yet, more than half of the nation's rainfall finally ends up in the sea without any productive usage. Further, the country has many locations where water is scarce, and a sizable portion of it occasionally experiences droughts that last for many months. On the other hand, flooding from the highlands frequently inundates the coastal regions. Further, when using groundwater in some dry zone regions, there is a risk of seawater intrusion.

There are 103 major rivers in Sri Lanka. About 20 of these river basins are perennial, and the remaining rivers are seasonal. Depending on the extent, which ranged from 10 to 10,000 km2, the size of the river basins varies. Geographically, river basins make up around 90% of the land. Despite the absence of sizable natural reservoirs, Sri Lanka has a vast number of man-made tanks and an irrigation canal system, where some of those tanks were built centuries ago and have since been restored to their current state. The Dry Zone has roughly 14,000 tanks, which range in size from 1 to 6,500 hectares. However, most of these cover less than 300 hectares. A crucial component of conserving water resources is the cascade irrigation system in the Dry Zone. However, majority of river basins send 60–70% of their water to the sea; it is these basins that frequently flood[48].

Another important source of water in Sri Lanka is spring water, of which there are approximately 1,544 springs in the districts of Nuwara Eliya, 204 in Kandy, 319 in Kurunegala, 210 in Monaragala, and 288 in Matale. Overall, there are around 3,540 spring water resources nationwide[49].

The Mahaweli Water Security Improvement Programme, the Climate Resilience Improvement Project (CRIP), the Climate Resilient Integrated Water Management Project (CRIWMP), the Strengthening Climate Resilience for Communities in Vulnerable River Basins, Watershed areas and downstream of the Knuckles Mountain Range, and "Surakimu Ganga" (protect our rivers) are just a few of the notable government initiatives to improve water security and management. Authorities are taking Integrated River Basin Management (IRBM) strategies more seriously to improve water security and strike a balance between competing water use demands. For instance, the Integrated Watershed and Water Resources Management Project (IWWRMP) provided access to water for 700,000 people in 7 districts

The National Water Resource Policy and Institutional Arrangement (2020) serves the objective of ensuring the use of water resources in an effective, efficient, and equitable manner, consistent with the social, economic, and environmental needs of the present and future generations. Further, the National Agriculture Policy (Draft) will also provide specific

[48] Colombo Development Dialogue 2, Water Security and Climate Vulnerability, 2018

[49] National Policy on Protection and Conservation of Water Sources, their Catchments and Reservations in Sri Lanka (2014).

guidance on irrigation water use and efficiency.

Water supplies for agriculture, energy production, human health, and human settlements are all anticipated to suffer because of climate change's overall effects on the water security. Availability of comprehensive data/information base is fundamental to understand the impacts on water security and thereby implement relevant interventions to address the issues. In fact, the degree of uncertainty and lack of spatial specificity associated with any water-related estimates is a significant barrier to efficient water governance and planning.

The sector has ten NDCs (*Table 4-5*) which includes one overarching NDC covering IRBM; five NDCs on domestic water use including groundwater monitoring, climate-resilient water supply schemes (WSSs), promoting the use of wastewater, managing salinity at water intakes, capacity building for climate change adaptation; and four NDCs on irrigation water use including restoration, rehabilitation, and augmentation of irrigation systems, the introduction of alternative water sources, improving irrigation efficiency and early warning for river flooding.

Table 4-5 NDCs of Water Sector

NDC #	NDC
1	Integrate River Basin Management (IRBM) adopted in 15 prioritised river basins in Sri Lanka
2	Ground and surface water monitoring in the northern, North-Central and North-Western provinces and other areas of high drinking water vulnerability to drought
3	Promote climate-resilient water supply schemes
4	Promote the use of wastewater for gardening, sanitary, construction, and other purposes to reduce demand for treated water
5	Establish salinity barriers in 3 rivers where intakes are subjected to climate change influenced saline water intrusion during the drought season
6	Capacity building for water sector personnel and public awareness on building resilience to climate change
7	Restore, rehabilitate, and augment 25 major/ medium reservoirs and 300 minor irrigation systems and 200 km length of irrigation canals of Sri Lanka for enhancing climate resilience in the agriculture sector
8	Introduce or promote alternative water resources as a climate change resilience building intervention for domestic and supplementary irrigation
9	Enhance water management in 40 irrigation schemes
10	Assess river floods and mitigation measures and early warning systems for possible flash floods for five priority basins

4.5.1 Gender Aspects in the Water Sector

There is a gendered division of labour in water resource management, i.e., gender-differentiated roles, responsibilities, and corresponding needs and access, which are different for men and women.

Women require access to water to manage domestic water requirements (drinking, cooking, cleaning, sanitation) as well as for production purposes as farmers, workers, and entrepreneurs.

Women traditionally manage household water, family gardens and livestock and are in the frontline of managing impacts of reduced water availability and disaster impacts[50]. Women therefore have a major stake in all matters related to water resource management.

4.5.2 Recommendations for Gender Responsive Planning and Implementation of NDC s in the Water Sector

In consideration of the role and contribution of women in the water sector, it is important to facilitate, support and enhance their role through the NDC implementation process, for more efficient and effective overall NDC outcomes. The following recommendations are suggested for consideration:

i. NDC activity planning and implementation need to account for gender differences in how water resources are accessed, used, and managed both for production related functions and for household functions.

ii. Identify women's, as well as men's roles, status, resources, needs and priorities in relation to water as a basis for defining interventions and planning.

iii. Recognise women's role and stakes, technical knowledge, and capacity to contribute to water management issues in domestic and production spheres.

iv. Ensure women agriculture producers are included in promoting practices introduced through the NDCs (such as rainwater harvesting, water conservation), in training and capacity building programmes by setting a percentage target

v. Include/consult Women Farmer Organisations (i.e., ''Sithamu''- introduced by the Department of Agrarian Development), women members of the CBOs working with community-based water supply projects at planning stages of proposed activities/sub activities.

vi. Carry out activities to encourage and promote women's engagement and potential in the water sector (through community water use organisations, rural development organisations, and through training and capacity building programmes implemented under the NDC actions).

vii. Include collection of sex disaggregated data to review gender responsive activities and

[50] Green Climate Fund. Gender Assessment, FP016: Strengthening the Resilience of Smallholder Farmers in the Dry Zone to Climate Variability and Extreme Events through an Integrated Approach to Water Management (the three target river basin locations are Yan Oya, Malwathu Oya, and Mi Oya).

outcomes in the progress review and monitoring of the NDC plans.

4.5.3 Water Sector NDC Implementation Plan

NDC 1 - Integrated River Basin Management (IRBM) approach adopted in 15 prioritized river basins in Sri Lanka																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1 River basin wide vulnerability, risks and capacity assessments carried out in 15 river basins in Sri Lanka.	MoIrri	MoWS, ID, MASL, PIDs, DoA, DAD, WRB, FD, DWC, NWSDB, CEB, LUPPD, BOI Academia & Research Agencies, NGOs, INGOs	Number of Assessments completed in river basins	Completed Assessments Reports and other records of MoIrri	10 complete d under CRIP	15	√	√	√	√	√	-	-	-	-	-	6.6, 13.1
1.2 Climate change adaptation considerations built into integrated river basin management planning initiatives of Sri Lanka	MoIrri	MoWS, ID, MASL, PIDs, DoA, DAD, WRB, FD, DWC, NWSDB, CEB, LUPPD, BOI Academia & Research Agencies, NGOs, INGOs	Number of integrated plans	Prepared plans and other records of MoIrri	6 complete d under CRIP	15	√	√	√	√	√	√	-	-	-	-	6.5, 13.2, 15.1
1.3 Water resource development and management plans for the selected 15 river basins are prepared.	MoIrri	MoWS, ID, NWSDB, DCWS, Provincial Authorities,	Number of water resource development and	Prepared plans and other records of MoIrri	6 complete d under CRIP	15	√	√	√	√	√	√	√	√	√	√	6.5, 6.6, 13.1

		DAD, DoA, MD, WRB	management plans														
1.4 Integrated River Basin Management (IRBM) plans are prepared (by 2025) for at least five critical river basins and implemented. (Five basins identified are Kalni, Attanagalu, Mahaweli, Malwathu, Gin)	MoIrri	MoWS, ID, LUPPD, MoE, NPPD, DAD, MASL, NWS&DB	1. Number of IRBM plans prepared 2. Number of IRBM plans implemented	Approved plans, progress reports and other records of MoIrri	1. None 2. None	1. Five (5) by 2025 2. Five (5)	√	√	√	√	√	√	√	√	√	√	6.5, 13.1, 15.1
1.5 Establish water flow and sediment load monitoring systems in five priority basins	ID	MorriI, MoWS, MASL, LUPPD, NPPD	1. Number of systems established for water flow 2. Number of systems established for sediment load	Updated data base at ID	1. None 2. None	1. Five (5) 2. Five (5)	-	-	-	√	√	√	-	-	-	-	6.4, 6.5, 13.1
1.6 Harness excess water in selected river basins to storage facilities elsewhere through trans-basin diversions	ID	MoIrri, MASL, CEA, IWMI, FD, DWC, DAD, NWS&DB, CEB, Academia, IUCN	Number of feasibility studies	Feasibility Reports and other records of ID and MASL	Upper Elahera canal & Wayamb a Ela (NWP diversion) under MWSIP in progress, Uma oya diversion to Kirindi oya in progress	Three (3)	√	√	√	√	√	√	√	-	-	-	6.5, 12.2, 13.1
1.7 Enhancement of water retention/recharge in catchments using appropriate measures such as ecosystem restoration, tree planting, small ponds, check dams to enhance climate resilience	MoIrri	MoWS, MoA, MCWS, MASL, DCWS, ID, DAD, FD, WRB, IMD,	Number of initiatives	Annual reports and other records of MoIrri, MoWS, MoA, MASL	None	Target to be established (5 priority basins are there)	-	-	√	√	√	-	-	-	-	-	6.6, 13.1, 15.1

		NGOs, MASL, NWS&DB, CBOs, Academia, International Org															
1.8 Implementation of the five plans addressing climate vulnerability	ID	MoIrri, MoWS, MASL, PIDs, DoA, DAD, WRB, FD, DWC, NWSDB, CEB, LUPPD, BOI Academia & Research Agencies - local and international, NGOs	Number of plans implemented	Records / annual reports of MoIrri, MoWS, MoA, MASL	None	Five (5)	-	-	-	-	-	√	√	√	√	√	13.1, 13.2
1.9 Prepare remaining 10-climate inclusive river basin development plans. Ten basins identified are Kala Oya, Ma Oya, Gal Oya, Deduru Oya, Mundeni Aru, Mi Oya, Yan oya, Kalu Ganga, Nilwala and Kirindi Oya	MoIrri	MoWS, ID, LUPPD, MoE, NPPD, DAD,	Number of IRBM plans	Approved IRBM plans and other records of MoIrri, ID	None	Ten (10)	-	-	-	-	-	√	√	√	√	√	6.5, 6.6, 13.2

NDC 2 - Ground and surface water monitoring in the Northern, North Central and North Western provinces and other areas of high drinking water vulnerability to drought

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1 Conduct risk assessments and contingency plans for all new drinking water projects in priority areas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

2.1.1 New drinking water projects	NWSDB	MoWS, WRB, LA, CEA, DoI, DNCWS, MASL	Number of new projects with risk assessments and contingency plans	Progress reports of Corporate Plan of NWSDB	18 (out of 44 A1 projects)	143	√	√	√	√	√	√	√	√	√	√	6.1, 6.4, 6.6, 13.1
2.1.2 New community-based drinking water projects	DNCWS	MoWS, WRB, LA, CEA, DoI, NWSDB	Number of new Community based Water projects with risk assessments and contingency plans	Water safety plans, National survey report from Dep of Census and Statistics	23	4000	√	√	√	√	√	√	√	√	√	√	6.1, 6.4, 6.6, 13.1
2.2 Seek new water sources and options (i.e. rainwater harvesting and sub surface water) to augment water supply in areas where supply is scarce	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.2.1 Seek new water sources and options – Surface and sub surface water	NWSDB	WRB, DNCWS, DAD, ID, DoA, MASL, Plantation Sector Co,	1. Number of Ground Water Sources approved 2. Number of Surface Water Sources approved	Ground water and surface source approvals (Databases of ID, MASL, NWSDB), Corporate plan of NWSDB, and Study reports / Annual reports of WRB, DNCWS, ID, MASL,	1. None 2. 165	1. 6 2. 253	√	√	√	√	√	√	√	√	√	√	6.1, 6.4, 6.5, 6.6, 13.1
2.2.2 Seek new water sources and options – Promote rainwater harvesting (RWH)	DNCWS	LRWHF, NWSDB Plantation	1. Number of Rainwater harvesting	Study Reports/ Annual	1. 48,000 (cumulative) by	1. Additional 20,000	√	√	√	√	√	√	√	√	√	√	6.1, 6.4, 6.5, 6.6, 13.1

		Sector Co, DAD, ID, DoA	systems (RWHSs) installed 2. Number of RWHS with well water recharging systems installed	reports of DNCWS, LRWHF	SLRWHF 2. 800 (cumulative) by LRWHF	(10,000 by DNCWS and 10,000 by LRWHF with further external funding) 2. Additional 5,000 (by LRWHF)											
2.3 Mitigation of drought impact by establishing "Provisional" (Standby) deep wells on risk prone districts	WRB	NWSDB, DNCWS, LAs, DS	1. No of investigation reports of provincial sources (new and existing wells) in identified areas 2. No of provisional wells established (constructed/ rehabilitated) within the risk prone areas	NWSDB Groundwater Investigation reports, Disaster mitigation reports of WRB, NWSDB, DMC & other stakeholder agencies working on the drought mitigation	1. 100 reports 2. 50 wells	1. Additional 2,000 reports 2. 1,000 wells	√	√	√	√	√	√	√	√	√	√	6.1, 6.6, 13.1
2.4 Identify and implement appropriate groundwater recharge systems of the water deficit areas	WRB	NWSDB, DNCWS, IWMI, LRWHF, NGOs, CBOs, LAs	1. 1. No. of areas feasible for implementing groundwater recharge systems 2. No. of	Study Reports of WRB, Reports of the NWSDB	1. One area 2. One (Wariyapola)	1. 10 areas 2. Additional 10 = One per year (Cumulative 11)	√	√	√	√	√	√	√	√	√	√	6.5, 6.6, 13.1

			large-scale groundwater recharge systems installed														
2.5 Ensure water security at all times with the required quality and quantity of water	NWSDB	WRB, DNCWS, DCS, DS, NGOs, CBOs, LAs, DS	1. % No of samples tested satisfied for microbiology and physical parameters against no of samples tested 2. Total quantity (MCM/day) produced and delivered per day (pipe borne), 3. Number of wellhead protection established, 4. Total no. of new schemes with required quality (SLS 614, based WHO guidelines), 5. % of Rural water Supply Schemes (RWSSs) Rehabilitated	MIS Reports of NWSDB by Central Lab and Regional Labs, Progress of the Corporate Plan of NWSDB, Groundwater investigation reports of NWSDB, Annual action plan of DNCWS,	1. 99% 2. 2.14 MCM/day, 3. 0, 4. None, 5. Baseline to be established.	1. 100%, 2. 3.00 MCM/day, 3. 45, 4. 1,000 new schemes (under PrajaJalaAbimani 1000 village programme implemented by DNCWS), 5. 100% (Note: DNCWS will rehabilitate 4,000 registered community water schemes)	√	√	√	√	√	√	√	√	√	√	6.1, 6.6, 13.1

			to ensure required water quality (SLS 614 WHO guidelines)													
2.5.1. Climate resilient Water safety plans for WSSs	MoWS	NWSDB, DNCWS, MASL, DoI. PCs & LAs, MoH, MoE, UNICEF	No of scheme specific Water Safety plans	Records of WSP audits (Internal Formal Audits)- NWSDB, DNCWS	28 by NWSDB and DNCWS	344 WSSs (NWSDB) and 4,000 Community water schemes (DNCWS)	√	√	√	√	√	√	√	√	√	√	6.1, 6.6, 13.1
2.6 Establish sustainable extraction levels of ground water in at least three river basins (by 2025) and expand coverage by further three river basins	WRB	DNCWS, IWMI	No of ground water resources tested for extraction commercial & industrial scale)	Records of WRB, Regulation reports of the ground water resources of a particular river basin (management reports)	None	At least 3 by 2025 and further 05 by 2030 (Total 8)	-	-	√	√	√	√	√	√	√	√	6.4, 6.5, 6.6, 13.1

NDC 3 - Promote climate-resilient water supply schemes																
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1 Establish new technology in real-time measurement of water quality and level on major water sources in a collaborative manner with water sector institutions	MoWS	NWSDB, DNCWS, CEA, UDA, LAs, IWMI, WRB, MoH	1. A System for real-time measurement of water quality and level on major water	Publish report by responsible agencies (MoWS, NWSDB,DNCWS & WRB), Real	1. Some systems available at agency level, without central	1. Established system (by 2025) 2. Three by 2028	√	√	√	√	√	√	√	√	-	-	6.3, 6.a

			sources 2. No of real time monitoring stations for water quality measurement 3. A central database	time monitoring database / report from NWSDB (Quality and river water level),	coordination 2. One (Kelani river at Amgatale) 3. Not available	(Two additionally - Kalu Ganga and CHICO plant at Kelani River) 3. Established Central database (by 2028)											
3.1.1 Promote RWH for domestic use with regular testing and monitoring	MoWS	LRWHF, LAs, WRB, NWSDB, DNCWS, NGOs, CBOs, UDA	1. A System for monitoring and measurement of water quality of domestic RWHSs 2. No of household having RWHSs	Records of MoWS, LRWHF, DNCWS	1. Some monitoring 2. About 50,000 (include 48,000 systems installed by LRWHF)	1. Established system by 2025 2. Additional 20,000 (10,000 by DNCWS and 10,000 by LRWHF)	√	√	√	√	√	√	√	√	√	√	6.1, 6.4, 6.5, 6.6, 13.1
3.2 Device mechanisms to supply of safe drinking water during floods, droughts and during saltwater intrusion for all water supply schemes vulnerable to floods, droughts and saltwater intrusion.	MoWS	NWSDB, DNCWS, DMC, MD,, DoI, LAs, DS, UNICEF and other development partners	1. WASH Cluster coordinating mechanism, 2. Infrastructure for emergency water supply during disasters (such as drought, salt water	Water safety plans of MoWS, NWSDB, DNCWS, WASH Strategy for emergency response, reports and minutes of DMC, Disaster Management Plans.	1. Not fully operational 2. Limited infrastructure and facilities 3. 28 (Internal Formal Audits) and 14 (External Formal	1. Re-activated and fully operational WASH Cluster coordinating mechanism by 2025 2. Target is to be established 3. 208 (Internal	-	√	√	√	√	√	√	√	√	√	5.5, 6.1, 6.5, 13.1

			inclusion and floods) – Mobile treatment facilities, Bowsers, water bottles, treated water units 3. Emergency response plans under Water Safety Plans (WSPs) by NWSDB 4. Institutional Disaster Management Plan		Audits) 4. Not commenced	Formal Audits) and 84 (External Formal Audits) by 2024 4. Adopted plan by 2024											
3.3 Strengthen interagency coordination for early warning on climate and weather-related disasters and health emergencies with timely disaster response	DMC	MoWS, DoI, NBRO, MD, DMC, MoH	Effective inter-agency coordinating mechanism	Records of DMC	Existing coordinating mechanism	Existing interagency coordination system strengthened	√	√	√	√	√	-	-	-	-	-	5.5, 6.1, 13.1
3.4 Innovative approaches such as Payment for Ecosystem Services (PES) to be explored for catchment protection in vulnerable regions	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.4.1 Develop innovative approaches for catchment protection in vulnerable regions	MoE	MoWS, FD, DWC, CEA, DoA, Pvt sector, NGOs, CBOs, IUCN	1. Number of innovative approaches/ tools introduced 2. Number of projects implemented with	Records of MoE, MoWS, FD, Water Safety Plan, Progress reports from MoWS (WASIP)	1. None 2. None	1. At least two innovative approaches/ tools by 2024 2. The target number of projects to	-	-	√	√	√	√	√	√	√	√	12.2, 15.9

			innovative approaches			be established											
3.5 Establish desalination or RWH facilities in most vulnerable areas with inadequate other sources of potable water	MoWS,	NWSDB, LAs, LRWHF, Private Sector	1. No of desalination plants completed against planned 2. No. of RWHSs installed	Progress reports of the MoWS, NWSDB and DNCWS, Records of LRWHF	1. Two (2) Desalination plants (Nainathivu & Delft – 1000 m3/day) 2. About 50,000	1. Four (4) (Additional two desalination plants: Jaffna Tallaiadd by 2024i - 20,000 m3/day and Kalpitiya – 10,000 m3/day by 2030) 2. Additional 20,000 by 2030	√	√	√	√	√	√	√	√	√	√	6.1
3.6 Minimize the level of Non-revenue Water (NRW) as a water conservation / efficiency improvement measure in all water supply schemes.	MoWS	NWSDB, DNCWS, LAs	NRW percentage	MIS report of NWSDB	24.63%	15%	√	√	√	√	√	√	√	√	√	√	6.1, 6.5

NDC 4 - Promote the use of wastewater for gardening, sanitary, construction and other purposes to reduce demand for treated water																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4.1 Some policy initiatives at the national level for use of treated water for other purposes piloting in industries, industrial parks and apartment buildings	MoWS	CEA, BOI, NWSDB, LAs, MSc, Academia, Research Agencies including	Policy and legislative instruments and instructional setup: 1.	Published Amended Act and policies, Meeting minutes and other records of MoWS and	Not commenced	Conducive Policy and legislative instruments and instructional setup in	-	√	√	√	√	√	-	-	-	-	6.3, 6.a

		IWMI, LRWHF	Amendments to the Act 2. National Policy on Sanitation 3. National Level Integrated water resource management (IWRM) policy 4. Improved organizational setup for IWRM	other stakeholder agencies		place 1. Amended Act 2. Approved National Policy on Sanitation 3. Approved National Level IWRM policy 4. New organizational setup for IWRM											
4.2 Promotion of most appropriate mechanisms of water conservation / reusing / recycling for different purposes	MoWS	MoI, MoE, MoH, Chambers, UDA, LA, NWSDB, SLLDC, LRWHF, DNCWS, Tourism sector agencies, Construction Co (high rises), high water consuming industries,	1. Number of promotional programme conducted per year 2. Different purposes having potential for water conservation / reusing / recycling 3. % of institutions having appropriate	MI Reports, report related to the domestic waste water monitoring NWSDB Reports – Quantity reused or recycled	Baselines to be identified	1. To be established 2. To be identified by 2024 3. Target to be established 4. 13,300 m3/day of treated wastewater for Agriculture purposes in Jaffna district by 2030 and	√	√	√	√	√	√	√	√	√	√	6.4, 6.a

			mechanisms 4. Quantity reused/ recycled			Reusing 20 m3/day of treated wastewater for Vehicle washing in Rathmalana , Colombo District by 2025											
4.2.1 Implement regulatory measures for water fittings	NWSDB	SLSI, MoWS,	1. Number of appliance categories covered 2. Testing facility	Published regulations, Minutes of expert consultation meetings; Records of SLSI, NWSDB, MoWS	1. Not commenc ed 2. Not commenc ed	1. Six categories (Float operated valves – metal, Float operated valves - PVC, all valves – metal, all valves – PVC, ceramic commodes, cisterns) by 2024 2. Established Water fittings testing units at SLSI & testing of fittings	√	√	√	√	-	-	-	-	-	-	6.4, 6.a
4.2.2 Establishment of interagency coordination mechanism for Activity 4.2	MoWS	MoH, UDA, LAs, NWSDB, SLLDC,	Interagency coordination mechanism and	Records of MoWS, Consultation meeting	There was a water and sanitation	Interagency coordinatio n mechanism	-	-	√	√	√	√	√	√	√	√	17.20

		LRWHF, DNCWS, WRB, CEA	organizational setup for water conservation/ reusing/recycling	records, Meeting minutes	platform, which could reactivated to implement this activity	and organizational setup enacted by 2024 and operationalized										
4.3 Introduce by-laws and building codes to introduce reuse of wastewater in new industrial constructions including areas under industrial estates	MoUD&H	USDA, UDA, LAs, MoI, BOI, NWSDB, Tourism sector agencies, CEA, SMEs, SLSEA, Academia	1. Number of legal instruments (such as by-laws and codes) enforced 2. Number of final green building certifications issued	Records on legislations, regulations, codes enacted/ published	National Green Building Regulations (Blue Green SL) enforced by UDA (incorporating marks for wastewater reuse, buildings above 1,000 m2 – mandatory, industrial sector not covered at present)	Targets to be established	-	-	√	√	√	-	-	-	-	-	6.3, 12.5
4.4 Introduce market mechanisms for promoting above.	MoWS	MoE, MoF, CBSL, CIDA, BOI, SMEs, NWSDB USDA, UDA, Academia	Market mechanisms	Records of MoWS	In related policies (e.g. NEP), regulations (e.g. EPR) and action plans	Market mechanisms established	-	-	√	√	√	-	-	-	-	-	12.8

					(e.g. NEAP), need for this has been identified												
4.5 Public awareness-raising on private and social benefits of wastewater management	MoWS	MoH, MoE, NWSDB, CEA, DoGI	No of public awareness programs on benefits of reusing waste water developed and conducted per year	Records of MoE, Progress reports, Annual reports	Some awareness programmes were conducted under projects implemented with the assistance of Development partners (NWSDB)	At least 10	√	√	√	√	√	√	√	√	√	√	6.b, 12.8
4.5.1 Some policy initiatives at the national level for use of treated water for other purposes piloting in industries, industrial parks and apartment buildings	MoWS	CEA, BOI, NWSDB, LAs, MSc, Academia, Research Agencies including IWMI, LRWHF	Policy and legislative instruments and instructional setup: 1. Amendments to the Act 2. National Policy on Sanitation 3. National Level Integrated water	Published Amended Act and policies, Meeting minutes and other records of MoWS and other stakeholder agencies	Not commenced	Conducive Policy and legislative instruments and instructional setup in place 1. Amended Act 2. Approved National Policy on Sanitation	-	√	√	√	√	√	-	-	-	-	6.3, 6.a

			resource management (IWRM) policy 4. Improved organizational setup for IWRM			3. Approved National Level IWRM policy 4. New organizational setup for IWRM										

NDC 5 - Establish salinity barriers in 03 rivers where intakes are subjected to climate change influenced saline water intrusion during the drought season (covering Kelani Ganga, , Kalu Ganga, and Malwathu Oya)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
5.1 Identify best solutions (covering technical and financial) for salinity barriers for each case	NWSDB	ID, IWMI, CEA, LHI, Academia	1. No of Salinity barriers having identified best solutions including water quality, quantity and water flow to identify the salinity intrusion 2. Number of Feasibility reports	Preliminary Study Completion reports (including feasibility reports and EIAs), Records of NWSDB and ID on feasibility assessments	1. Three (Completed in 2020 - At Gin Ganga, Nilwala Ganga and Walawe Ganga) 2. Three feasibility Studies for salinity barriers at Gin Ganga,	1. Five (Additional two at Ambathale and Kalu ganga) 2. Five (Additional two feasibility studies at Ambathale and Kalu ganga)	√	√	√	√	-	-	-	-	-	-	6.5, 6.6, 6.a

					Nilwala Ganga and Walawe Ganga were complete d												
5.2 Establish salinity barriers at each critical river identified	NWSDB	ID, CEA, Academia	Number of salinity barriers installed	Records of NWSDB and ID, Project Completion reports	Two (At Gin Ganga and Walawe Ganga)	Five (Additional three at Kalani Ganga - Ambatalae, Kalu Ganga and Nilwala Ganga)	√	√	√	√	√	√	√	√	-	-	6.1, 6.6, 6.a
5.3 Assess and establish regulatory mechanisms to manage ground water extraction in areas with salinity intrusion issue	WRB	ID, NWSDB, IWMI	No of sources been regulated by the established mechanisms	Management , regulation or technical reports (Annual Study reports on the coastal areas included with the possible recommendati ons)	100	410	√	√	√	√	√	√	√	√	√	√	6.1, 6.6, 6.a
5.4 Monitoring and recording of saline water intrusion into drinking water sources especially during drought periods	NWSDB	MoWS, WRB, DNCWS, Academia	Frequency of Water quality Monitoring	Management Information (MI) Reports	Daily reports	Daily reports	√	√	√	√	√	√	√	√	√	√	6.1, 6.6, 6.a
5.5 Strengthening interagency coordination in early warning of salinity intrusion and allocation of water for flushing as a priority when needed	MoWS	MoD, MoE, DoI, DoA, CEB, MASL, NWSDB, DNCWS, NPPD	1. Interagency coordination framework 2. Frequency of meetings	Water Panel Meeting minutes	1. Present interagency coordination with limited river basin coverage, 2.	1. Interagency coordination strengthened 2. Maintain the weekly meetings	-	-	√	√	√	√	√	√	√	√	6.6, 6.a, 13.1, 17.20

					Weekly											
			Number of salinity barriers installed	Records of NWSDB and ID, Project Completion reports	Two (At Gin Ganga and Walawe Ganga)	Five (Additional three at Kalani Ganga - Ambatalae, Kalu Ganga and Nilwala Ganga)	√	√	√	√	√	√	√	√	-	-	6.1, 6.6, 6.a

NDC 6 - Capacity building for water sector personnel and public awareness on building resilience to climate change

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
6.1 Capacity needs assessment of the water sector institutions and the personnel on climate resilience building	MoWS	NWSDB DNCWS, WRB, CCS, IWMI, UNICEFF, Provincial Authorities, s, DAD, Academia	1. Main capacity gaps on climate change impact facts that to be adapted to any situation identified number of participants 2. Number of Staff trained on Climate-resilient water safety planning (CRWSP) 3. Number of Staff trained under	Need Assessment Reports and post Evaluation reports, Post Evaluation reports (outcome base) training on CRWSP, DNCWs Training Plan	1. Limited informati on on capacity gaps 2. 120 (NWSDB) 3. Baseline to be identified	1. Main capacity gaps on climate change impact facts that to be adapted to any situation identified by 2024 2. 1,350 3. 468 Annually	√	√	√	√	√	√	√	√	√	√	6.a, 13.1

			DNCWS Training Plan													
6.1.1 Include gender awareness and gender issues in climate change with specific reference to water sector in the above capacity needs assessment	MoWS	NWSDB DNCWS, WRB, CCS, IWMI, UNICEFF, Provincial Authorities, , DAD, Academia	1. Main capacity gaps for gender responsive planning and implementation on identified and equal gender participation 2. Number of training programmes on gender responsive CRWSP conducted 3. Number of Staff trained on gender responsive CRWSP	Need Assessment Reports inclusive of gender aspects in CC and water sector post Evaluation report training on CRWSP	1. Limited information on capacity gaps for gender responsive planning and implementation 2. Baseline to be identified 3. Baseline to be identified	1. Main capacity gaps for gender responsive planning and implementation identified 2. Target to be established 3. Target to be established	-	√	√	√	√	√	√	√	√	√	5.5, 6.5, 13.1
6.2 Prepare plans for building capacity in each institution to effectively implement the sector NDCs including that of community water supply schemes	MoWS	NWSDB, DNCWS, CCS, IWMI, UNDP, UNICEFF, DNCWS, DoA, LAs, DAD, Academia, LRWHF, NGOs	1. Monitoring and evaluation (M&E) system for capacity building initiative 2. Number of training programmes for effective implementation of the	Records of the training programmes, Post Evaluation reports	1. Not in place 2. None 3. None	1. Operational M&E system by 2025 2. 8 programmes (one per year) by NWSDB 2. 60 annually by NWSDB	-	-	√	√	√	√	√	√	√	√	6.a, 13.1

			sector NDCs conducted 3. Number of Staff trained for effective implementation of the sector NDCs														
6.2.1 Capacity building in drinking water - Community water supply sector	DNCWS	MoWS, NWSDB, WRB, CCS, IWMI, UNICEFF, LAs, Academia	1. Number of capacity building programmes conducted 2. Number of participants/ trainees	Records on capacity building programmes (MoWS, DNCWS, NWSDB)	Baselines to be identified	1. 40 programmes for officers, 500 for CBOs 2. Target to be established	√	√	√	√	√	√	√	√	√	√	6.1, 6.a
6.2.2 Capacity building in the RWH sector	DNCWS	LRWHF, MoWS, CCS, IWMI, UNICEFF, LAs, Academia	1. Number of capacity building programmes conducted 2. Number of participants/ trainees	Records on capacity building programmes (MoWS, LRWHF, DNCWS)	Baselines to be identified	1. One per year, Eight in total (2 programs for government official on RWH in Badulla and Mullativu. 6 training program for constructio n of RWHS conducted in Badulla, Moneragala , Mulaltivu,	√	√	√	√	√	√	√	√	√	√	6.1, 6.a

						Mannar, and Anuradhapura by LRWHF). This is in addition to the five programmes conducted in 2021 and 2022.											
6.2.3 Incorporate gender aspects in climate change adaptation in the domestic water use sector in the capacity building plans	MoWS	NWSDB DNCWS, CCS, IWMI, UNDP, UNICEF, DCWS, DoA, LAs, DAD, Academia, NGOs, LRWHF	1. Capacity building plans incorporating gender aspects in CC and water sector 2. Number of capacity building programmes incorporating gender aspects in CC and water sector conducted 3. Percentage of participation by gender	Capacity building plans and completion report	1. Not formulated 2. Five training programmes on CRWSP &SP conducted 3. Baseline to be identified	1. Capacity building plans formulated 2. Target to be established 3. Fair % of gender participation	√	√	√	√	√	√	√	√	√	√	5.5, 6.b, 13.1
6.3 Awareness raising and behavioral change campaigns for the public towards sustainable use of water as a climate resilience building for water security	NWSDB	MoWS, DNCWS, ID, MASL, NGOs, UNICEFF, UNDP, Research Org,	Number of awareness programmes conducted by NWSDB and DNCWS	Water Safety Plans (WSP) documents	28 by NWSDB, Awareness programmes	208 by NWSDB Target for DNCWS to be obtained	√	√	√	√	√	√	√	√	√	√	6.b, 6.5., 13.3

		GWP, NGOs, CBOs			conducted by DNCWS to be obtained												
6.4 Capacity development in communities and Community Based Organizations (CBOs) in addressing climate resilience in water resources	DNCWS	NWSDB, Academia, International Organizations, NGOs, CBOs, Private Sector including Plantation Companies	1. Number of capacity development programmes conducted 2. Number of participants	DNCWs Progress Report	Baselines to be identified	1. Target to be established 2. 32,000 participants	√	√	√	√	√	√	√	√	√	√	6.b, 13.3
6.4.1 Incorporate gender issues into the capacity development programmes, allocate a share/a percentage for women participants in the programmes	DNCWS	NWSDB, Academia, International Organizations, NGOs, CBOs, Private Sector including Plantation Companies	- 1. Incorporation of gender aspects in Training modules 2. Percentage of women participation	Progress reports, Training modules	Not initiated	1. Training modules have incorporated gender issues 2. Target to be established	-	-	√	√	√	√	√	√	√	√	5.5, 6.b, 13.3
6.5 Demand-side management and promotion of 3R amongst water users in most vulnerable areas for climate change	MoWS	MoI, NWSDB, DNCWS, ID, CEA, BOI, IWMI, Academia, NGOs	1. Number of promotional / awareness programmes conducted 2. Number of programmes for School children	Progress reports, Attendance records	None	1. Target to be established 2. 250 for School children	-	-	√	√	√	√	√	√	√	√	5.5, 6.5, 13.3
6.6 Establish accreditation schemes for water sector technicians/plumbers with awareness on climate change vulnerabilities	NWSDB	CIDA, VTA	1. Accreditation schemes	Records on the accreditation schemes and	Accreditation scheme under	1. Accreditation schemes established	-	-	√	√	√	√	√	√	√	√	5.5, 6.5, 13.3

			2. Number of personnel accredited	on Number of certificates issued	development	2. 50 annually by NWSDB											

NDC 7 - Restore, rehabilitate and augment 25 major /medium reservoirs and 300 minor irrigation systems and 200 km length of irrigation canals of Sri Lanka for enhancing climate resilience in the agriculture sector																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
7.1 Prioritize abandoned tanks (including small tank cascade systems) and canals to be rehabilitated in the most critical areas of climate change vulnerability paying attention to productivity gains in restoration	MoIrri	DAD, ID, PIDs	Prioritized List	Reports of ID	None	Prioritized List prepared	√	-	-	-	-	-	-	-	-	-	6.5, 13.1
7.2 Prepare indicative cost estimations, means of implementation with national capacity and international support needed for the priorities for restoration	MoIrri	DAD, ID, PIDs	Cost estimation of prioritized list	Reports of ID	Cost estimation of a few major / medium tanks available	Cost estimation of prioritized list completed	√	-	-	-	-	-	-	-	-	-	17.20
7.3 Restoration / rehabilitation of 50 tanks and canals of 100km length	MoIrri	DAD, ID, PIDs	Prioritized minor tanks restored / rehabilitated Prioritized canals rehabilitated	Reports of ID	Ongoing activity	50 tanks out of prioritized minor tanks restored / rehabilitated 100 km out of 200 km of prioritized canals	√	√	√	√	√	√	√	√	√	√	6.5

						rehabilitated											
7.4 Augment capacity of irrigation tanks to enhance climate change resilience covering 25 major/medium reservoirs	MoIrri	ID	Prioritized major/medium tanks augmented	Reports of ID	Ongoing activity	25 tanks out of prioritized major/medium tanks augmented	√	√	√	√	√	√	√	√	√	√	6.5, 13.1
7.4.1 Construction of upstream reservoirs for drinking water	NWSDB	MoWS, MoIrri	Number of tanks constructed	Feasibility studies and other records of NWSDB	2	4	√	√	√	√	√	√	√	√	√	√	6.5

NDC 8 - Introduce or promote alternative water resources as a climate change resilience building intervention for domestic and supplementary irrigation																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
8.1 Carryout feasibility studies for use of alternative sources of water for irrigation and ground water recharge for building climate resilience	DoI	LRWHF, WRB, NWSDB, DNCWS, MASL	Feasibility studies conducted	Records of DoI, MASL, NWSDB	0	One feasibility study conducted as a pilot	√	√	√	√	√	-	-	-	-	-	6.5, 13.1
8.1.1 Promote appropriate alternative sources of irrigation according to above study findings (2030)	DoI	LRWHF, WRB, NWSDB, DNCWS, MASL	1. No of proposals prepared 2. No. of RWHS for irrigation installed 3. % no of women targeted/participated in promotion of	Records of ID, DAD, PIDs, MASL	1. None 2. To be updated – information available at HARTI 3. None	1. Target to be set 2. LRWHF target : 250 RWH ponds for irrigation 3. Target to be set	-	-	-	-	-	√	√	√	√	√	5.b, 5.5, 13.3

			alternative sources of irrigation														
8.1.2 Update the draft gender assessment and analysis for the Irrigation sector to identify main gender issues in the sector relevant for adaptation with external assistance	MoIrri	ID, DAD, PIDs, LRWHF, WRB, MASL	Assessment	Records of ID Sector gender assessment document with recommendations for identifying and promoting gender responsive adaptation measures in the Irrigation sector; Records of communication of the findings	None	Main gender issues in the irrigation sector documented and shared amongst sector institutions	-	-	√	√	-	-	-	-	-	-	5.5, 6.5
8.1.3 Build awareness and capacities of the main planning and implementation agencies in irrigation sector on gender issues related to climate change and access and use of irrigation water	MoIrri	Ministry in charge of Women affairs, International Development agencies	Number of Awareness building programmes conducted on gender issues in climate adaptation at the planning and decision-making level Number of agencies covered per year	MoIrri Reports on awareness and training programmes on gender issues in climate adaptation, on gender responsive planning &implementation	None so far	10 (One Programme per year covering all relevant agencies)	-	-	√	√	√	√	√	√	√	√	5.b, 6.5
8.1.4 Ensure women participation in promoting technology and knowledge	MoIrri	MoWS, ID, MASL,	% of women targeted and	ID and MASL	Not assessed	Not less than 15%	-	-	-	√	√	√	√	√	√	√	5.b, 13.3

transfer activities, training sessions, extension programmes, demonstration, etc. in promoting climate adaptation activities in the irrigation sector		NWSDB, DCWS, Provincial Authorities, DAD, DoA, MD, WRB	reached	reports indicating women's engagement/participation		of women included in the climate adaptation activities in the irrigation sector											
8.2 Assessment & identify priority domestic water supply and priority supplementary irrigation schemes to be supported by groundwater resources (by means of tube wells/deep wells) as a climate change resilience building intervention	WRB	NWSDB, LRWHF, ID, DCWS, UNICEF	Prioritized list	Records of NWSDB, WRB, ID	None	Prioritized list completed	√	√	√								6.4, 6.5, 13.1
8.2.1 Include consultations with women at the local level and their participation in the assessment & identifying priority domestic water supply and priority supplementary irrigation schemes as a climate change resilience building interventions (activity 8.2)	MoI rri	MoWS, NWSDB, WRB, LRWHF, DCWS, ID, MASL, UNICEF	1. No of women's organizations consulted 2. No of women consulted.	Assessment reports from MoIrri, MoWS, NWSDB, LRWHF WRB indicating women's inputs to the process.	1. None 2. None	1. Target to be established 2. Target to be established	-	-	-	√	√	√	√	√	√	√	5.5, 6.5, 13.3
8.3 Regulate provision of groundwater through Agro wells for irrigation based on water availability and safe abstraction levels (2030).	WRB	DCWS, DAD, NWSDB	Level of enforcement of the Regulations	WRB	Regulation in place	Target need to be set	√	√	√	√	√	√	√	√	√	√	6.5, 15.1
8.3.1 Include gender expertise in the PMUs and Planning teams	MoWS	MoIrri , NWSDB, WRB, DAD	Percentage of PMUs and planning teams equipped with gender expertise, as reflected by the gender analysis	Records of MoWS and MoI (Reports with gender analysis related to irrigation water sector; Sex	None	All PUMs and Planning teams by 2030	-	-	√	√	√	√	√	√	√	√	5.5, 13.1

			related to the projects implemented	disaggregated data on the relevant climate change resilience building interventions													

NDC 9 - Enhance water management in 40 irrigation schemes

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
9.1 Increase system water use efficiency in irrigation schemes by 10% to cover at least 45,000 ha of irrigated land	MoIrri	ID, MASL	Number of schemes and extent covered	Records of ID and MASL	Current water duty (Acre feet per acre) of different schemers ranging from 4 – 7 feet (Average 5.5 feet)	30 schemes in ID Balance 10 schemes in MASL	√	√	√	√	√	√	√	√	√	√	2.4, 6.5
9.2 Introduce water-saving applications like micro- irrigation system (sprinkles) and low water intensive crops	DoA	PDoA, DAD, Private Sector	1. Number of micro irrigation systems introduced 2. Number of types of crops introduced	Records of D0A, PDoA	None	14 by 2025	√	√	√	√	√						2.4, 6.5
9.3 Farmer training and awareness on	MoIrri	IMD, ID,	1. Number of	Records of	Ongoing	1. Not less	√	√	√	√	√	√	√	√	√	√	5.b, 6.b

water saving applications		MASL, DAD	Programmes conducted; 2. % of programmes attendance of women farmers participated	IMD, ID, MASL Attendance disaggregated by sex	activity	than 40 programmes per year 2. Not less than 10% of programmes from the above, where attendance of women farmers participated											
9.4 Introduce efficient distribution of water among farmer organizations through better water allocation mechanisms	MoIrri	DoA, ID, DAD, PDoI	Pilot study	Feasibility reports	Not commenced	Completed pilot study by 2025	-	-	√	√	√						2.4, 6.5
9.5 Promote market-based instruments for the adoption of new irrigation technologies (water Subsidy schemes and tax reliefs)	DoA	DAD, PDoI	Number of pilot studies	Feasibility reports	None	Target to be set	-	-	√	√	√	√	√	√	√	√	12.8, 6.5

NDC 10 - Assess river floods and mitigation measures and early warning systems for possible flash floods for five priority basins (2030) (covering Kelani Ganga, Attanagalu Oya, Kalu Ganga, Kirindi Oya and Malwathu Oya on pilot basis)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
10.1. Install rivers and reservoir gauges and collect rainfall data and river flow data for the five priority basins	ID	MD, NBRO	Basins covered with adequate hydro meteorological data network	Reports of ID	16 stations in all 5 basins covered with hydro meteorol	All 5 basins covered with enhanced hydro meteorological data network	√	√	√	√	√	√	√	√	√	√	6.6, 13.1, 13.3

					ogical data network												
10.2 Prepare digital elevation maps / models for all priority basins and establish automated early warning systems	ID	, MD, NBRO, DMC	Digital elevation models (DEMs) for priority river basins Early warning systems for priority river basins	Records of ID	Digital elevation models (DEMs) for 2 priority basins available (Kalani and Attanagalu) Manual early warning systems for all 5 priority river basins available	Digital elevation models (DEMs) for flood prone areas for 3 priority basins prepared Early warning systems for 5 priority river basins upgraded	-	-	√	√	√						13.3
10.3 Conduct capacity building programs for newly established early warning systems associated technological applications and dissemination	ID	,MD, NBRO, DMC	1. Number of capacity building programmes conducted 2. Sex disaggregated numbers of participants in the capacity building programmes indicating % of women participated	Records of ID	Average level of competency of relevant staff for the existing systems	1. Capacity building of all relevant agencies	-	-	√	√	√						5.b, 6.5, 13.3
10.3.1 Reach out to communities	ID	MD, , NBRO,	1. Mobile app	Records of ID	1. Not	1. App	-	-	√	√	√						5.b, 6.5,

effectively using mobile Applications on river flooding.		DMC	2. % of women targeted/included in introducing the app	disaggregated by sex	available 2. App is yet to be introduced	introduced 2. Not less than 50% of women reached with the app											13.3
10.4 Introduce flood mitigation structures to handle climate change influence risks	ID	LUPPD, MD, , DMC	Flood mitigation structures	Records of ID	Existing structures in 2 river basins (Kalani, Kalu)	Existing structures enhanced where necessary and 2 suitable structures introduced (Ambatale salinity barrier, Wee oya reservoir)	√	√	√	√	√	√	√	√	√	√	13.1, 13.3

4.6 Biodiversity Sector

Sri Lanka exhibits remarkable biological diversity distributed in a wide array of ecosystems and habitats covering different bioclimatic zones. The country has a diverse ecosystems, terrestrial, and aquatic (freshwater, marine, and brackish water), despite having a comparatively small amount of land (65,610 km^2). Specific forest types, such as rainforests, mountain cloud forests, dry zone monsoon forests, and arid thorn scrub forests, are indicative of the various climate zones that occur in the nation. Numerous species of flora and animals can thrive in most places due to the country's ecological, climatic, soil, and topographical diversity. Based on the high degree of endemism and exposure to threats, Sri Lanka together with the Western Ghats has been identified as one of the biodiversity hotspots out of the 36. Sri Lanka records the threatened status of it's flora and fauna in it's National Red List.

The primary threats to Sri Lanka's biodiversity are habitat loss, fragmentation, and degradation; overexploitation of biological resources; extinction of traditional crop and livestock varieties, and breeds; pollution; conflicts between people and wildlife; the rapid spread of alien invasive species; and rising human population density. Land use changes in forests, ad hoc wetlands reclamation, uncontrolled use of coastal areas, landfills in wetlands, and deforestation all contribute to habitat loss. Other grave concerns include alteration of coastal habitats, destructive fishing methods, ship pollution, and negative effects from land-based activities that lead to generation of waste ends up in the sea.

Sri Lanka has implemented a number of legislative, strategic, regulatory, and operational actions to protect the nation's biodiversity. The Ministry of Environment is the Focal Point for the Convention of Biological Diversity. The status of Sri Lanka's biodiversity is reported in it's 6th National Report (6thNR) of 2019[51]. Under the direction of the Biodiversity Secretariat of the MoE, Sri Lanka's overall policy for protecting biodiversity is outlined in the National Biodiversity Strategic Action Plan (NBSAP) 2016–2022[52]. MoE is the national focal point for the Convention on Biological Diversity. Other government agencies with biodiversity conservation as the core-function include the Department of Wildlife Conservation (DWC), Department of Forest Conservation (FD), and Ministries in charge of the subjects of Wildlife and Forest Conservation. The national policy framework commits to biodiversity conservation, including the planned and systematic integration of biodiversity conservation into tourism, education, and cultural activities, as well as the restoration and rehabilitation of degraded ecosystems.

The National Forestry Policy of 1995, the National Wildlife Policy of 2000, the National

[51] MoE (2019) Sri Lanka's Sixth National Report: Biodiversity Profile - Sri Lanka to the Convention on Biological Diversity

[52] MoMD&E (2016). National Biodiversity Strategic Action Plan 2016-2022. Colombo, Sri Lanka: Biodiversity Secretariat, Ministry of Mahaweli Development and Environment. xxi + 284 pp

Environmental Policy of 2022, and the National Policy on Invasive Alien Species (IAS) in Sri Lanka of 2016, National Environmentally Sensitive Areas Policy of 2022, are some of the major policies pertaining to biodiversity conservation in Sri Lanka. The primary pieces of legislation that support the DWC and FD, respectively, in the conservation of biodiversity in Sri Lanka are the Fauna and Flora Protection Ordinance No. 22, as revised in 2009, and the Forest Conservation Ordinance No. 65, as amended in 2009, Forest Conservation Ordinance No 16 of 1907, the National Heritage Wilderness Areas Act No 03 of 1988, the National Environmental Act No. 47 of 1980 and it's amendments, Soil Conservation Act No. 25 of 1951, and Marine Pollution Prevention Act No. 59 of 1981 forms the basic Sri Lankan legal framework in protecting the biodiversity. Another key document that supported the sector is the Forestry Sector Master Plan (FSMP) 1995-2020 with an update taking place for 2021-2030

The draft FSMP has integrated some NDC activities of the Biodiversity Sector into the plan. The need to conserve sensitive areas outside the PAs, the linking of ecological corridors and landscapes to increase climate resilience and management of IAS are some of the outputs highlighted in the plan.

The nation sees rapid deforestation throughout time as a result of the economic pressures that the government and industry are under, making room for large-scale construction projects, expansive plantations, and resettlement initiatives that promote economic growth. The habitat that many ecosystems depend on is destroyed by this deforestation, which has a negative impact on carbon sequestration. The climatic conditions in ecosystems will change as a result of climate change, and invasive plant species will flourish as a result of rising temperatures and shifting rainfall patterns. The possibility of extinction of domestic plant species, which some animals depend on for their individual food cycles, could result from this unfavorable effect of climate change, upsetting the ecological balance of ecosystems. Due to the depletion and deterioration of water resources brought on by several anthropogenic activities, Sri Lanka also faces many challenges in combating water pollution, which harms biodiversity. The endangerment of marine life and coastal ecosystems has been greatly exacerbated by inadequate management and control of domestic sewage, irrigation, ship oil spills, garbage disposal, and coral & sand mining.

Resilience-building actions for biodiversity are presented under five NDCs (*Table **4-6***) covering management of climate-sensitive areas and restoration of degraded areas within and outside the PAs, increased connectivity for species migration to accommodate climate-driven changes, possible expansion of PAs to build the resilience of biodiversity as a system of PAs, strengthening ex-situ conservation of fauna and flora and effective management of Invasive Alien Species (IAS). Some of the mitigation co-benefits of biodiversity including carbon sequestration are captured under Forestry Sector under the mitigation NDCs.

Table 4-6 NDCs of Biodiversity Sector

NDC #	NDC
1	Management of climate-sensitive areas and restoration of degraded areas inside and outside the Protected Areas (PAs) network to conserve habitats that are

	highly vulnerable to climate change
2	Increase connectivity in the zones that will be subjected to climate-driven changes according to current predictions through landscape approaches
3	Expansion of PA extent to enhance the ability of the PA network to function as a buffer for climate change
4	Strengthen ex-situ conservation programmes covering climate-vulnerable taxa and regions
5	Effective management of the spread of Invasive Alien Species (IAS) triggered by favorable climate conditions

4.6.1 Biodiversity Sector NDC Implementation Plan

NDC 1 - Management of climate-sensitive areas and restoration of degraded areas inside and outside the protected areas (PAs) network to conserve habitats that are highly vulnerable to climate change (2030)																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1 Identify habitats using existing maps that are most vulnerable to climate change-driven changes and adaptive measures taken in response to climate change to inform priority sites that need to be restored or rehabilitated both within and outside PAs	MoE (BDS & CCS), DNBG	FD, DWC, CC&CRMD, CEA, MEPA, MASL, MD, DMC, NARA, NWPEA, Academia & researchers, NGOs	1.No of Habitats identified which are vulnerable to climate change 2. No of habitats thus identified in which appropriate adaptive measures taken Number of existing PAs and ESAs	Records of BDS	105 PAs under DWC 875 PAs under the FD 10 EPAs under the CEA 14 Special Management Areas under CC&CMD 5 Environment Sensitive Areas 3 NWPEA (these	1. Identification of habitats which are most vulnerable to climate change in the entire country 2. Appropriate adaptation measures taken to increase their resilience At least 500 (PAs and ESAs) identified/ declared/ gazette/co-managed			√	√	√	√	√	√	√	√	13.1, 15.1, 15.4

					have been declared based on their Ecological importance not climate vulnerability)												
1.2 Prepare maps indicating terrestrial wetland landscapes, coastal and marine areas such as mangroves, seagrass beds, fog-interception area, villus, etc. that should be the focus of priority actions identified above in order to enhance their resilience	MoWL&FC, DNBG	MoE, FD, DWC, CC&CRMD, CEA, MEPA, MASL, MD, DMC, NARA, SD, NWPEA, , Academia & reserchers, NGOs	No. of Maps prepared	Maps prepared	Maps on mangroves and other PAs are available , maps are prepared by the DWC which indicates areas that contain IAS, degraded habitats, mangrove degraded areas) ESA maps Base line – 89 forests (18959.72ha)	500 maps prepared to include all the identified vulnerable ecosystems			√	√	√	√	√	√	√	√	13.1, 14.2, 14.5 15.1, 15.4

1.3 Identification of species of fauna and flora that are highly vulnerable to climate change	MoE, DNBG,	MoWL&FC, FD, DWC, CC&CRMD, CEA, MEPA, DNM, Academia, Private Sector, NGOs, CBOs	Updated list of species vulnerable to climate change identified through scientific methods	MoE (BDS) report on species (fauna & flora) vulnerable for climate change	Existing National Redlist	Comprehensive list of fauna and flora which are affected by climate change prepared	√	√	√	√	√	√	√	√	√	√	13.1, 14.2, 15.1
1.4 Encourage research and studies on most vulnerable species and habitats identified in 1.1 and 1.3	MoWL&FC, DNBG	MoE, DWC, FD, NRC, NSF, CARP, NARA, MoSTR, Academia, Independent research groups	Number of scientific communications, research projects	Published research papers, recovery plans	Research work scattered on these aspects ie. 3 projects-DNBG +2 recovery plans DNBG and also by academia but not collated under the umbrella of climate change	Long term research projects done in the identified vulnerable ecosystems	√	√	√	√	√	√	√	√	√	√	13.1, 14.2, 15.1, 15.4
1.5: Establish long-term monitoring plots and mechanisms in climate sensitive areas to identify climate change driven changes in species and habitats	MoWL&FC, DNBG	MOE (CCS, BDS), FD, DWC, CC&CRMD, CEA, MEPA, NARA, Academia, Research institutes, & Private sector organizations	1. Number of monitoring plans for climate vulnerable species 2.Number of long-term monitoring plots with	Records of MoWL&FC	3 Sinharaja - Prof Gunatilleke, Prof Singhakumara-Pitakele, Walankanda Endana	Long-term monitoring plots with appropriate mechanisms are established to cover all the climate zones in the country	√	√	√	√	√	√	√	√	√	√	13.1, 14.2, 15.1, 15.4

			appropriate mechanisms		Estate, 4500 plots demarcated by FD -need to identify climate vulnerabilities for future research, Hambantota NBG-Mirijjawila Research station regeneration plot											
1.6 Restoration of at least 25% each of degraded terrestrial and wetland landscapes including coastal & marine habitats identified above (1.2) and based on current extent and prioritized according to biodiversity value, ecosystem values and climate change vulnerability	MoWL&FC	MoE (CCS, BDS), FD, DWC, CC&CRMD, CEA, MEPA, NWPEA, Academia, Research institutes & Private sector, IUCN, UN agencies	% of restored extent	Monitoring and progress reports of MoWD&FC	This will be stated after completion of 1.1 and 1.2.	At least 25% of the identified extents under activity 1.1 & 1.2 restored	√	√	√	√	√	√	√	√	√	√	13.1, 14.2, 14.5, 15.1, 15.4
1.7 Restore the natural ecosystem in fog interception zones at least by 25%	MoWL&FC	MoE, FD, DWC, RPCs, Academia, Research institutes	% of restored extent	Progress reports, M&E and other records of DWC, FD,	This will be stated after completion of identification of degraded fog	At least 25% of the identified extents from 1.1 and 1.2	√	√	√	√	√	√	√	√	√	√	15.1, 15.4

					intercepted landscapes (ESA maps- ongoing, vulnerability maps) Ulex removed from 19.5 ha												

NDC 2 - Increase connectivity in the zones that will be subjected to climate driven changes according to current predictions through landscape approaches

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Conduct a feasibility assessment (based on 1.2 above) to identify connectivity corridors on a landscape/Seascape level using the river basins located in the climate sensitive areas	LUPPD	MoE (CCS & BDS), FD, DWC, NARA, DAAD, SD, NWSDB, ID, Academia, Research institutes	Feasibility assessments of landscape and seascape	Validated reports and maps adopted for 2.2 – 2.3	Feasibility studies on corridors had been done but not exclusively taking climate vulnerability into account	Feasibility assessments conducted on all the identified vulnerable ecosystems in 1.2			√	√							14.2, 14.5, 15.1, 15.4
2.2: Restore climate-vulnerable riparian and instream areas that can act	ID, MASL, FD	FD, DWC, CEA, LAs	% of restored extent	Progress reports of ID,	0	At least 25% of the					√	√	√	√	√	√	13, 14.2, 15.1,

as corridors based on the above feasibility study covering at least 25% of identified areas		and the Private sector		MASL, FD	(Will be done after the completion of 2.1) Restoration by DWC for North of Wilpattu Mollikulam at Kal Aru and Hungamala Elephant Corridor	identified areas restored											15.2, 15.4
2.3: Monitor such corridors for their efficacy to serve as biodiversity corridors and making adaptive changes to enhance movement	ID, MASL, FD	DWC, Academia, Research institutes, & the private sector	Monitoring of identified corridors also the species and numbers of fauna which uses the corridors	M&E biodiversity reports and recommendations Records of FD, DWC	0	All identified corridors are continuously monitored					√	√	√	√	√	√	13, 14.2, 15.1, 15.2, 15.4

NDC 3 - Expansion of Protected Area (PA) extent to enhance the ability of the PA network to function as a buffer for climate change

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1: Identify ecologically/ environmentally sensitive areas (based on 1.2) within the climate sensitive areas that can be annexed	MoWL&FC, CEA, NWPEA	MoE (BDS, Env Eco), FD, DWC, NWPEA,	The extent of areas identified to be included in	Assessment reports	5 ESAs identified already including	All areas thus identified				√	√	√	√	√			13.1, 14.2, 15.1, 15.4

(included) to existing PAs		LUPPD, LRC, SD, CC&CRMD, Academia, Research institutes, Private sector, NGOs, CBOs	the existing PA network		18,000 ha of mangroves	will be made PAs										
3.2: Identified areas to existing PAs / to be declared as new PAs under mandated agencies	MoWL&FC, CEA, NWPEA	MoE (BDS, Env Eco), FD, DWC, LUPPD, LRC, SD, CC&CRMD, Academia, Research institutes, Private sector, NGOs, CBOs	Gazette notification of the declared sites	Reports of FD, DWC, CC&CRMD	0	All Identified areas declared The number cannot be stated here as this will be done based on the need. There would not be large ones on land but those adjoining the Mirissa, Thalawila Sanctuaries will be declared in the future by DWC					√	√	√	√	√	√	13.1, 14.2, 15.1, 15.4, 15.9

NDC 4 - Strengthen ex-situ conservation programmes covering climate vulnerable taxa and regions

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key					2	2	2	2	2	2	2	2	2	2	

		Agencies	(KPI)				021	022	023	024	025	026	027	028	029	030	
4.1: At least two facilities to be established for ex-situ conservation of flora in the climate vulnerable region (botanical gardens and arboreta) within 5 years	DNBG	FD, DWC, LAs, LRC, PGRC, Arboreta	Botanical gardens established	Records of DNBG	6 facilities existing (Peradeniya, Hakgala, Gampaha ,Awissawela, Hambanthota, Ganewaththa) (Pinnaduwa-land acquisition progressed) 1 Medicinal Plant Garden	2 facilities for ex situ conservation for flora established					√						13.1, 14.2, 15.1, 15.4
4.2: At least two facilities to be established for ex-situ conservation of fauna in the climate vulnerable regions (ex-situ conservation centres) within 5 years	DNZG	MoWL&FC, DWC, Academia, Research institutions	Ex-situ facilities	Records of DNZG, DWC	3 (Safari Parks - Ridiyagama, Gonapala Farm, Dehiwala , Pinnawala Conservation Centre)	2 ex situ facilities established (montane +intermediate)					√	√					13.1, 14.2, 15.1, 15.4
4.3: Establishing a mechanism to assist translocation/reintroduction of climate sensitive or threatened fauna	MoWL&FC	DWC, FD DNZG, NARA,	Mechanism to assist translocation/	Records of DWC, DNBG	Relocation of climate	Mechanism established			√	√	√	√	√				13.1, 14.2, 15.1,

and flora		DNBG, MASL, ID, IUCN, Academia, Research institutions	reintroduction of climate sensitive or threatened fauna and flora		sensitive or threatened species not done but work done based on their conservation status especially related to development projects Alphonsea hortensis reintroduced to suitable habitats under FD Done in Moragahakanda Project by DWC Threatened/near extinction species are being reintroduced by the FD (approxi												15.4

					mately 3/year), Yan Oya, NWP Canal Project, Upper Kotmale (Ravana), Upper Elahera												
4.4: Introduction of three new number of Veterinary/ Epidemiology facilities for Ex-situ Conservation Centers	DWC, VRI, DNZG	DWC, NARA, DAPH, Academia, Research institutions,	Facilities introduced	Annual reports of VRI, DWC, DNZG	Giritale, Hiyare Rescue centre, DWC (Bellanwila) 3 zoos have new hospitals	3 facilities introduced			√	√	√	√	√	√	√	√	13.1, 14.2, 15.1, 15.4
4.5: Develop Gene Banks in National Zoological Gardens (NZGs) and National Botanical Gardens (NBGs) and Plant Genetic Resources Center (PGRC)	DNBG, DNZG, VRI	PGRC, NARA, Academia, Research institutions	Gene banks (Flora and fauna) Number of accessions Number of species, sub-species	Data bases of PGRC, DNBG, DNZG	DNA Bank Initiated - Herbarium, PGRC	Gene banks in NZGs and NBGs and Plant Genetic Resources Center (PGRC) developed / upgraded								√	√	√	13, 14.2, 15.1, 15.4

NDC 5 - Effective management of spread of Invasive Alien Species (IAS) triggered by favorable climatic conditions

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					202	202	202	202	202	202	202	202	202	203	

							1	2	3	4	5	6	7	8	9	0	
5.1: Conduct a desk assessment based on the available distribution maps of IAS to identify IAS that are likely to undergo range expansion or whose range expansion can be facilitated by climate change and anthropogenic activities	MoE (BDS)	DoA, National HerbariumNH), FD, DWC, NARA, MEPA, Academia, Research institutions	Assessment report	Assessment report of MoE (BDS)	Distribution maps available with BDS	Desk assessment completed			√	√							13.1, 14.2, 15.1, 15.4, 15.8
5.2: Implement programs in critical areas as identified in 5.1 to enhance the resilience of ecological & economical systems towards possible biological invasions triggered by climate change	MoE (BDS)	MoSTR, DoA, FD, DWC, LAs, CEA, NWPEA, Academia, Research institutions	Number of programmes conducted	Progress reports of the activities of MoE (BDS)	0	Programmes conducted in all (as defined by 5.1) critical areas				√	√	√	√	√	√	√	13.1, 14.2, 15.1, 15.4,

4.7 Coastal and Marine Sector

Sri Lanka's coastal zone plays an important role in the social, environmental, cultural, and economic development of the Country. The coastline stretches over nearly 1,790 km, and it provides 230,000 km^2 of the marine economic zone[53]. A unique ecology and biologically diverse coastal environment are provided by the coastline. The most significant ecosystems, including mangroves, salt marshes, sand dunes, beaches, and coastal marshy wetlands, are found in this coastal area. The negative effects of climate change exacerbated by anthropogenic activities, such as inundation, shoreline erosion, coastal floods, and salinity of estuaries and aquifers, which endanger the biological balance and coastal infrastructures, are likely to influence all these ecosystems to varied degrees. Along with fisheries, coastal beach tourism is essential to the country's economy. Tourism at coastal beaches includes activities like deep-sea sport fishing, watching marine mammals, sailing, various sorts of diving, boating, and recreational sports, as well as sunbathing and turtle watching in the shallower reef waters. According to estimates, beach tourism generates close to 60% of the sector's overall sales and offers a wide range of value-added goods. Over 25% of the population resides in the coastal region, which covers roughly 23% of the nation's total land area and is located about 50 kilometers inland from the ocean. A significant portion of the nation's industries and tourism attractions are located in the coastal region, which also accounts for about 40% of the country's GDP[54].

The Coastal Zone Management Plan of 1997 was revised and updated in 2004, 2016 and 2018 which is the foundation and guiding principles for coastal zone management. It focuses on shoreline management, coastal pollution control, management and conservation of coastal habitats, special management areas and regulatory mechanism.

The main legal framework for coast conservation is provided by the Fisheries and Aquatic Resources Act No. 2 of 2016 and its regulations, the Coast Conservation Act No. 57 of 1981 and amendments/ Coast Conservation Regulations, the Marine Pollution Prevention Act No. 35 of 2008 and amendments, and the Marine Environmental Protection Authority Regulations. In 2011, the Coast Conservation Act was amended and renamed as the Coast Conservation and Coastal Resources Management Act.

In accordance with the United Nations Convention on the Law of the Sea, Sri Lanka is currently in the process of claiming a sizable amount of extra seabed area. This will increase the country's economic opportunities.

The cargo vessel "X-press Pearl" maritime disaster in Sri lanka in 2021 was responsible for the single worst incident of plastic marine pollution in the world, according to a committee assessing the damages from the disaster. Not having a baseline of the environmental conditions has been one of the biggest challenges in doing this environmental assessment. This is a major drawback for not receiving the due compensation to Sri Lanka yet for this disaster.[55]

[53] Department of Census and Statistics, Sri Lanka, http://www.statistics.gov.lk/abstract2021/CHAP1
[54] Annual Report 2021, Central Bank, Sri Lanka
[55] https://news.mongabay.com/2022/06/a-year-since-x-press-pearl-sinking-sri-lanka-is-still-waiting-for-compensation/ (Accessed on 2 April 2023)

Priorities for coastal and marine sector adaptation have been established under four NDCs (*Table 4-7*), primarily involving the development of technical skills and mechanisms for observing and addressing climate change and variability. These include developing a reliable method for predicting sea level rise, updating vulnerability and risk maps, stepping up shoreline management efforts, and protecting special natural areas in exposed coastal locations. Restoration of mangroves, for example, has adaptation benefits relating to the Biodiversity Sector as well as mitigation benefits under the Forestry Sector.

Table 4-7 NDCs of Coastal and Marine Sector

NDC #	NDC
1	Establish an accurate sea level rise forecasting system for Sri Lanka
2	Prepare updated vulnerability and risk maps for the coastal belt of Sri Lanka
3	Adopt optimal shoreline management works/measures covering affected length of shoreline using a combination of hard and soft solutions to prevent coastal erosion in the areas most vulnerable to SLR
4	Identify and declare coastal and marine natural areas of high priority for building resilience for climate change impacts

4.7.1 Coastal and Marine Sector NDC Implementation Plan

NDC 1 - Establish an accurate sea level rise forecasting system for Sri Lanka

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1. Establish the required database with historical tidal level data	NARA	CC&CRMD, SD, DMC, MD, SLN, SLPA	Number of years for which the database is established	Records of NARA	No national level database in operation (However there were data in scattered form with different agencies)	Tidal Database with historical tidal level data up to year 2022 to be published by 2023 and update yearly	√	√	√	√	√	√	√	√	√	√	11.5, 11.b, 13.1, 14,a
1.2. Measure and record present Mean Sea Level (MSL) and assess and publish sea level rise measurements	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.2.1. Measure and record present Mean Sea Level (MSL)	SD	, CC&CRMD, DMC, MD, SLPA, SLN, NARA	% number of locations w*ere the present MSL is measured and recorded	Records of SD	0% (However, earlier version of the MSL are available)	100% (All the locations with revised MSL)	√	√	√								11.5, 11.b, 13.1, 14,a
1.2.2. Assess and publish sea level rise) measurements	CC&CRMD,	SD, DMC, MD, SLPA, SLN, NARA	% number of locations where the	Records of CC&CRMD,	0% (However, earlier versions of sea	100% (All the - locations with revised sea				√	√	√	√	√	√	√	11.5, 11.b, 13.1, 14,a

			present MSL is accessed and published		level rise records and maps are available)	level rise											
1.3. Establish additional sea level measurement stations in identified locations, to cover the coastline of Sri Lanka in addition to the existing stations	NARA	CC&CRMD, SD, DMC, MD, SLN, SLPA	Number of additional /backup tidal measurement stations	Records of CC& CRMD, SLPA and SLN	Present stations (07)	Three new automated stations with backups and 07 backups for all existing stations	√	√	√	√	√						11.5, 11.b, 13.1, 14,a
1.4. Estimate sea level rise predictions for Sri Lanka using global best practices	NARA	CC&CRMD, SD, DMC, MD, SLPA, SLN, Academia	Number of locations for which the sea level rise is estimated	IPCC annual reports	Since 2016, sea level rise has been estimated by NARA, which continues to date	10			√	√	√	√					11.5, 11.b, 13.1, 14,a

NDC 2 - Prepare updated vulnerability and risk maps for the coastal belt of Sri Lanka

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1. Update inundation maps covering coastal area according to the sea level rise forecast Based on 1.1	CC&CRMD	NARA, SD, DMC, UDA, ID, DS, Academia	% of the coastline covered by the	DMC Filed data and LAs field records	0%	100%			√	√	√						11.5, 11.b, 13.1, 14,a

			inundation maps														
2.2. Identification of areas vulnerable to sea level rise	CC&CRMD	NARA, SD, DMC, UDA, ID, DS, Academia	Number of DS divisions covered	Data and maps of DMC	None	All 74 DS divisions	√	√	√	√							11.5, 11.b, 13.1, 14,a
2.2.1. Identify locations where vulnerable communities are present and take action to reduce them	DS	NARA, SD, DMC, UDA, ID, NPPD, CC&CRMD, Academia	1. Number of locations by GN divisions 2. % of relocations of families who are vulnerable	Records of CC&CRMD and DMC	Baselines to be obtained	Targets to be established	√	√	√	√	√						11.5, 11.b, 13.1
2.2.2. Prevent the establishment of new settlements in vulnerable areas	NPPD	LAs, UDA, NARA, SD, DMC, DS, CC&CRMD	1. Regulation to prevent new settlements 2. Number of interventions conducted to prevent new settlements	Records of NPPD, CC&CRMD and DMC	1. No regulation in place 2. No interventions	1. Enacted regulation to prevent new settlements 2. Target to be established			√	√	√						11.5, 11.b, 13.1
2.3. Prepare sea level rise influenced risk maps for the coastal zone with 0.5m contour intervals and take appropriate actions	DMC	SD, NARA, UDA, ID, DS, CC& CRMD, Academia	% area covered by risk maps	Maps of SD, DMC	Some hazard maps available, but not validated	100%					√	√	√				13.1, 13.2
2.3.1. Prepare vulnerability databases for the coastal zone with 0.5m contour intervals.	SD	NARA, DMC, UDA, ID, DS. CC & CRMD, Academia	% coastal zones covered by vulnerability databases	Records of relevant institutions	No database, but some information/ data available on vulnerability	100% (Databases cover the entire coastal zone)				√	√						13.1, 13.2
2.3.2. Establish Digital Elevation Model (DEM) for the entire coastal zone	SD	NARA, DMC, UDA, ID, DS, CC& CRMD, Academia	% coastal zones covered by DEM	Records of relevant institutions	0% (No DEM)	100% (DEM covers the entire coastal				√	√						13.1, 13.2

						zone)											
2.4. Use findings in 2.3 to update the existing coastal development setbacks	CC&CRMD	NARA, SD, DMC, UDA, ID, DS, Academia	% of updated setbacks defined incorporating sea level rise in the Coastal Zone Management Plan (CZMP)	Records of CC&CRMD	0% (Updated setbacks yet to be incorporated in the CZMP)	100% (All setbacks are updated incorporatingsea level rise covering the entire coastal zone)						√					11.5, 11.b, 13.1, 13.2

NDC 3 - Adopt optimal shoreline management works/measures covering affected length of shoreline using a combination of hard & soft solutions to prevent coastal erosion in areas most vulnerable to sea level rise																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1. Long term data collection programmes, including wave measurements and a sediment transport study	CC&CRMD	NARA, SLPA, SLN, Academia	Number of programmes/studies	Records of CC&CRMD	Not commenced	Wave measurements and a sediment transport study completed		√	√	√	√	√					13.1, 13.2
3.2. Update the erosion management plan	CC&CRMD	NARA, Academia	Erosion management plan updated	Records of CC&CRMD	Existing erosion mgt plan - 1986	Updated erosion management plan	√	√	√	√	√	√					13.1, 13.2
3.3. Establish programs (in collaboration with universities and other research agencies) for monitoring of coastal erosion and collect related data/information on: coastal erosion trends and status, scientific investigations of sediment balances and assessments of sediment	CC&CRMD	GSMB, NARA, SD, SLN CEA, Academia	1. Number of research areas covered 2. Number of collaboration/ studies initiated per year	Records of CC&CRMD and other relevant agencies	1. None 2. None	1. Five research areas (Coastal erosion trends and status; Sediment balances and assessments of	√	√	√	√	√	√	√	√	√	√	13.1, 13.3, 13b, 14.2, 14a

sources, threats to dwellings, land use and critical habitats from erosion, bathymetric & hydrologic conditions						sediment sources; Threats to dwellings; Land use and critical habitats from erosion: Bathymetric & hydrologic conditions) 2. Two per year											
3.4. Restoration of coastal ecosystems including mangroves covering 1,000ha. (this action linked to action 1.6 of the Biodiversity Sector NDC 1	CC&CRMD	LAs, NGOs, FD, DWC, CEA, MEPA, Private sector, NGOs, CBOs	No of hectares of coastal ecosystems restored	Records of CC&CRMD	100 ha	1,000 ha of mangrove coverage	√	√	√	√	√	√	√	√	√	√	13.1

NDC 4 - Identify and declare coastal and marine natural areas of high priority for building resilience for climate change impacts																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4.1. Prepare appropriate criteria and list of candidate sites to be declared as high priority natural areas	CC&CRMD	MEPA, NARA, CEA, UDA, DWC, Academia	Number of candidate sites declared	Records of CC&CRMD	Two sites (Established before 2020)	Additional ten (10) sites	√	√	√	√	√						13.1, 13.2, 14.5, 14c
4.2. Declare and manage high priority natural areas as required through gazette notifications	CC&CRMD	MEPA, NARA, CEA, UDA, DWC, Academia	1. No of new sites gazetted 2. Number of new management plans prepared	Records of CC&CRMD	Activity not commenced	Targets to be established	√	√	√	√	√	√	√	√			13.1, 13.2, 14.5, 14c

4.8 Health Sector

The Sri Lankan healthcare system includes a variety of medical practices, including acupuncture, homeopathy, ayurveda, unani, siddha, conventional western medicine, and more. Western or allopathic medicine is the dominant subset of these, serving the requirements of the vast majority. GoSL maintains a universal health care system that extends free healthcare to all citizens, which has been a national priority. In addition, a large number of private hospitals and other healthcare facilities have appeared in the country due to the rising income of people and demand for private services. The public health sector is divided into two parallel streams: (i) community health services, which emphasize health promotion and prevention, and (ii) curative care services, which range from primary care that is not specialized to specialist care and are provided by a variety of institutions[56].

The primary organization overseeing the development and regulation of health services is the Ministry of Health of the central government. Additionally, it oversees providing resources for the health sector, including qualified human resources, a medicine supply, and significant investments in infrastructure. The provision of healthcare in the public sector is decentralized, and the provincial health authorities oversee primary care at select specialized Allopathic institutions.

Figure 4-5 shows the variation in number of medical doctors and nurses and midwives per 1,000 population from 2004 to 2019 (data source[57]). Figure 4-6 (a) shows the source of health expenditure and (b) shows the average per capita health expenditure and the total health expenditure as a share of the GDP.

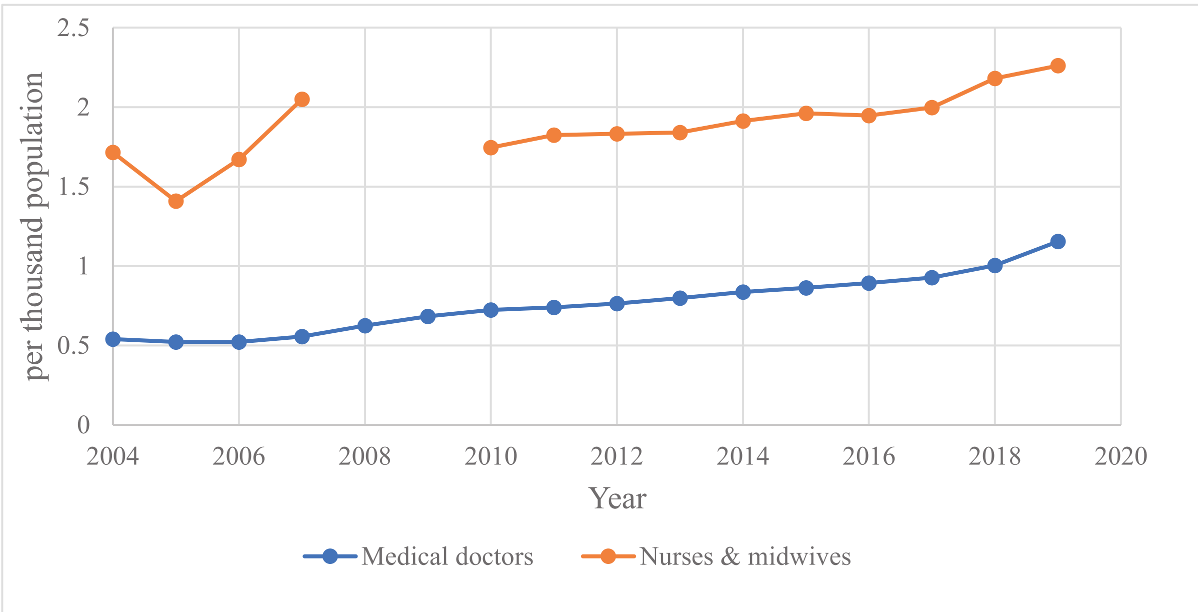
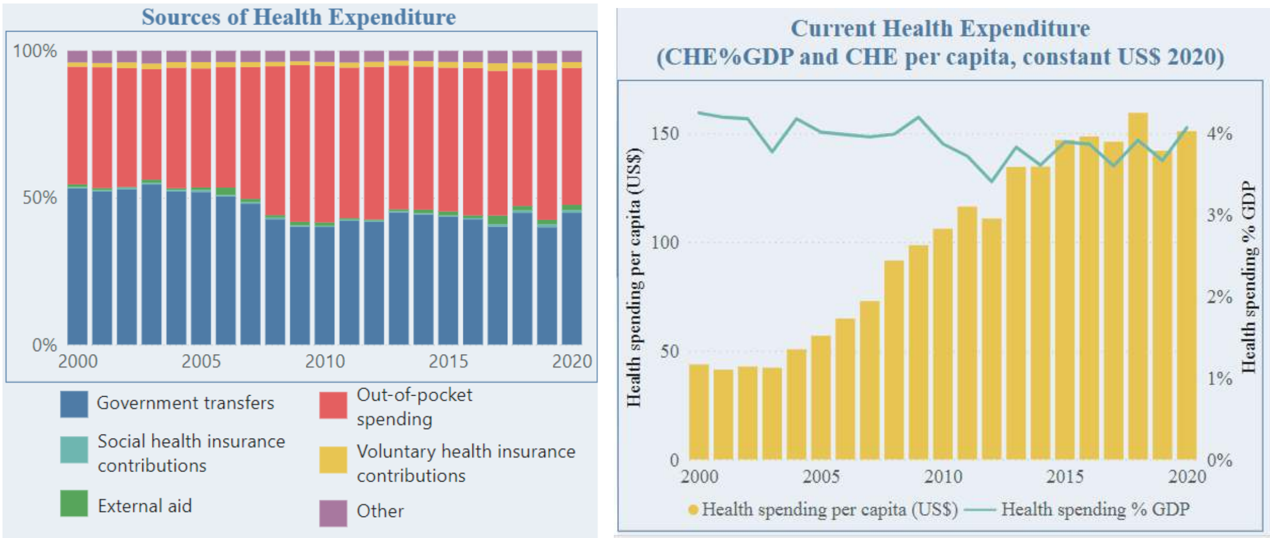


Figure 4-5 Ratio of health workforce per 1000 population[58]

[56] Annual Health Bulletin (2019), Ministry of Health, Sri Lanka
[57] WHO, Global Health Expenditure Database: https://apps.who.int/nha/database/country_profile/Index/en

Sri Lanka has a well-advanced healthcare system. Sri Lanka performed well in its efforts to attain the health-related Millennium Development Goals (MDGs). As per the latest statistics (2019), the country has 643 state-owned hospitals and 86,589 beds in these hospitals. The average number of hospital beds per 1,000 population is 4, where Mannar district recorded the highest ratio of 7.6 while three districts, namely, Gampaha, Kaluthara, and Puttlam recorded the lowest ratio 2.5[58].



(a) (b)

Figure 4-6 (a) Source of health expenditure and (b) Per capita health expenditure (Source: WHO[59])

Despite having a robust healthcare system, Sri Lanka has a surprisingly high rate of malnutrition among children and women. A as a high incidence of dengue cases has shown an increase from 2022 to 2023 however with a decline in the number of deaths reported[59]. A high number of leptospirosis cases are reported each year. The number of deaths increased during the COVID 19 pandemic since more people took to agriculture and more focus was on the pandemic. Vector borne diseases are influenced greatly by the monsoons[60].Major issues include underweight infants (6.4%), low birth weight neonates (almost 12%), pregnant women with low BMI on or before 12 weeks of pregnancy (15%), young children aged 1-2 (12%), and aged 2-5 (19%) might be highlighted [57].

People's health and well-being are negatively impacted by climate change, and as a result, the health sector will unavoidably suffer. Six NDCs present adaptation targets for the health sector (*Table 4-8*). These cover policy-level initiatives to mainstream targeted climate resilience

[58] Department of Census and Statistics, Sri Lanka
http://sis.statistics.gov.lk/statHtml/statHtml.do?orgId=144&tblId=DT_HEA_ANN_117&conn_path=I2

[59] https://cdn.who.int/media/docs/default-source/sri-lanka-documents/dengue-sit-rep-1-12.05.2023-v2.pdf?sfvrsn=80da2b2d_1
[60] https://www.e-epih.org/upload/pdf/epih-44-e2022015.pdf

actions, improved capacity to manage climate-influenced health and disease conditions, address the health impacts of air pollution, and reduce morbidity and mortality from climate-induced disasters,

Table 4-8 NDCs of Health Sector

NDC #	NDC
1	Policy initiatives for enhancing the climate resilience of the health sector promoted and integrated to all related sectors
2	Improved capacity to manage non-communicable diseases (NCD) and heath conditions directly attributable to climate change
3	Manage the worsening of under-nutrition and malnutrition due to climate change
4	Strengthen surveillance and management of climate-sensitive vector and rodent borne disease (dengue, malaria, filaria, leishmaniasis and leptospirosis)
5	Reduce morbidity and mortality from extreme weather/climate events (floods, droughts, landslides, and other climate-related emergencies)

4.8.1 Health Sector NDC Implementation Plan

NDC 1 - Policy initiatives for enhancing climate resilience of the health sector promoted and integrated to all related sectors (2030)																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1: Development and implementation of the Heat – Health Action Plan (HHAP) for Sri Lanka	Environmental health, Occupational health and Food safety (EOH) Directorate of MoH)	MoH (Other relevant units), MoE, CEA,MD, Provincial Health Authorities, LAs, Academia	HHAP	Published HHAP, Progress monitoring meeting minutes	Draft HHAP in place	Heat Health Action Plan finalized by 2023 and implemented	√	√	√	√	√	√	√	√	√	√	3.9, 13.2
1.2: Development and implementation of the National Strategic Plan for Health, Environment and Climate Change (NHSPEC)	EOH Directorate of MoH	MoH (Other relevant units), MoE, CEA, MET, MoPC&LG, MoF, NBRO, DMC, Academia, UN agencies, CBOs	NHSPEC	Published NHSPEC, Progress monitoring meetings minutes	Not commenced	NHSPEC developed and implemented.	-	-	√	√	√	√	√	√	√	√	3.9, 13.2
1.3: Development and implementation of guidelines and standards to make Green and Healthy Hospitals	EOH Directorate of MoH	MoE, MoF, MoH (Other relevant units - Health Care Quality Unit, DPRD), DMC, UDA, SLSEA,	1. Guidelines and standards 2. % of certified Green & Healthy	Guidelines and standards, Green, Healthy & Safe Hospital Audits	1. Not commenced 2. Two pilot projects on safe	1. Guidelines and standards to make Green and Healthy Hospitals	√	√	√	√	√	√	√	√	√	√	3.9, 11.7, 13.2

		CEA, LAs, Academia, GBCSL	Hospitals, 3. Green , Healthy & Safe Hospital Index		hospitals initiated 3. Not commenced	developed by 2024 and implemented. 2. At least 5% 3. Finalized Healthy & Safe Hospital Index											
1.4: Health action plan prepared to reduce the disease burden due to air pollution and implementation commenced	EOH Directorate of MoH	MoH (Other relevant units), MoE, CEA, MD, , Academia	1. Health Action Plan for reduction of disease burden due to air pollution 2. Surveillance system to monitor disease burden due to air pollution	The action plan, Published records of MoH, Progress monitoring meetings minutes	Not commenced	1. Health action plan prepared to reduce the disease burden due to air pollution developed and implemented 2. Operational Surveillance system to monitor disease burden due to air pollution	-	-	√	√	√	√	√	√	√	√	3.9, 13.2

NDC 2 - Improved capacity to manage Non-communicable Diseases (NCD) and health conditions directly attributable to climate change (2024)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Identify diseases and health conditions expected to aggravate due to climate change	EOH Directorate of MoH)	MoH NCD Bureau and other related units), MoE (CCS, NOU), Relevant Professional Colleges, SLMA, Academia	Coverage of the assessment of diseases & health conditions expected to aggravate due to climate change	Publications, Disease survey reports and bulletin, Records and registers	Not commenced	Diseases & health conditions expected to aggravate due to climate change identified and recorded	-	-	√	√							3.9, 13.b
2.2: Develop management guidelines for the prioritized diseases and health conditions including clinical and preventive guidelines	EOH Directorate of MoH	MoH, NCD Bureau and other related units), MoE (CCS, NOU), Relevant Professional Colleges	The guidelines	MoH records on the development of guidelines	Not commenced	Guidelines for the prioritized diseases and health conditions including clinical and preventive guidelines developed	-	√	√	√	√						3.c
2.3: Capacity building of health system in addressing climate change influenced diseases and health conditions.	EOH Directorate of MoH	MoH, NCD Bureau and other related units), MoE (CCS, NOU), Relevant Professional Colleges	1. Number of programmes held 2. No of staff trained	MoH records of funds allocated and utilized, Attendance records, Progress reports	Specific capacity building programmes not commenced	1. 5 programmes per annum 2. 250 health workers trained per annum	-	-	√	√	√	√	√	√	√	√	3.9, 13.b
2.4: Identify potential at-risk categories/vulnerable groups (elderly,	EOH	MoH, NCD Bureau and	Roadmap in managing	MoH progress reports	Vulnerable	Finalized roadmap	-	-	√	√	√	√					3.2

children, vulnerable worker groups and any other vulnerable categories) and to develop a road map in managing climate change induced non-communicable diseases (NCDs)	Directorate of MoH	other related units), MoE (CCS, NOU, MoEd, Relevant Professional Colleges	climate change induced NCDs for different vulnerable groups		communities identified but not specifically related to climate change												
2.5: Strengthen research capacity on generating evidence on climate change and health impacts	MoH	MoSTR MoEd, MoF, NSF, UN Agencies, IFS, IPS, Academia	1. Research agenda developed 2. Number of research activities conducted & published	Publications, Information from repositories	1. Research agenda development not commenced 2. Number of the existing research reports on the topic is to be identified	1. Research agenda published 2. At least one research completed per annum	√	√	√	√	√	√	√	√	√	√	13.2

NDC 3 - Manage worsening of nutrition related health impacts due to climate change (2023)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1: Develop a mechanism to receive and analyze food availability related early warning to minimize nutrition-associated health issues	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.1.1: Provide nutrition status data to relevant agencies to develop surveillance system for food and nutrition security in Sri Lanka	MoH (DDG PHS 2)	MoH MoH (EOH Directorate , Nutrition Division, DPRD, FHB,),NCD Unit), SMoWCP&P MRI , DCS; MoEd, MoA, DoA, MD , UN agencies, FAO, Academia	Nutrition status data provided	Records of FHB, Nutrition Division, MRI (nutrition unit)	Limited informati on nutrition status	Comprehen sive nutrition status data is collected and communica ted			√	√	√						2.1, 13.3

3.2: Social welfare systems strengthened to cover vulnerable groups including families below the poverty line, elderly, disabled people, nursing mothers and young children in Medical Officer of Health (MOH) areas identified as vulnerable to food insecurity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.2.1: Develop and implement programmes to improve nutrition among vulnerable groups (differently abled persons, elderly etc)	MoH (Nutrition Division)	MoH (FHB, YEDD, MoH (EOH Directorate ,Food Safety Unit), MoEd, MRI, Provincial Secretariat, DS, Social services	Programmes to improve nutrition among vulnerable groups	Reports, guidelines and food regulations	No specific programmes developed	Programmes to improve nutrition among vulnerable groups developed and implemented	-	-	√	√	√	√	√	√	√	√	3.3, 13.3
3.3: Strengthen public health system to intervene early in climate related nutrition issues	MoH (Nutrition Division)	MoH (EOH Directorate (Food control unit), NCD Unit), MoEd, MoA, SMoWCP&P, MRI (nutrition unit), DCS; DoA, MD, , UN agencies, FAO,	Integration of climate related nutrition aspects in public health system	Records of MoH, FHB	The issues identified and interventions initiated	Climate related nutrition issues identified and addressed. (Under 5 malnutrition, micro nutrient deficiency)	√	√	√	√	√	√					2.1, 13.3

		Academia														

NDC 4 - Strengthen surveillance and management of climate sensitive vector and rodent borne diseases (Dengue, Malaria, Filaria, Leishmaniasis and Leptospirosis) (2024)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4.1: Strengthen disease surveillance system for climate sensitive vector borne diseases	DDG Public Health Services	MoH (Epidemiology Unit), National Dengue Control Programme, Anti Malaria Campaign, Anti Filariasis Campaign, LAs	Climate sensitive vector borne surveillance system	Records of National Dengue Control Unit, Anti Malaria Campaign monthly review reporting system, Filariasis quarterly reviews, data base of the Epidemiological unit	A surveillance system for Dengue, Malaria, Filariasis, and Leishmaniaisis in place	Well-functioning vector borne surveillance system,	√	√	√	√	√	√					3.3, 13.3
4.2: Develop early warning systems at MOH level based on rainfall/temperature forecast for each climate sensitive vector borne disease	DDG Public Health Services 1	MoH (Epidemiology Unit), National Dengue Control Programme, Anti Malaria Campaign, Anti Filariasis Campaign, DMC, MD,	% coverage of MOH level improved early warning system for vector borne diseases	Records of Dengue surveillance system, Malaria Campaign monthly review reporting system, Filaria monthly reviews, data base of the	20%	100%	√	√	√	√							3.3, 3.d, 13.3

				Epidemiological unit													
4.3: Capacity building of the public health system, local authorities and other stakeholders in prevention of occurrence of outbreaks and to rapidly respond to early warnings through effective interventions in prevention and control infectious diseases	MoH (DDG Public Health Services 1)	MoH (Epidemiology Unit), National Dengue Control Programme, Anti Malaria Campaign, Anti Filariasis Campaign, LAs, Provincial Ministries of Health	1. Number of capacity building programmes 2. Number and sectors trained 3. Training manuals	Records of Provincial Secretary's office	1. A few programmes are conducted yearly 2. Number and sectors trained to be identified 3. Training manuals yet to be published	1. Five programmes per annum 2. (i) 250 public health staff trained per year (ii) 50 Local government and community based organization members trained per year 3. Training manuals published	√	√	√	√	√	√	√	√	√	√	3.3, 3.d, 13.3
4.4: Strengthen public health risk communication regarding vector borne disease control during predicted outbreaks	DDG Public Health Services 1 &2	MoH (Media unit), MoE (CCS), HPB, National Dengue Control Programme, Anti Malaria Campaign, Anti Filariasis Campaign, DMC, DoGI,	1. Plan for public health risk communication regarding vector borne disease control during predicted outbreaks 2. Communication as per the plan during predicted	Records of HPB, Dengue Control Programme, Anti Malaria Campaign, Anti Filariasis Campaign, Epidemiology Unit	1, Existing plan 2. Existing communications during predicted outbreaks	1, Improved plan 2. Improved communications during predicted outbreaks	√	√	√	√							3.3, 3.d, 13.3

			outbreaks														
4.5: Inter-sectoral coordination and information system linked to the surveillance system for coordination with public health, local authorities and other stakeholders	DDG PHS 1	MoH (DPRD, Epidemiology Unit) MoEd, MoE (CCS), MoFish, MoD, MoUD&H, MoEd, MoPC&LG, Ministries in charge of Technology and Research, MoMM, CEA, MD,, Dengue Control Programme, Anti Malaria Campaign, Anti Filaria Campaign, Provincial Ministries of Health	1. Number of Inter-sectoral committees and frequency of reporting 2. Information sharing (ICT) platform	Minutes of the committee meetings, ICT platform	1. About 40% coverage 2. Not establishe d	1. Inter-sectoral committees for each disease and reported every quarter 2. Information sharing platform established	√	√	√	√	√	√	√	√	√	√	3.c, 13.2

NDC 5 - Reduce morbidity and mortality from extreme weather/climate events (floods, drought, landslides and other climate related emergencies) (2022)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
5.1: Strengthening timely and accurate early warning receipt and dissemination to health sector on possible extreme events or rainfall	MoH (DPRD)	DMC, DS, PMoH, RDHS	A system for receipt dissemination of	Records of DPRD	Existing system covering all major	Comprehen sive system for receipt disseminati	√	√	√	√	√	√	√	√	√	√	3.c, 13.3

variability and linking them to national, regional, MOH and village level interventions			information on disasters and early warning		events (but not comprehensive enough to cover national, regional, MOH and village level)	on of information on disasters and early warning in place											
5.2: Risk assessments for all hazards including climate-related events for the health sector	EOH Directorate of MoH	MoH (DPRD, Epidemiology unit, Vector/food/ water borne/viral disease control units) PDHS, RDHS, DMC, MD, MRI	Rsk assessment maps	Records of DPRD, PDHS, RDHS, MRI, Epidemiology Unit, maps	In progress covering four provinces	Risk assessment s maps covering all the provinces			√	√	√	√					3.c, 13.3
5.3: Improved health preparedness for all hazards including-climate-related disaster events at national, subnational, MOH and village level both in curative and preventive sectors	MoH (DPRD)	RDHS, DMC, PDHS, MD,, DMC	Health preparedness plans at national, provincial and district level	Annual reports of DPRD	Plans for four provinces	Health preparedne ss plans at national, provincial and district level established	√	√	√	√	√						3.c, 3.9, 13.3
5.4: Public awareness on health impacts of climate change and promotion of resilience designed and disseminated through traditional, electronic and social media on how to address immediate disaster risks	MoH (HPB),	MoH (DPRD, E&OH, Epidemiology Unit, FHB, Nutrition Division, EOH), MoE (CCS), DMC, DoGI,	No of awareness programmes and promotions conducted per year	Records of HPB, DPRD, E&OH	Ongoing, the number of the program mes conducte d to be estimated	Target is to be established	√	√	√	√	√	√	√	√	√	√	3.c, 13.3

		Dengue Control Programme, Anti Malaria campaign, Anti Filaria campaign,															

4.9 Urban Planning and Human Settlement Sector

According to the definition of urban population, which includes those residing in designated Municipal Councils (MCs) and Urban Councils (UCs), Sri Lanka's urban population is 18.7%, with a projected population share of 21% by 2030. Urbanization has become a rapidly growing force, as an increasing number of people have begun to move to towns and cities. This situation has led to a number of problems, including a rise in service demand, increased traffic congestion and its effects from pollution and natural disasters, health risks, unsuitable housing, the urban heat island effect, and low living standards for the urban poor (growth of slums). The GoSL places a strong emphasis on rural development and evenly distributes infrastructure and services between the urban and rural regions. The idea of de-urbanization through agro-industrialization has been put out, and the GoSL has started several initiatives to close the infrastructural and service gap. The policies for urban development are established by the Ministry of Urban Development and Housing. The overall framework and rules for spatial planning are provided by the National Physical Planning Policy and the Plan 2017-2030 (2019). The Urban Development Authority (UDA) is given the authority to carry out urban planning and land distribution by the Urban Development Authority Act (Amended) No. 36 of 2007 and related UDA Planning and Building Regulations. Further, Regional Physical Plans have been developed for five provinces (Uva, Sabaragamuwa, Southern, Eastern and North Central) that provide the Provincial and Local Level Authorities with necessary framework for the translation of national level policies and development programmes into local level action projects as well as to reformulate and regulate the local development initiatives in harmony with those at national level.

The emphasis given to this sector also become apparent with the inclusion of environment management in cities and human settlements (C&HSs) as one of the eight thematic areas in the NEAP. It highlights that, though C&HSs in urban areas are dynamic and vital parts of the human society and are the main engines of social, economic and technological development, there are numerous challenges and threats as a consequence of urbanization and poor urban planning, particularly the adverse impacts on surrounding ecosystems and local environmental issues such as inefficient water management and sanitation, air quality degradation, solid waste and health impacts, among others. The NEAP includes nine strategies and 60 actions to meet sustainability objectives in this sector.

As climatic hazards grow, it is anticipated that outmigration in villages dependent on agriculture would cause cities to overpopulate. This can result in the growth of haphazard, low-income settlements in metropolitan areas, which have several risks. Climate change poses two different and evident challenges to human settlements: (i) rising temperatures will make urban and suburban regions across the nation uninhabitable; and (ii) urban heat islands will increase the effects of heat waves in cities. Temperature increases during the day and at night will affect how much energy is used for cooling. Water shortages will occur in the Dry Zone due to increased temperatures, high evaporation rates, and extended dry periods. Water constraints resulting from the drought are already noticeable in places with higher watersheds, such Nuwara Eliya and Badulla. Similar issues could arise in the Wet Zone's developing urban centers as demand increases due to urban growth. The increased frequency of weather-related disasters, as well as the increased risk of flood, drought, and landslides, represent the second risk of the climate to human settlements. Towns in the southwest of the country that are already at risk of flooding may face increased hazards, according to positive rainfall anomalies for the Wet Zone. In the hill region, plantation workers' homes are particularly vulnerable to landslides, and this susceptibility is increased by their substandard housing and precarious economic situation. The coastline region of Sri Lanka is heavily inhabited, particularly in the western and southern regions. Drinking water systems in coastal areas are particularly sensitive to saline intrusion and sea level rise, and therefore represent a key adverse impact of climate change.

Four NDCs make up the adaptation measures (*Table 4-9*) in the urban planning and human settlement sector. They highlight the need for better planning, incorporating disaster risk reduction and impending climate risks, boosting built-environment climate resilience, and reducing the effects of slow-onset climate change events. Further, some of the strategies proposed under mitigation NDCs, such urban forestry, eco-friendly transportation, and green buildings, will provide co-benefits to improve adaptation.

Table 4-9 NDCs of Urban Planning and Human Settlement Sector

NDC #	NDC
1	Enhance the resilience of human settlements and infrastructure through mainstreaming climate change adaptation into national, sub-national and local level physical planning
2	Incorporate Disaster Risk Reduction (DRR) into the urban and human settlement planning/implementation in areas of high vulnerability to climate change risks
3	Establish a climate-resilient build environment
4	Minimize the impact of slow onset events (sea-level rise) on coastal settlements and infrastructure

4.9.1 Urban Planning and Human Settlement Sector NDC Implementation Plan

NDC 1 - Enhance the resilience of human settlements and infrastructure through mainstreaming climate change adaptation into national, sub-national and local level physical planning (2025)																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1: Integrate most current climate change risk and vulnerability into physical planning at all levels	NPPD	MoUD&H, MoPC&LG, MoH, UDA, ID, SLLDC, NBRO, LAs	1. NPPD - the updated National Physical Plan (NPP) 2. The level of adherence to the items in the NPPD by stakeholders	Climate change integrated National Physical Plans of NPPD, NBRO reports	1. Updating of National Physical Plan including climate change risk and commenced 2. NPP-2019 (the latest version by then) adhered with by all stakeholders (however, there are challenges in ensuring full adherenc	1. Updated National Physical Plan published (2023) 2. Full adherence by the stakeholders	√	√	√								13.2

					e)												
1.2: Prepare the sub-national and local plans considering climate risks and vulnerability based on the recommendations of the National Physical Plan (NPP)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.2.1: Prepare Regional (Provincial) Physical Plans considering climate risks and vulnerability based on the recommendations of the National Physical Plan (NPP)	NPPD	MoUD&H, MoPC&LG, MoH, ID, UDA, CEA, SLLDC, NBRO, LAs,	The number of Regional Physical Plans prepared incorporating climate risks and vulnerabilities.	Records of NPPD, NBRO, UDA	Identification and preparation of Regional physical Plans in progress	Four regional Physical Plans (Eastern, Central, UVA, Central fragile zone)	√	√	√	√							13.2
1.2.2: Prepare Local Development Plans in UDA declared areas	UDA	MoUD&H, MoPC&LG, MoH, ID, NPPD, CEA, SLLDC, NBRO, LAs	The number of Local Physical Plans prepared incorporating climate risks and vulnerabilities in UDA declared areas.	Records of UDA, NBRO, NPPD	Twenty (20) Local Physical Plans in UDA declared areas	All MCs, UCs and PSs (in UDA declared areas)	√	√	√	√	√						13.2
1.2.3: Prepare Local Development Plans in LA areas	LAs	MoUD&H, MoPC&LG, MoH, ID, UDA, NPPD, CEA, SLLDC, NBRO, LAs	The number of Local Physical Plans prepared incorporating climate risks and vulnerabilities	Records of respective LAs, UDA, NPPD, NBRO	Identification of areas for Local Physical Plans in progress	275 Local Development Plans prepared	√	√	√	√	√	√					13.2
1.3 Adhere to the guidelines prescribed by the NPPD and UDA in all urban infrastructure projects and programmes	Project Approving Agencies (PAAs)	UDA, USDA, NBRO. DMC, SLLDC, CEA,	Degree of Adherence	Records of PAAs (Compliance reports, Planning	The criteria and evaluation	100% (All projects adhered to the NPP	√	√	√	√	√						11.3 11.5 11.6 11.b

		CC&CRMD, DWC		committee clearance)	methodology for the Degree of Adherence are not established	and UDA guidelines)											
1.4: Introduce adaptation measures such as urban zoning incorporating disaster risk, forest parks, ground water recharge, air passages/wind corridors, wise-use of wetlands and roadside planting into urban planning, bio engineering technologies, etc. to build resilience to climate change	UDA	DMC, SLLDC, ID, NBRO, LAs	Number of Local/Urban Development Plans prepared with integration of climate change adaptation measures	Records of respective LAs, UDA, DMC, NBRO, Respective LAs	Incorporated in gazetted 21 Development plans of the UDA	275 Local Development Plans	√	√	√	√	√						11.3 11.5 11.6 11.b
1.5: Integrate and adhere to the Guideline for Climate Resilient Human Settlement and Infrastructure developed by the Climate Change Secretariat (CCS)	MoE	CCS, DMC, SLLDC, ID, NBRO, LAs	1. Number of awareness and capacity building programmes conducted 2. Degree of Adherence	Records of MoE and other stakeholder agencies	1. No programmes planned and conducted 2. The criteria and evaluation methodology for the Degree of Adherence are not established	All housing and settlement projects adhere to climate resilient guidelines of CCS	√	√	√	√	√						11.3 11.5 11.6 11.b

NDC 2 - Incorporate Disaster Risk Reduction (DRR) into urban and human settlement planning / implementation in areas of high vulnerability to climate change risks (2025)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Develop Guidelines on Climate Change influenced Disaster Risk Management (DRM) for urban and human settlement planning	DMC	NBRO, UDA, NHDA, USDA, CCS, ID, SLLDC, NPPD	1. Number of guidelines prepared 2. Areas of coverage in the guidelines 3. Effectiveness of the guidelines	Annual reports of DMC and other stakeholders	1. Key Agencies have developed several guidelines (e.g. UDA – Wetland Conservation Development Plan for Western Province) 2. Baseline to be established 3. Baseline to be established	1. Target for the number of guidelines to be established 2. Target for the areas of coverage to be established 3. Incorporation of DRR into urban and human settlement planning based on the guidelines developed by key agencies.	√	√	√								13.2
2.1.1: Review and revise Urban & Human settlement planning legislation to incorporate climate change influenced disaster risk management	MoUD&H	MoE, USDA, DMC, Attorney General	1. Urban Settlement Policy formulation	Records of MoUD&H, USDA, DMC, AGDs, MoE	1. Policy formulation not	1. Urban Settlement Policy incorporati	√	√	√	√	√						13.2

aspects		Department (AGD), CCS	incorporating climate change influenced disaster risk management aspects 2. Specific legislations for the implementation of the Urban Settlement Policy		commenced 2. Specific legislations not developed	ng climate change influenced disaster risk management aspects by 2023 2. Enacted specific legislations by 2025											
2.2: Design, Implementation & maintain infrastructure giving due consideration to the runoff system/drainage and flooding	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.2.1: Design of infrastructure giving due consideration to the runoff system/drainage and flooding	ID	MoPC&LG, RDA, CEA, NBRO, UDA, SLLDC	1. Number of river basins covered in the designs 2. Area coverage of Urban/ local floods designs	Records of DoI and other related agencies	1. Three (03) - (Kelani, Gin; Nilwala river basins) 2. No coverage of Urban/ Local floods	1. 05 Additional river basing covered 2, Target to be established	√	√	√	√	√	√	√	√	√	√	11.3 11.5 11.6 11.b
2.2.2: Implementation & maintain of infrastructure giving due consideration to the runoff system/ drainage and flooding (in accordance with the Design in 2.2.1)	LAs	ID, RDA, CEA, NBRO, MoPC&LG, UDA, SLLDC	1. Number of river basins covered in the implementation and maintenance 2. Area coverage in the implementation and	Records of LAs, DoI and other related agencies	Not implemented	1. Implementation and maintenance of 08 river basins 2. Target to be established	√	√	√	√	√	√	√	√	√	√	SDG 11.3 11.5 11.6 11.b

			maintenance of Urban/ local flood control														
2.3: Incorporate slope stability and soil conservation measures in developing infrastructure in hilly areas	NBRO	DS, LUPPD, NPPD, Ministry in charge of Estate Housing/Infra structure Development, PHDT, NRMC of the DoA	1. % No of plans rejected due to slope instability in hilly areas; 2. % of districts covered	NBRO Database, Records of LIPPD and NPPD	Baselines to be identified (Implemented in some areas, but % is to be estimated)	1. Up-to-date information on % No of plans rejected 2. 100% (Implemented in all the hilly areas)	√	√	√	√							11.3 11.5 11.6 11.b
2.4: Assess landslide / flood risk to human settlement and infrastructure and introduce measures to reduce the vulnerability in high risk areas	DMC	Ministry in charge of Estate housing/Infra structure Development, PHDT, NBRO, SLLDC, ID, DS, LUPPD,	% of districts covered	NBRO reports, Records of DMC, ID	Baseline needs to be established (Maps available on the Landslide risk to human settlements and infrastructure)	100% (Implemented in all districts)	√	√	√	√	√	√	√	√	√	√	11.3 11.5 11.6 11.b
2.5: Assess drought risk to human settlement and introduce measures to reduce vulnerability in high risk areas	DMC	MD, DSs, LAs	% of districts covered by the drought risk assessment and plans introduced	Records on by relevant agencies	Some assessment done, but not very comprehensive	100% (Assessment covering all high risk areas)	√	√	√	√							11.3 11.5 11.6 11.b

NDC 3 - Establish climate resilient built environment (2030)																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1: Integrate climate risk projections into climate resilient built environment strategies implemented by respective stakeholder institutions	UDA	MoUD&H, MD, NBRO, GSMB, DMC, CEA, NHDA, DCS, NRMC, Academia	Number of UDA development plans which has incorporated climate resilient concerns	Records of UDA	Baseline to be established (this is done in planning, but need to identify the level of incorporation)	Climate risk projection are integrated to all the plans	√	√	√	√	√						11.3 11.5 11.6 11.b
3.2: Review and update climate resilient design strategies to address emerging climate risks	UDA	MoUD&H, CEA, CCS, DArch. ., NPPD, LUPPD, USDA, CIDA, NBRO, FD, CC&CRMD, DWC, MASL	Number of climate resilient design strategies and guidelines developed, updated and incorporated	Review and updated reports, updated climate resilient design strategies, green building codes incorporated into development plans of UDA and other stakeholder agencies	There are related design and guidelines – for example Blue Green Sri Lanka- National Green Building standards integrated to UDA Gazetted regulations in 2019)	Target to be established (one example is Green Building Certifications to be issued under UDA building approval process in the country)	√	√	√	√	√	√	√	√	√	√	11.3 11.5 11.6 11.b

3.3: Amend and gazette existing human settlement plans integrating climate resilient strategies 3.2	MoUD&H	UDA, CEA, CCS, DArch, NPPD, LUPPD, USDA, CIDA, NBRO, FD, CC&CRMD, DWC	The number of existing human settlement plans integrating climate resilient strategies	Published amended gazettes, human settlement plans and other records of UDA and relevant PAAs	20 Plans	275 Plans	√	√	√	√	√						11.3 13.2
3.4: Review, update and enforce existing rules and regulations to prevent built environments in areas highly vulnerable to climate change	UDA	CEA, CCS NPPD, LUPPD, BOI USDA, RDA, DArch CIDA, NBRO, FD, CC&CRMD, DWC, PRDA	1. Number of rules and regulations reviewed, updated and enforced 2. Level of enforcement	Consultations, rules and regulations incorporated climate vulnerability, projects/ plans adhered to cc built environment rules and regulations, projects approved by NPD according to rules and regulations of CC vulnerability aspects, M & E plans for the enforcement of rules and regulations of UDA and other relevant PAAs	1. The existing rules and regulatio ns are enforced 2. The criteria and evaluatio n methodol ogy for the Level of enforcem ent are not available	1. Target to be established 2. All application s for built environmen t are aligned to the applicable rules and regulations	√	√	√	√	√	√	√	√	√	√	11.3 13.2
3.5: Include sustainable built environment concepts into	UGC	SLSEA, Professional Org, GBCSL,	List of degree /professional	Curricula of relevant institutions/	Baseline to be establishe	Target to be established	√	√	√	√	√						11.3 13.2

Architecture and Engineering curricula		Academia, Technical Colleges,	training programs having green building concept incorporated in the curricula	programmes	d (Presently, there are 37 UG/PG degrees/ diplomas offered by Engineering and Architecture disciplines)	(e.g. Introduced the sustainable built environment concepts to all Architecture and Engineering curricula)											
3.5.1: Introduce sustainable built environment concepts to capacity building	MoUD&H	MoE- Planing division, Institute of Architects, Town & country planning Dept of Universities, SLSEA, SLEMA, SLIDA	List of Awareness and Training Programmes initiated with sustainable built environment concepts	Training curricula and manuals of the relevant institutions	Presently, there are a range of continuous professional development programmes conducted by different institutions, where the sustainable built environment concepts are covered)	Target to be established (e.g. Introduced the sustainable built environment concepts to all relevant CPD programmes)	√	√	√	√	√	√	√	√	√	√	11.3 13.3 13.b
3.6: Promote vertical housing solutions, where appropriate to	MoUD&H	USDA, NBRO, MD,	No of vertical housing	Project reports, Cooperate plans,	Projects are	Vertical housing	√	√	√	√	√	√	√	√	√	√	11.3 11.5

communities living in high climate risk areas		Condominium Management Authority, NHDA, UDA LUPPD, Banks, NPPD	projects introduced to communities living in high climate risk areas	Performance report, Mixed used projects, strategic plans of USDA, UDA	Implemented but not specifically in high climate risk areas	solutions in place to all communities living in high climate risk areas											11.a 11.b

NDC 4 - Minimize the impact of slow onset events (sea level rise) on coastal settlements and infrastructure (2030) reef coastal zone																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4.1 Design coastal settlements and associated infrastructure considering future sea level rise	UDA	MoUD&H, NPPD, NHDA, CC&CRMD, SLTDA, USDA, NWSDB, CEB, SLLRDA. LUPPD, , NARA, RDA, , LAs	1. Updating of Coastal Zone Management Plan (CZMP) 2. Number of Local Area Development Plans of UDA	Progress report, annual reports of UDA and other related agencies	1. CZMP 2018 in effect for UDA declared areas 2. Baseline to be identified	1. Updated CZMP for UDA declared areas by 2023 2. Target to be established	√	√	√	√	√	√	√	√	√	√	11.3 11.5 11.a 11.b
4.2 Demarcate protection areas from sea level rise to facilitate for shifting urban densification inward	CC&CRMD	Ministry in-charge of Resettlement, SD, UDA DMC, LAs, DS, UDA	Number of maps prepared	Existing inundation maps of CC&CRMD, Vulnerability assessments, Survey maps , DMC maps	2011 Version (Climate Change Vulnerability Database) in effect	Updated inundation maps, demarcate protection areas from sea level rise			√	√	√	√	√	√	√	√	11.3 11.5 11.a 11.b
4.3 Prepare and commence implementation of risk management plans (RMPs) for existing coastal infrastructure and settlements	DMC	CC&CRMD, DS, LAs SLTDA, SLCG, SLN	1. Number of (RMPs	RMPs and other records of DMC, Records of	1. Previous versions RMPs	1. RMPs prepared for all the existing coastal			√	√	√						11.b

			2. Level of implementation of RMPs	other stakeholder agencies	were available 2. Level of implementation is to be identified.	infrastructure and settlements 2. The target for the level of implementation will be identified through an established methodology and criteria											

4.10 Tourism and Recreation Sector

Tourism has traditionally been the third largest foreign exchange earner and an important income generator for Sri Lanka. Sri Lanka ranked 74th out of 141 countries in the Travel & Tourism Competitiveness Report 2021 of the World Economic Forum. As illustrated in Figure 4-7, the tourism sector has been steadily growing between 2012 and 2018, contributing to the country's economy. However, the Easter attack in 2019, followed by the COVID-19 pandemic, has shrunken the sector, reversing its economic developments to a decade back in history. The tourism sector created nearly 400,000 direct and indirect employment in 2019, while the amount dropped to approximately 350,000 in 2020 and 2021[61].

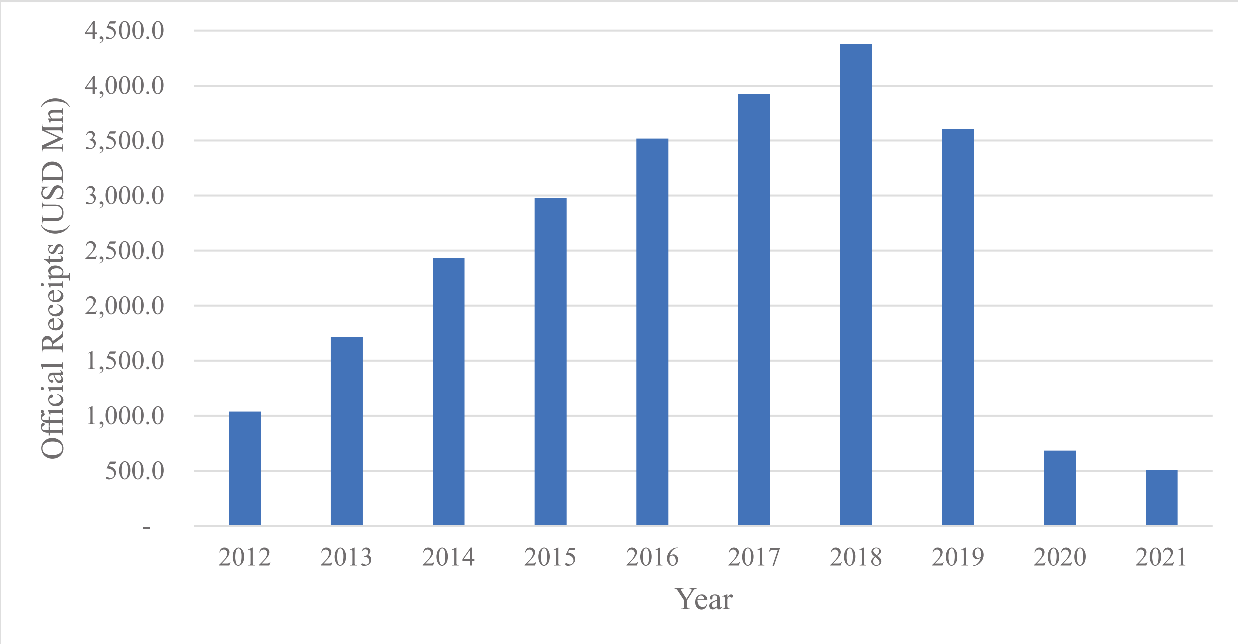


Figure 4-7 Tourism sector foreign exchange earnings (Data: Statistical pocketbook, 2022)

Although the majority of visitors are now primarily interested in leisure travel, Sri Lanka has a lot of potential to attract travelers interested in community-based travel and the expanding health tourism subsector. The Sri Lanka Strategic Plan for Tourism 2022–2025 was created to revive the industry from its current state of decline brought on by the pandemic. The plan identifies issues and opportunities to focus on and provides a structured rationale for the actions proposed. Its purpose is to set an agenda for the recovery and future resilience of the tourism sector. There are several areas of opportunities for the diversification of tourism sector, for example, kite surfing, speleology, adventure, and palaeobiodiversity.

Tourism has already been impacted by global warming. Extreme heat, floods, storms, the loss of beaches, and the depletion of coral reef resources will all exacerbate the risks associated with tourism operations in tropical and subtropical areas. About 60% of Sri Lanka's tourist spots are found along the coast, where the height is less than two meters above sea level. The

[61] Department of Census and Statics, Statistical Pocket Book, 2022

monsoons are a definitive factor in the choice of tourism destinations for the tourists. There are seasons and areas for beach, bird watching, whalewatching, adventure etc. Hence, tourism zones are infromally demarcated based on annual climate.

Most of the inland tourism destinations are situated in highly scenic but vulnerable locations. Unplanned and unauthorized constructions create excessive risk-taking in the face of climate disasters. High density tourism areas create water shortages during the drought and are impacted by contaminated water during floods. Infrastructure is also impacted by climate change leading to unsuitable conditions for the tourists. The tourism sector provides mitigation co-benefits through decarbonization activities such as energy efficiency, waste management, and reforestation landscaping, etc making this sector a key sector to increase Sri Lanka's foreign revenue, increase climate change resilience while following a low carbon development pathway.

Three NDCs addressing sustainable tourist practices, sector risk reduction, and resilience building measures embracing the green construction concept are provided as adaptation targets for the tourism sector (*Table 4-10*). Energy efficiency, green building, and landscaping-related activities are among the NDCs for the tourism sector, all of which will have a mitigating effect.

Table 4-10 NDCs of Tourism and Recreation Sector

NDC #	NDC
1	Build resilience through sustainable tourism practices and improved risk preparedness in destinations of high climate change vulnerability
2	Introduce risk reduction and risk transfer mechanisms for climate-induced disaster affecting tourism
3	Promote climate resilience in the tourism sector by introducing green building design to all new constructions and refurbishments

4.10.1 Tourism and Recreation Sector NDC Implementation Plan

NDC 1 - Build resilience through sustainable tourism practices and improved risk preparedness in destinations of highest climate change vulnerability (2025)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1: Undertake studies to assess climate impacts on tourism, carrying capacity studies and identification of tourism facilities in areas which are vulnerable to climate change	Ministry of Tourism and Lands	MoE, MoPC&LG, SLTDA, UDA, CEA, MEPA, , CC&CRMD,, NARA, SLSDC, CCF, DWC, FD, DMC, NBRO, MD	**1** - Studies on climate impacts on tourism in most vulnerable sites **2** - Carrying capacity studies and identification of tourism facilities in critical sites	Records and reports of Ministry of Tourism and Lands	**1** – 0 **2** - 0	**1** - Studies on climate impacts on tourism in 5 most vulnerable sites completed **2** - Carrying capacity studies and identification of tourism facilities in 8 Nos of critical sites completed including Kalpitiya and Hikkaduwa	√	√	√	√	√						14.1, 14.2, 14.5, 15.9
1.2: Identification and promotion of adaptation measures in the destinations identified in 1.1	Ministry of Tourism and Lands	MoPC&LG, SLTDA, UDA, CEA, MEPA, CC&CRMD, NARA,	Number of destinations covered	Reports and records of Ministry of Tourism and Lands	Partially taken into account in the	5 destinations covered				√	√						14.1, 14.2, 14.5, 15.9

		SLSDC, CCF, DWC, FD, DMC, NBRO, MD			Master plan												
1.3: Advocate diversified tourist attractions and products (e.g: Cultural, Adventure, Lifestyle, Festivals and Marine Tourism, etc.) as alternatives to identified vulnerable destinations	SLTDA	Ministry of Tourism and Lands, MoE, SLINTGL, DWC, FD, CC&CRMD, CEA, Provincial Councils, CCF, International Bureau of Education	Alternative measures for vulnerable areas	Reports and records of Ministry of Tourism and Lands	0	Alternative measures identified for all vulnerable areas	√	√	√	√	√						14.1, 14.2, 14.5, 15.9
1.4: Inclusion of guidelines/principles for sustainable tourism practices relevant to different stakeholders	SLTDA	Ministry of Tourism and Lands, SLSDC, GSTC, SLAITO, THASL, ASMET	GSTC guidelines covering destination, accommodati on & tour operation	Guidelines of the SLTDA for different sectors	Globally available accommo dation guideline s (2019) & destinatio n guideline s (2020) localized Tour operator guideline s complete d	Guidelines on sustainable tourism including tour operator guidelines to different stakeholder s developed	√	√	√	√	√						11.b, 12.b
1.5: Increased number of tourism establishments and destinations certified under the National Sustainable Tourism Certification Scheme by SLTDA in collaboration with Global Sustainable Tourism	SLTDA	Ministry of Tourism and Lands, Provincial Councils, UNDP, IUCN	Number of certified destinations and accommodati on	SLTDA annual reports	**1** – 0 **2** - 37 accommo dation establish	**1** - 9 destinations in 9 Provinces certified	√	√	√	√							12.b

Council (GSTC)		Private sector tourism associations, Civil society partners	establishments & tour operators/travel agencies		ments certified in 2019	**2** - 75 Accommodations/ establishments certified											

NDC 2 - Introduce risk reduction and risk transfer mechanisms for climate- induced disasters affecting tourism (2025)

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Strengthen early warning systems and capacity building in most vulnerable tourism destinations	SLTDA	DMC, MD, NBRO, CC&CRMD, ID	**1** - Strengthened early warning systems in vulnerable destinations **2** - Capacities of stakeholders of vulnerable areas	SLTDA records and reports	Early warning systems exists but not specifically targeting on vulnerable tourism destinations	**1** - All 5 vulnerable areas covered with strengthened early warning systems **2** - Capacities of stakeholders of all 5 vulnerable areas built			√	√	√						13.1, 13.3
2.2: Implement coastal rehabilitation and protection measures	CC&CRMD	Ministry of Tourism and Lands, SLTDA, MEPA, FD, DWC	Coastal areas (if any) of all 5 vulnerable areas	CC&CRMD records	Ongoing main task of CC& CRMD	Coastal areas (if any) of all 5 vulnerable areas covered	√	√	√	√	√	√					14.1, 14.2, 14.5, 15.9
2.3: Expand development of coastal tourism zonal planning	SLTDA	, CC&CRMD,	Expanded zonal plans	1.Gazetted master plans	Zonal plans are	Expanded zonal plans	√	√	√	√	√						14.1, 14.2,

		UDA, MEPA, CEA, BOI	for vulnerable coastal areas	2. Report on expanded tourism zones	available for Passikuda, Yala, Bentotota	for vulnerable coastal areas developed and gazetted										14.5, 15.9
2.4: Develop climate inclusive insurance scheme for risk management in tourism	Ministry of Tourism and Lands	SLTDA, National Insurance Trust Fund, Insurance Companies	Climate inclusive insurance scheme in line with international risk transfer mechanism	Annual Report of the National Insurance Trust Fund	0	Climate inclusive insurance scheme developed			√	√	√					11.b

NDC3: Promote climate resilience in the tourism sector by introducing green building design to all new constructions and refurbishments																
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)									Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1: Review and update existing Green Building Guidelines (GBG) specific to tourism to include climate change and ecological aspects	UDA	Ministry of Tourism and Lands, MoE, SLTDA, GBCSL, SLSEA, Tourism Advisory Committee, SLIA, SLIE	GBG specific to tourism industry	Green Building Guidelines of UDA	Existing GBG	GBG reviewed and updated	√	√	√								6.3, 6.4, 7.2, 7.3, 11.b, 12.8
3.2: Legalize GBG specific to tourism	UDA	Ministry of Tourism and Lands, MoE, SLTDA, SLSEA	New gazette	New gazette	UDA had prepared the document	Updated GBG gazetted			√	√	√						6.3, 6.4, 7.2, 7.3, 11.b, 12.8
3.3: Dissemination of Green Building	UDA	SLTDA, LAs	Number of	Records of	0	All LAs				√	√						6.3, 6.4,

Code on tourism with planning committees of the relevant local authorities			LAs that have incorporated the guidelines	UDA, LAs SLTDA		covered											7.2, 7.3, 11.b, 12.8
3.4: Initiate awareness programmes for the Architects and Engineers responsible for designing tourism related structures through their respective professional associations on the Green Building Codes on tourism	SLTDA	GBCSL, SLIA, SLIE, IEPSL Academia, Professional bodies	Awareness of All relevant stakeholders	Curricula of professional courses on GB offered by professional associations	Curricula of existing professional courses on GB not specifically focusing on tourism industry offered by professional associations	Awareness of All relevant stakeholders created			√	√	√	√	√	√	√	√	6.3, 6.4, 7.2, 7.3, 11.b, 12.8
3.5: Enforce above GB guidelines for all new constructions and refurbishments in the tourism sector	SLTDA	UDA, LAs, CC&CRMD, CEA, MEPA, NBRO	Updated SLTDA approval system	SLTDA reports and records	SLTDA existing approval system does not have GB guidelines for new constructions and refurbishments	GB Guidelines for all new constructions and refurbishments included in SLTDA approval system						√					6.3, 6.4, 7.2, 7.3, 11.b, 12.8

5 NDC IMPLEMENTATION – LOSS & DAMAGE

5.1 Overview

Sri Lanka has faced a number of large-scale disaster events including devasting droughts, floods and landslides during the past two decades. These impacted food security, livelihoods, infrastructure and incurred reconstruction needs estimated at over USD 790 million. The government's contingent obligation for 2017 was LKR 23.8 billion (US$ 149 million), or around 1% of all expenditure[62]. Potential effects of climate change are projected to reduce yearly GDP by 1.2% by 2050. Further, it is estimated that Sri Lanka could face housing/roads losses and relief needs related to natural disasters of more than LKR 237 billion (US$ 1.8 billion) once every 100 years. These estimates do not account for long-term losses brought on by economic turmoil, effects on poverty levels, social security, effects on health, education, gender, and other social concerns, or consequences on social security. Furthermore, these figures do not take into account the erosion of natural resources such as watersheds, historical sites, tourist attractions and beaches. Flood frequency and severity are on the rise, according to historical data. In addition, Sri Lanka must deal with climate risks that develop slowly, such as desertification, sea-level rise, and salinization, which have the potential to have serious negative effects on the country's food and water security, agriculture, biodiversity, and habitats.

The Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts (Loss and Damage Mechanism), was established to address loss and damage associated with impacts of climate change, including extreme events and slow onset events, in developing countries that are particularly vulnerable to the adverse effects of climate change. This was established at COP 19 (November 2013) in Warsaw, Poland. Subsequently, Article 8 of the Paris Agreement enshrines the importance of averting, minimizing and addressing loss and damage and the role of sustainable development in reducing the risk of loss and damage

The Loss and Damage Mechanism promotes approaches to address loss and damage associated with the adverse effects of climate change in a comprehensive, integrated and coherent manner by undertaking the following functions[63]:

1. Enhancing knowledge and understanding of comprehensive risk management approaches to address loss and damage associated with the adverse effects of climate change, including slow onset impacts, by facilitating and promoting:

- Action to address gaps in the understanding of and expertise in approaches to address loss and damage associated with the adverse effects of climate change, including, *inter alia*, the areas outlined in decision 3/CP.18, paragraph 7(a);
- Collection, sharing, management and use of relevant data and information, including gender-disaggregated data;

[62] World Bank, Contingent Liabilities from Natural Disasters Sri Lanka, 2018
[63] unfcc.int

- Provision of overviews of best practices, challenges, experiences and lessons learned in undertaking approaches to address loss and damage.

2. Strengthening dialogue, coordination, coherence and synergies among relevant stakeholders by:

- Providing leadership and coordination and, as and where appropriate, oversight under the Convention, on the assessment and implementation of approaches to address loss and damage associated with the impacts of climate change from extreme events and slow onset events associated with the adverse effects of climate change;
- Fostering dialogue, coordination, coherence and synergies among all relevant stakeholders, institutions, bodies, processes and initiatives outside the Convention, with a view to promoting cooperation and collaboration across relevant work and activities at all levels.

3. Enhancing action and support, including finance, technology and capacity-building, to address loss and damage associated with the adverse effects of climate change, to enable countries to undertake actions, pursuant to 3/CP.18 (para. 6) including by:

- Providing technical support and guidance on approaches to address loss and damage associated with climate change impacts, including extreme events and slow onset events;
- Providing information and recommendations for consideration by the Conference of the Parties when providing guidance relevant to reducing the risks of loss and damage and, where necessary, addressing loss and damage, including to the operating entities of the financial mechanism of the Convention, as appropriate;
- Facilitating the mobilization and securing of expertise, and enhancement of support, including finance, technology and capacity-building, to strengthen existing approaches and, where necessary, facilitate the development and implementation of additional approaches to address loss and damage associated with climate change impacts, including extreme weather events and slow onset events.

A need to streamline the disaster management infrastructure, policies frameworks and plans under shared objectives, all aligned with the Sustainable Development Goals, Climate action and the Sendai Framework for Disaster Risk Reduction has been identified. The current institutional challenges arise from the many policies, overlapping responsibilities and resulting confusion of roles, especially in the phases of response. Furthermore, the implementation of policies at the local levels has been an issue due to lack of resources, human capacity and technical know-how. Figure 5-1 illustrates the analysis of existing policy landscape between disaster risk reduction and climate change at various levels, while good practices are documented and disseminated[64].

Figure 5-1Comprehensive Disaster and Climate Risk Management

At COP 27 in Sharm-el-Sheik, Egypt, an agreement was made to establish a fund for vulenerable countries exposed to floods droughts and other climate disasters. In the broadest understanding, all efforts being taken to curb the global average temperature increase and to adapt to the adverse effects of climate change can contribute to preventing or reducing the risks of loss and damage associated with climate change borne by societies and individuals.

The NDCs of Sri Lanka are based on institutional and coordination mechanisms that operationalozes the Sendai Framework for Disaster Risk Reduction (2015-2030) and the Warsaw International Mechanism. It is related in Table 5-1.

Table 5-1 NDCs of Loss and Damage Sector

NDC #	NDC
1	Conduct a gap analysis to assess the current status and understanding of L&D
2	Strengthen the existing weather and climate forecasting system
3	Improve data management systems to record losses and damages per sector
4	Establish an overarching, nationally appropriate, functional institutional mechanism for L&D
5	Develop a Comprehensive Risk Management Framework

[64] https://www.undrr.org/comprehensive-disaster-and-climate-risk-management-crm

5.1.1 Loss and Damage Sector NDC Implementation Plan

NDC 1 - Conduct a gap analysis to assess the current status and understanding of L&D: This includes weather and climate related extreme events, slow-onset disasters and natural processes attributed to climate change. The analysis would cover; i) awareness and capacity on L&D ii) data collection and analysis and iii) policy, institutional arrangements and mandates

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.1: Design and carry out a **study to identify the existing institutional mechanisms** to assess and record disaster Loss and Damage (L&D) taking the national requirements and the requirements of the Warsaw International Mechanism (WIM) as criteria of analysis.	MoDM	MoE, DMC, MD, NBRO, NDRSC, Other relevant sectoral agencies	Study to identify the existing institutional mechanisms	Study report of MoDM	Isolated & stand-alone initiatives by different agencies	Study report prepared		√	√	√							1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
1.2: Establish **methodology and agree** on the required **definitions** to **estimate** the L&D (economic, non-economic) by sectors.	MoDM	MoE, DMC, Selected Sectoral agencies	Methodology definitions	Data sources from MoDM and DMC	Not available	Methodology developed and definitions agreed	√	√	√								1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
1.3: Design a **methodology for post disaster assessment** of L&D for climate induced disasters in the categories of extreme events such as: drought, high wind, Lightening, tropical cyclone, storm surge, flood, landslide, heatwave.	MoDM	MoE, MoH, MoWS, DMC, MD, NBRO, NDRSC, ID, MASL, DoA, DoF, Other relevant sectoral agencies	Methodology for post disaster assessment of extreme events	MoDM records	Different methodologies by different agencies	Methodology for post disaster assessment of extreme events established	√	√	√	√							1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
1.4: Design a **methodology for post disaster assessment** of L&D for climate induced disasters in the categories of slow onset events and processes such as: sea level rise, salinization, ocean acidification,	MoE	MoDM, MoH, MoWS, DMC, MD, NBRO, NDRSC, ID,	Methodology for post disaster assessment of slow onset events	Records of Ministries in charge of relevant adaptation and	Different methodologies by different agencies	Methodology for post disaster assessment of slow onset	√	√	√	√							1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3

desertification, land and forest degradation, increasing temperatures, loss of biodiversity,		MASL, NARA, DoA, DoF, Other relevant sectoral agencies		mitigation sectors		events established											
1.5: Design a **methodology for pre-disaster assessment** of L&D for climate induced disasters in the categories of extreme events	MoDM	MoE, MoH, MoWS, DMC, MD, NBRO, NDRSC, ID, MASL, DoA, DoF, Other relevant sectoral agencies	Methodology for pre-disaster assessment of extreme events	MoDM records	Different methodologies by different agencies	Methodology for pre-disaster assessment of extreme events established	√	√	√	√							1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
1.6: Design a **methodology for pre-disaster assessment** of L&D for climate induced disasters in the categories of slow onset events and processes	MoE	MoDM, MoH, MoWS, DMC, MD, NBRO, NDRSC, ID, MASL, DoA, DoF, Other relevant sectoral agencies	Methodology for pre-disaster assessment of slow onset events	Records of Ministries in charge of relevant adaptation and mitigation sectors	Different methodologies by different agencies	Methodology for pre-disaster assessment of slow onset events established	√	√	√	√							1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
1.7: Based on the above activities, establish a **system to assess, analyze and report** L&D from climate change induced extreme events (economic, non-economic) for selected main sectors from taking 2015 as the base year.	MoDM	MoE, MoH, MoWS, DMC, MD, NBRO, NDRSC, ID, MASL, DoA, DoF, Other relevant sectoral agencies	System to assess, analyze and report	MoDM records	Different methodologies by different agencies	System to assess, analyze and report established				√	√						1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
1.8: Based on the above activities, establish a **system to assess, analyze and report** L&D from climate change induced slow onset events/processes (economic, non-economic) for	MoE	MoDM, MoH, MoWS, DMC, MD, NBRO,	System to assess, analyze and report	Records of Ministries in charge of relevant adaptation	Different methodologies by different agencies	System to assess, analyze and report established				√	√						1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3

selected main sectors from taking 2015 as the base year.		NDRSC, ID, MASL, NARA, DoA, DoF, Other relevant sectoral agencies		and mitigation sectors													
1.9: Obtain **legal provisions** to bind the relevant Ministries and sector agencies to provide the L&D data (by establishing a data sharing mechanism through MoUs between Ministry of DM and the relevant authorizes)	MoDM	MoE	Legal provisions	MoDM records	None	Legal provisions made				√	√	√					1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3

NDC 2 - Strengthen the existing weather and climate forecasting system: i) to improve early warning and user services; ii) to improve capabilities to predict and record damages and losses for weather and climate related extreme events, slow-onset disasters and natural processes attributed to climate change iii) to determine losses and damages attributable to climate change.																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
2.1: Review/take stock of the **status** and capability of current weather and climate monitoring and forecasting systems and early warning systems to assess technical capacities, equipment, communication mechanisms required to improve forecasting, early warning and user services of **extreme events**	MoDM	MoE, MoH, MoWS, MoA, MoPlant, MD, NBRO, DMC, NARA, MEPA, ID, MASL, DoF, Agencies who use weather and climate monitoring information	Study report on existing forecasting, early warning systems and evacuation	MoDM records	Existing forecastin g, early warning systems and evacuatio n	Gaps identified	√	√	√	√							1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3

2.2: Review/take stock of the **status** and capability of current weather and climate monitoring and forecasting systems and early warning systems to assess technical capacities, equipment, communication mechanisms required to improve forecasting, early warning and user services of **slow on set events**	MoE	MoDM, MoH, MoWS, MoA, MoPlant, MD, NBRO, DMC, NARA, MEPA, ID, MASL, DoF, Agencies who use weather and climate monitoring information	Study report on existing forecasting, early warning systems and evacuation	MoE records	Existing forecastin g, early warning systems and evacuatio n	Gaps identified	√	√	√	√							1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
2.3: Address the **gaps** identified in actions 2.1 and 2.2.	MD, MoH, NBRO, DMC, NARA, MEPA, ID, MASL, MASL, DoF, Agencies who use weather and climate monitoring information	MoDM, MoE	Sendai indicators A & B; (A-1 to A-3, B-1, B-2) – Affected people and deaths	"DesInventra" database of DMC	187,250 affected people in 2015 151 deaths in 2015	Affected people and deaths reduced by 50% in 2030		√	√	√	√	√	√	√	√	√	1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3

NDC 3 - Improve data management systems to record losses and damages per sector: This involves taking 2015 as the base year, to assess and quantify both economic and non-economic losses and to inform disaster and climate risk management strategies and national development planning process

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
3.1: Develop technical **capacities** at the national and sectoral level to assess and document L&D associated with	MoDM, MoE, DCS	All relevant agencies	Number of staffs trained in L&D data	DMC records	Trained staff only at	Technical capacities of 100			√	√	√						1.5, 3.9, 3.d, 11.5, 13.1,

climate induced events, adverse effects of climate change (economic, non-economic).			handling Centralized database for L&D		institutional level "DesInventra" database, Disaster related statistical framework (DRSF)	(Around 5 from each key agency) developed Either "DesInventra" database for L&D information enhanced or a new database set up											13.2, 13.3
3.2: **Assess and record** the **recovery /compensation** programmes implemented under the main sectors with respect to the defined major climate induced events since 2017	MoDM	MoE, MoH, MoWS, MoA, MoPC&LG, NPD, NDRSC, Adaptation and Mitigation sectoral agencies	Recovery and compensation expenditure	From sectoral agencies	Available only at institutional level	Recovery and compensation expenditure estimated			√	√							1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
3.3: Conduct the **estimates at regular intervals** (aligned with the planning cycles) to inform and use for sectoral and national planning with the objective of reducing the L&D (and for budget allocations).	MoDM	MoE, MoH, MoWS, MoA MoPC&LG, NPD, NDRSC, Adaptation and Mitigation sectoral agencies	Estimate of recovery and compensation and actual expenditure	Annual budget report(s)	Available only at institutional level	Recovery and compensation and actual expenditure estimated annually		√	√	√	√	√	√	√	√	√	1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3

NDC 4 - Establish an overarching, nationally appropriate, functional institutional mechanism for L&D in line with the 'Warsaw International Mechanism for Loss and Damage' (based on the Gap analysis – NDC 1). This institutional mechanism will have the mandate to coordinate with

multiple sector entities, in addition to monitoring functions, it will have financial and budgetary authority.																	
Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
4.1: Establish **institutional mechanism** with technical capacities and overarching advisory capacity **to interact with the Warsaw International Mechanism** or any other mechanism for L&D for national positioning, to maintain dialogue and to negotiate common considerations and benefits.	MoE, MoDM	MoF, NPD, DMC, MD, NBRO, NARA, NDRSC, ID, MASL, DoA, DoF, Other relevant sectoral agencies	Institutional mechanism	MoE, MoDM records	National Disaster Management Coordinating Committee Meeting NECCC Adaptation, NECCC Mitigation	Institutional mechanism established			√	√							1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
4.2: Strengthen **coordination, coherence** and **synergies** among relevant sector agencies to assess the L&D due to climate induced events, including economic and non - economic aspects of L&D	MoE, MoDM	DMC, MD, NBRO, NDRSC, ID, MASL, DoA, DoF, Other relevant sectoral agencies, Relevant academia, NGOs & INGOs	Coordinating mechanism	MoE, MoDM records	National Disaster Management Coordinating Committee Meeting NECCC Adaptation, NECCC Mitigation	Effective coordinating mechanism established			√	√	√	√	√	√	√	√	1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
4.3: Utilize the L&D assessment information for national gains/benefits	MoF (NPD, Dept	MoDM, MoE, MoWS,	Funds allocation	Data sources of Sectoral	Available at	Funds (budget			√	√	√	√	√	√	√	√	1.5, 3.9, 3.d, 11.5,

connecting with **national and sectoral planning, budget allocation** and monitoring functions	of national budget – NBD)	DMC, Sectoral agencies, MD, NBRO, NDRSC, ID, MASL, DoA, DoF, Other relevant sectoral agencies		budgets and plans	institutional level	allocation from consolidated fund and or from external sources) available											13.1, 13.2, 13.3
4.4: Utilize the L&D assessment information to facilitate relevant sectoral agencies to obtain compensation from international funding mechanisms	MoF (NPD, ERD, NBD)	MoDM, MoE, MoWS, DMC, MD, NBRO, NDRSC, ID, MASL, DoA, DoF, Other relevant sectoral agencies	Funds allocation	Data sources of Sectoral budgets and plans	Available at institutional level	Funds (budget allocation from consolidated fund and or from external sources) available			√	√	√	√	√	√	√	√	1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3

NDC 5 - Develop a Comprehensive Risk Management Framework founded on the provisions of the 2005 Disaster Management Act but expanded to include the entire spectrum of climate related extreme events, slow-onset disasters and natural processes attributed to climate change and anticipated future losses and damage.

This will support mainstreaming of disaster management strategies/ adaptation plans implemented nationally and locally by all relevant sectoral agencies (i) as a basis to minimize L&D, (ii) to enable and ensure development investments are risk sensitive and to recover residual L&D by incorporating appropriate mechanisms for risk transfer (Social protection, Risk retention, economic options such as insurance, contingency/emergency funds

Activities / Sub Activities	Implementation Responsibility		Key Performance Indicator (KPI)	Means & Source of Verification	Baseline	Target	Time Frame (2021-2030)										Relevant SDG Target
	Lead Agency	Other Key Agencies					2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
5.1: Develop a national level comprehensive **Risk Management Framework** based on the provisions	DMC	MoDM, MoE, NPD, All relevant	National level comprehensive Risk	MoDM, DMC records	National Disaster Manage	National level comprehen	√	√	√								1.5, 3.9, 3.d, 11.5, 13.1,

of Disaster Management Act 13 -2005 to establish greater **coordination** between **Disaster Risk Management**, **Climate Risk Management** and development.		line ministries and sector agencies	management framework		ment Plan (2013-2017) Sri Lanka Comprehensive Disaster Management Programme (2014-2018)	sive Risk Management Framework developed											13.2, 13.3
5.2: Enhance **understanding and knowledge** of the disaster, climate and development sector officials involved in planning on comprehensive risk management approaches to address L&D associated with disasters and adverse effects of climate change, as an essential development approach (as recommended in Sendai Framework, WIM and SDGs).	MoDM	MoE, Other relevant ministries and agencies	Number of programmes Number of officials	MoDM records	None, except individuals trained at institutional level	At least 100 officials trained per year through around 5 programmes per year			√	√	√	√	√	√	√	√	1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
5.3: Assess the national and local level L&D requirement in the context of **risk transfer** (based on NDC 1)	MoF, MoDM	MoE, NPD, DMC, NDRSC, Relevant sectoral agencies,	Assessment	Assessment report of MoDM/NPD	Isolated programs at some institutional level	Assessment conducted		√	√	√	√	√	√	√	√	√	1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
5.4: Review the **existing insurance policies** and policy instruments for addressing L&D. (based on NDC 1)	MoF, MoDM	Insurance Regulatory Commission of Sri Lanka (IRCSL), MoF, MoE, NDRSC, MoA, Sri Lanka Export Credit Insurance	Insurance policies review report	IRCSL records	Existing policies	Existing insurance policies reviewed		√	√	√	√						1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3

		Corporation (SLECIC), Social Security Board, Relevant ministries and agencies of adaptation and mitigation sectors															
5.5: **Strengthen** available insurance schemes to enable recovering L&D from adverse impacts of disasters and climate change	MoF, MoDM	MoE, DMC, NDRC, SLECIC, Insurance agencies (public and private)	Effective insurance schemes	IRCSL records	Existing insurance schemes	Available insurance schemes strengthene d					√	√					1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3
5.6: Enhance **knowledge and understanding** on approaches such as Social protection, Risk retention, Contingency/emergency funds to apply to managing the L&D as relevant.	MoF (NPD), MoDM	MoE, DMC, SLECIC, Relevant sectoral agencies	Number of officials of relevant agencies trained Number of programmes conducted for vulnerable communities	MoDM and relevant sectoral agencies records	Isolated programs at some institutio nal level	10 officials of relevant agencies trained per year 30 programme s for vulnerable communitie s per year conducted		√	√	√	√	√	√	√	√	√	1.5, 3.9, 3.d, 11.5, 13.1, 13.2, 13.3

6 MEANS OF IMPLEMENTATION

6.1 Overview

In order to achieve the long-term temperature goal, set out in Article 2 of the Paris Agreement on Climate Change, developed country parties shall provide financial assistance (Article 9), technology development and transfer assistance (Article 10) and capacity building assistance (Article 11) to the developing countries like Sri Lanka under the "means of implementation".

Sri Lanka's requirements for the successful implementation of its "conditional" NDCs are briefly discussed in this section. The technological and capacity-building requirements are addressed first, followed by the financial implications, and required external financial support. The subsequent sections describe and explore in detail the important elements of SDG alignment, gender responsiveness, and social inclusivity. Finally, a brief presentation of the NDCs' implementation procedures is made.

6.2 Technology Transfer and Capacity Building Needs

6.2.1 Technology Transfer:

Technologies that we use to address climate change are known as climate technologies. Some technologies help us to mitigate GHG emissions while other technologies help us to adapt to the adverse effects of climate change (increase resilience). As set out in Article 10 of the Paris Agreement on Climate Change, developing and transferring technologies is an essential element. It also urges developed country Parties to take all practicable steps to promote, facilitate and finance the transfer of, or access to, climate technologies to other Parties, particularly to developing countries. The extent to which Sri Lanka could effectively implement its commitments will depend on the effective implementation by developed country Parties of their commitments related to financial resources and transfer of technology. By gaining access to climate technologies, Sri Lanka could move away from technologies that are dependent on fossil fuels and advancing towards a low-carbon economy. Some technology needs already identified are; climate-smart agriculture, contemporary crop management techniques, climate forecasting and early warning, water supply and irrigation infrastructure, climate-smart cities, and tourism infrastructure, energy generation (new renewable energy technologies-NRE), and energy storage facilities, low-carbon transport and urban infrastructure, coastal resilience improvement, and cutting-edge technologies.

6.2.2 Capacity Building:

The capacity-building elements of the Paris Agreement must be successfully implemented in order for developing countries to more effectively adopt and monitor NDCs. To fully implement Sri Lanka's mitigation and adaptation measures, further technology transfer and capacity building are needed. *Table 6-1* lists a few critical capacity-building requirements in the adaptation and mitigation sectors. To deliver the NDCs, the following general capacity-building requirements must be met:

(a) Institutional development and strengthening, especially for overall coordination,

monitoring and reporting;
(b) Developing human resources through education, training, and research;
(c) Networking, partnerships, and sharing of experiences across sectors and beyond;
(d) Web-based tools/ICT applications/online courses to improve technical understanding and new knowledge.

Building capacity is also necessary for the private sector and national institutions to access climate finance. It is crucial to increase capabilities within Sri Lanka's government and non-government organisations in order to design, cost, review, and monitor climate actions that will increase resilience. It is urgently necessary to build up the basic competencies within the governance structure described below to promote climate change-related awareness and communication, evaluate initiatives, collect and disseminate data, track the development of the NDC, and effectively communicate country-specific information, data, and relevant

Table 6-1Urgent capacity building needs in mitigation and adaptation sectors (Source [65])

Capacity needs for mitigation actions	**Capacity needs for adaptation actions**
Industry knowledge and applications on off-shore wind resource development, smart grid, energy storage including pumped hydro technology, tri-generation, modern transport-sector infrastructure developments such as LRT, BRT systems, circular economy practices, eco-industry park concepts, Design for Sustainability (D4S), Life Cycle Approach (LCA), circular economy, and digital economy, precision agriculture and mechanization, value addition and modern recycling technologies, advance composting and waste thermal treatment (e.g pyrolysis technology for energy recovery), Land-fill Gas technology, and centralized sewage treatment, etc.	Establishing baselines, acquiring climate data, and monitoring for adaptive activities are all important aspects of developing climate forecasting and early warning systems, vulnerability analysis, and modifying development investments for climate resilience.
Baseline assessments, certification, and standard settings: eco-certification system, minimum performance and energy efficiency labelling programmes, green building & Building Management System (BMS), site-specific designing and planning for eco-industrial parks including baseline assessments, fuel economy labelling, transport sector baseline settings, MRVing of most technology-applications.	Establish sectoral databases, establish baselines, create climate information systems, set up long-term monitoring plots, and strengthen the public health system's capacity to treat diseases and health conditions brought on by climate change.
R&D and knowledge transfer: Precision agriculture, genetic enhancement of herds/breeds of animals, energy storage (grid and behind the meter),	Increased crop yield through research and development of novel cultivars, agrotechnology, climate-resilient

[65] Updated Nationally Determined Contributions, Sri Lanka

renewable energy resource development activities, labelling of vehicle performance and fuel economy	urban and coastal development, naturally based responses to climatic hazards, preservation of land and marine biodiversity, etc.

For all sectors to execute mitigation, adaptation, and L&D -related measures, data generation and management capacity improvement is crucial. Planning and implementation of development projects are generally hampered by a lack of timely, well refined, and standardised data. Recent studies of climate change and disasters show a dearth of data on critical indices for estimating losses and damages, susceptibility and capacity for adaptation, sensitivity to climatic parameters, etc.

Building capacity in MRV of climate change actions and M&E systems that support the L&D, adaptation, and mitigation sectors is a major opportunity. To effectively and efficiently deliver the 10-year NDC implementation and monitoring plans, this is essential. Strong MRV systems will boost investor trust and provide chances for resource mobilisation. The following are a few of the capacity requirements, as identified in the updated NDCs of Sri Lanka, particular to MRV/ M&E systems and resource mobilisation:

(a) Developing local climate vulnerability/resilience assessments using data and analytical tools;
(b) Tools and analysis to differentiate between BAU development scenarios vs climate change impacts and forecasted impacts;
(c) BAU emissions scenario and potential GHG emission reduction pathways for some mitigation sectors and mitigation actions;
(d) Putting in place procedures to facilitate data availability to measure the impact (to measure change through time).

The extensive consultation and engagement of sectoral stakeholders during the development of NDC implementation plans has resulted in a better understanding of NDC activities and created the necessary ownership and momentum to accelerate climate actions. To maintain this momentum, sectoral stakeholders should integrate NDCs into their regular sectoral development plans and develop detailed action plans for each NDC activity by assigning implementation responsibilities to relevant officials. The MoE is responsible for capacity building to sustain the momentum of accelerating climate actions. The Ministry has already conducted a capacity building program, with the assistance of the Climate Promise project of UNDP, targeting the "2050 Carbon Neutrality" initiative of the GoSL. To ensure effective capacity building, local experience and indigenous knowledge should be utilized, and cross-learning between climate change experts and sectoral specialists should be promoted.

6.3 Cost Implications and External Financial Support Needed

The GoSL t allocates public funds to promote certain climate initiatives that are in line with priorities for the country's development. However, the nation needs external financial support to expand ambition beyond this. To meet the stated mitigation and adaptation targets, increased funding for adaptation and low-carbon development are necessary.

Preliminary assessment through a rapid consultation was conducted as part of the NDC revision process to generate cost projections for conditional and unconditional mitigation measures through 2021 and 2030[66]. This assessment was limited to 6 mitigation sectors as required data of 9 adaptation sectors and theL&D sector were not available at the time of assessment.The analysis found that as of 2021, the expected face value of the mitigations sectors' overall expenses is US$10.85 billion. Methodology adopted for the assessment is indicated in the report mentioned before[67] .The estimate needs appropriate adjustments to account for the implications of the on-going economic crisis. *Table 6-2* shows the estimated cost for the mitigation sector. *Table 6-3* shows the sector-wise and NDC-wise breakdown of indicative cost estimate.

Table 6-2 Mitigation Sector NDC Indicative Cost Summary

NDC Sector	Lower Range Cost US$ millions	Upper Range Limit Cost US$ millions
Power	10,733,541.11	10,733,548.61
Industries	538.49	
Transport	114,247.36	114,272.36
Waste Management	1,677.13	N/A
Forestry	234.00	289.82
Agriculture & Livestock	216.20	N/A
Total	10,850,454.30	10,850,542.62

Table 6-3 Breakdown of Indicative Cost Estimate

Mitigation Sector	NDC	Lower range cost (USD Millions)	Upper range cost (USD Millions)
Agriculture	NDC1	76.51	N/A
	NDC2	77.3	N/A

66 This task was conducted by Mr Ranga Pallawala under the Climate Promise Project of UNDP and the draft report (unpublisged) is avialble at the CCS of MoE. “Final Report – Investment & Financing Strategy for Nationally Determined Contributions of Sri Lanka – December 2021”

67 Assessment was done under 3 options; Option 1 – Using already costed estimates at policy level with required adjustments for inflation / exchange rate deviations along with expert views, Opotion 2 – Based on secondary research and expert knowledge, scaling partially costed activities when unit or project cost is partially known, Option 3 – As no costing basis avialble locally, it will have to be generated through expert consultations and validation

Sector	NDC3	4.61	N/A
	NDC4	50.86	N/A
	NDC5	6.92	N/A
	NDC6	Captured under other NDCs	
Energy (Power) Sector	NDC 1	10,729,049.61	N/A
	NDC 2	17.70	N/A
	NDC 3	2,223.90	N/A
	NDC4	851.10	N/A
	NDC5	1,398.80	N/A
Industry Sector	NDC1	25.86	N/A
	NDC2	312.40	N/A
	NDC3	20.51	N/A
	NDC4	1.64	N/A
	NDC5	170.00	N/A
	NDC6	8.08	N/A
Forestry Sector	NDC1	51.712	N/A
	NDC2	108.372	164.192
	NDC3	24.64	N/A
	NDC4	49.28	N/A
Transport Sector	NDC1	1,076.70	N/A
	NDC2	1,661.50	N/A
	NDC3	239.48	264.48
	NDC4	4,200.00	N/A
	NDC5	102.88	N/A
	NDC6	138.90	N/A
	NDC7	61.50	N/A
	NDC8	3,058.85	N/A
	NDC9	0.50	N/A
	NDC10	1.50	N/A
	NDC11	103,690.00	N/A
	NDC12	12.55	N/A
	NDC13	3.00	N/A
Waste Sector	NDC1	86.5	N/A
	NDC2	919.31	N/A
	NDC3	165	N/A
	NDC4	502	N/A
	NDC5	4.321	N/A

Sri Lanka must raise significant climate finance through institutions established by the UNFCCC, the Paris Agreement, and leverage bilateral agreements for low-carbon development in order to satisfy its conditional contribution. The Green Climate Fund (GCF)-supported NAP Readiness Project, which will create a long-term pipeline of adaptation priorities for technical and financial assistance, will update Sri Lanka's National Adaptation Plan (NAP).

There are eight (8) strategic directions identified to mobilize financial resources to achieve the NDC targets[68] as listed in *Table 6-4*.

Table 6-4 Strategic Directions to Mobilize Funds

Strategic Direction 1	Integrated Project Development
Strategic Direction 2	Establishing and Strengthening Partnerships & Alliances
Strategic Direction 3	Promoting Private Sector Investments
Strategic Direction 4	Strengthen and Expand the Initiatives with the Specialized Climate Funds
Strategic Direction 5	Monitoring, Reporting and Verification (MRV) of Climate Finance
Strategic Direction 6	Enhance Local Capacities to access and mobilize Climate Investments
Strategic Direction 7	Exploring other Innovative Climate Finance Tools – Debt-swap-for Climate, Blue Bonds, Green Bonds
Strategic Direction 8	Exploring the potential to capitalize on Carbon Asset Based and Market Based Financing Options

6.4 NDC-SDG Alignment Assessment

6.4.1 The Rationale

It is evident that the challenges focused on by the 2030 Agenda for Sustainable Development SDGs and the Paris Agreement on Climate Change and NDCs are fundamentally similar. The two agendas are not only deeply intertwined at the international level, but their interconnectedness also extends down to specific actions at national, sub-national, and local levels. The fundamental interconnectedness of SDGs implies that Climate Action (SDG-13) is related to specific policy targets of all other goals in an integrated and indivisible manner while balancing the three dimensions of sustainable development: the economy, the society, and the environment, taking into the account national, sub-national, and local contexts.

Although NDCs primarily reflect specific climate actions the country commits to, their identification, selection, and prioritization need to take into account the national realities and priorities, while recognizing that GHG mitigation actions may lead to both positive and negative impacts on development goals. Accordingly, the emphasis has been given to better understand the concept of co-benefits of NDCs and ensuring positive relationships between climate goals and resilience-building through social, economic, and environmental objectives wherever possible.

[68] Final Report – Investment & Financing Strategy for Nationally Determined Contributions of Sri Lanka, UNDP- Sri Lanka

The underlying characteristics of SDGs and NDCs signify that each agenda acknowledges the importance of the other, while demonstrating a clear cohesion. In turn, the full achievement of the SDGs will not be possible without successful action on climate change, as identified in the NDCs, and vice versa.

.

6.4.2 Methodology

There have been many attempts to rationalize these interconnectedness and interdependence SDGs and NDCs in a holistic way, and much progress has been achieved to establishing them at conceptual levels with models for mappings of linkages. Some tools used to understand and address NDCs-SDGs interactions, as well as establish the interlinkages between them include Network analyses that can help to promote policy integration in areas that may be traditionally sectoral (or thinking in silos); and Matrix approaches that combine scientific evidence, expert opinions and participative policymaking processes to appraise the interactions. In general, the interlinkages could also be assessed as potential synergies or trade-offs with different levels of significance (scale). One such example entails scoring SDGs and NDCs according to the positive, negative or neutral relationship between each other. In this framework, a seven-point scale is developed based on scientific evidence and expert judgement of fundamental and functional relations between the SDGs and their targets. When the targets are anticipated to have synergetic effects contributing to each other's achievement, they are scored either +1 (enabling), +2 (reinforcing) or +3 (indivisible). Targets that demonstrate trade-offs are scored -1 (constraining), -2 (counteracting) or -3 (cancelling). Neutral relations are scored 0.

A similar approach for the appraisal of the interlinkages captures fundamental and functional relations of NDCs actions and targets with SDGs, as reflected through targets and indicators therein, with a scale to indicate the nature and extent of the interactions as:

- Indivisible: Strongest form of positive interaction, where the NDC activity directly contributes to the achievements of the particular SDG and targets therein (and vice versa).
- Contributing: Moderate form of positive interaction, where the NDC activity directly creates conditions that contribute to the achievement of the particular SDG and targets therein (& vice versa).
- Enabling: Mild form of positive interaction, in which the NDC activity creates a favourable environment for the achievement of the particular SDG and targets therein (& vice versa).
- Unrelated: Neutral form of interaction, in which the NDC activity does not create a notable contribution, and deemed to be neither positive nor negative, for the achievement of the particular SDG and targets therein (& vice versa).
- Constraining: Form of negative interaction (trade-off), where the NDC activity deteriorates, counteracts or creates an unfavourable environment for the achievement of the particular SDG and targets therein (& vice versa).

Here the positive interaction means a correlation in which improvement of one area will lead to improvement in the other, while deterioration of one area will result in deterioration in the other. The negative interaction means an inverse relationship of a situation where improvement of one area will lead to deterioration of the other (and vice versa).

The main steps used in the mapping of interlinkages are presented in Figure *6-1*.

Replaced with Dr TS new version

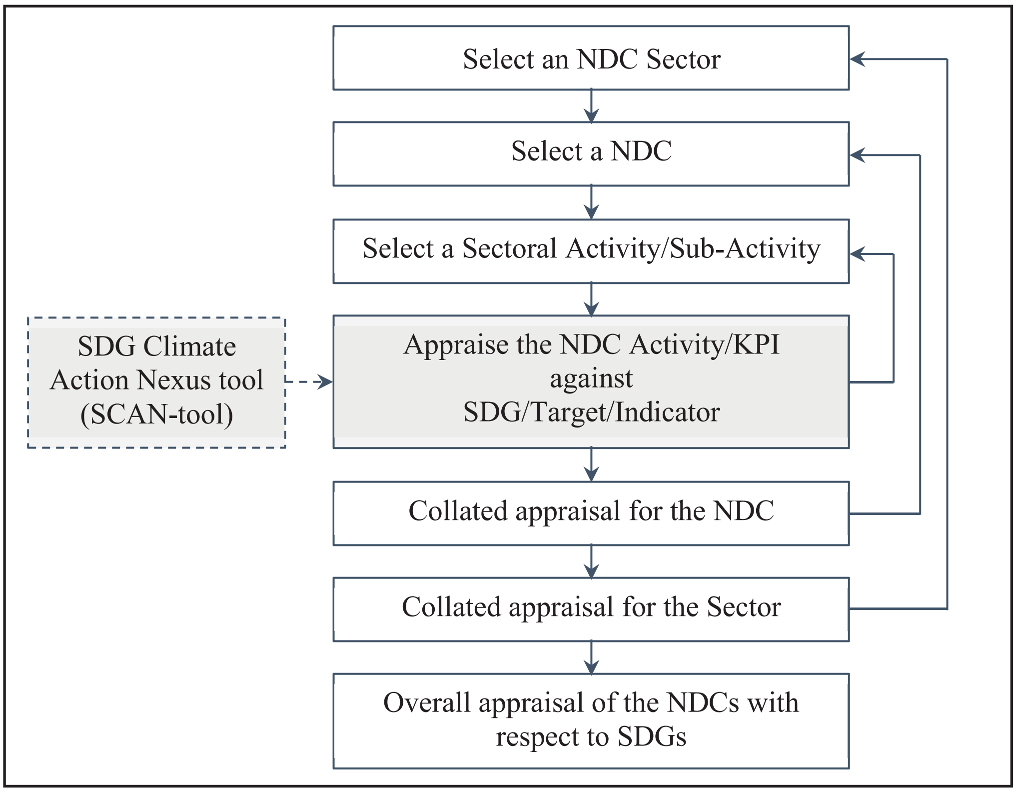


Figure 6-1 Main steps of mapping of NDC-SDG interlinkages

In the present study, the NDC implementation and monitoring plans include a field to present only the existence of the linkage with SDGs, without indicating whether the interaction is positive or negative and its level of significance. Thus, the methodology used in this assessment is to highlight the presence of linkage between NDCs and SDGs, based on the number of linkages. Here, SDG13 – Climate Action is not considered as NDCs are in fact represent interventions in addressing climate change issues.

6.4.3 Results

The analysis of the NDC implementation plan of each sector (six mitigation, nine adaptation and L&D) showed a wide range of multiple linkages between different NDCs covering all SDGs (see *Table 6-5*). In overall, 261 activities/sub-activities of the mitigation sectors have 753 linkages with SDGs, while 243 activities/sub-activities of the adaptation sector NDCs have 566 linkages. The 245 number of activities/ sub-activities of L&D have 100 linkages. Note that the number of linkages depends on the number of activities and sub-activities in a particular NDC sector. *Table 6-6* presents the number of linkages under each SDG, in mitigation and adaptation NDCs.

Table 6-5Multiple linkages between NDC and SDGs

Sector		No of Activities/ Sub-activities	Number of links
Mitigation	Agriculture	43	114
	Energy	22	37
	Forestry	35	58
	Industry	49	88
	Transport	64	229
	Waste	48	227
	Sub-total	**261**	**753**
Adaptation	Agriculture	30	65
	Biodiversity	19	61
	Coastal & Marine	19	33
	Fisheries	33	82
	Health	21	25
	Livestock	17	47
	Tourism	14	54
	Urban	24	58
	Water	66	141
	Sub-total	**243**	**566**
Loss and Damage		**25**	**100**
Total		**529**	**1,419**

Table 6-6 Number of linkages under each SDG

SDG	Number of links with NDCs			
	Mitigation	Adaptation	L&D	Total
SDG1 - No Poverty	1	1	25	27
SDG2 - Zero Hunger	45	67	0	112
SDG3 - Good Health & Well-Being	117	22	50	189
SDG4 - Quality Education	0	1	0	1
SDG5 - Gender Equity	13	43	0	56
SDG6 - Clean Water & Sanitation	53	118	0	171
SDG7 - Affordable & Clean Energy	107	22	0	129
SDG8 - Decent Work & Economic Growth	50	11	0	61
SDG9 - Industry, Innovation & Infrastructure	88	2	0	90
SDG10 - Reduced Inequality	0	0	0	0
SDG11 - Sustainable Cities & Communities	90	86	25	201

SDG12 - Responsible Consumption & Production	144	45	0	189
SDG14 - Life Below Water	1	94	0	95
SDG15 - Life on Land	41	51	0	92
SDG16 - Peace, Justice & Strong Institutions	0	0	0	0
SDG17 - Partnerships for the Goals	3	3	0	6
Total	**753**	**566**	**100**	**1,419**

Note that the NDC-SDG linkages identified are primarily those having direct and clear relations. Thus, further assessment is required to establish more comprehensive interlinkages that takes into account the indirect linkages as well as the type and level of significance

The interlinkages of NDCs in the mitigation, adaptation, and L&D sectors with SDGs are presented in *Figure 6-2,* Figure 6-3, and Figure 6-4, respectively. The colour code is used in the figures to distinguish the NDC sectors and SDGs with clarity in the visualization.

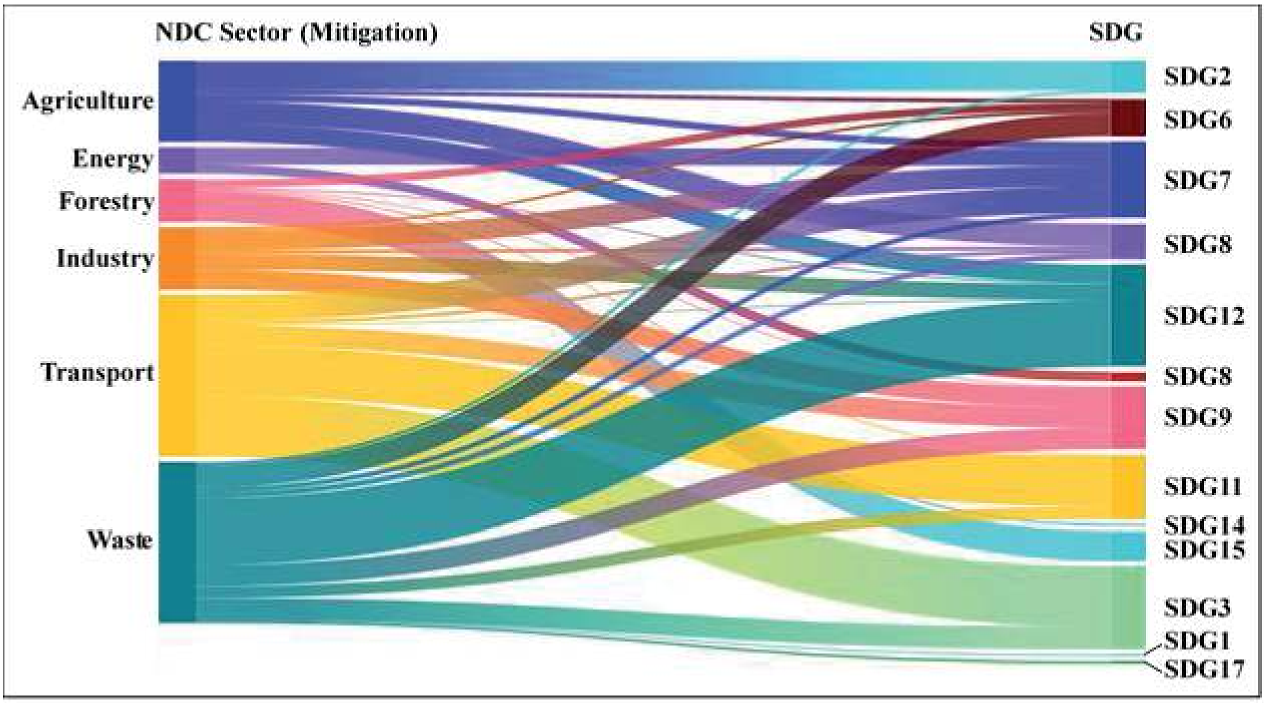


Figure 6-2 Linkages between mitigation sector NDCs and SDGs

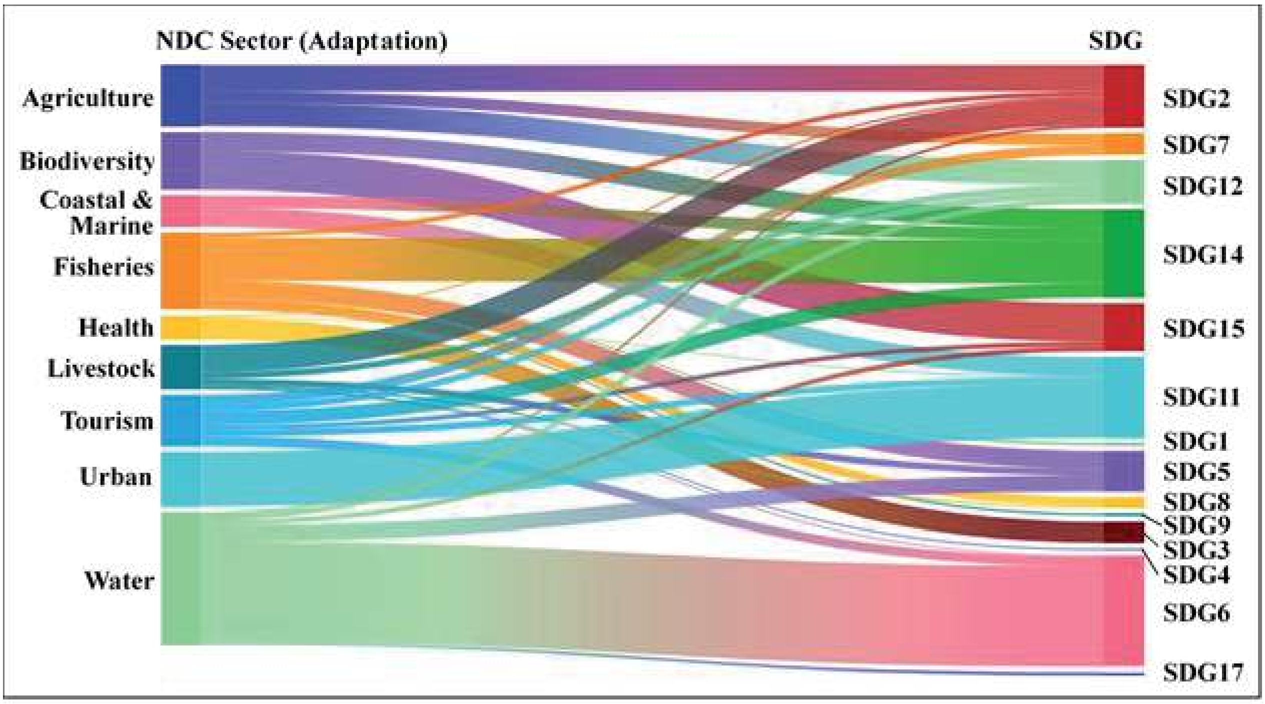


Figure 6-3 Linkages between adaptation sector NDCs and SDGs

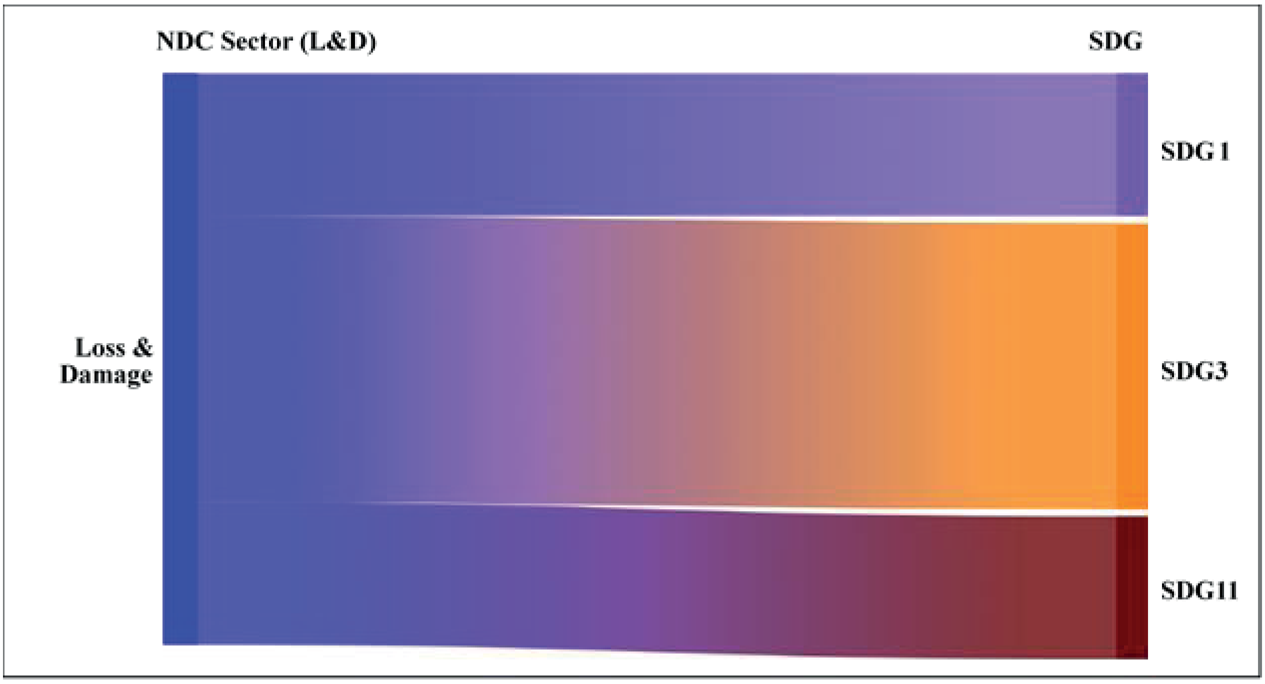


Figure 6-4 Linkages between L&D sector NDCs and SDGs

6.5 Gender Integration and Social Inclusion

6.5.1 Background and Context

The Paris Agreement underlines when taking actions to address climate change, respect, promote and consider the rights of local communities, and people in vulnerable situations and the right to development, gender equality and empowerment of women[69]. Through the Paris Agreement, Sri Lanka has committed to apply gender responsive, participatory approach to climate action taking into consideration vulnerable groups, communities, and ecosystems.

The effects of climate change are not equal. They disproportionately impact the poorest and most marginalized. Women are identified as one of the most vulnerable groups to climate change impacts due to persistent gender-based inequalities prevalent in most societies. Gender alone does not shape vulnerabilities and adaptive capacities; it intersects with a range of other social factors. Social inclusion therefore needs to be viewed and attended considering intersecting factors.

Some of the kay factors that intersect on vulnerabilities and adaptive capacities include sex, age, education, knowledge and skills, ethnicity, abilities, culture, and socio-economic status. Accordingly, the poor, women, differently abled, children, elderly and minority communities belong to marginalized groups to be considered in climate action, both in terms of vulnerabilities and capacities of these groups. It is underlined that gender and social differences are not just vulnerabilities, but potential sources of resilience[70].

Marginalised and or underrepresented groups can be left out in the promotion and knowledge sharing of the adaptive actions, in accessing resources, information and services. Many people see climate change as a scientific problem requiring technical solutions, disregarding social aspects directly related to adaptation. Women and other marginalised groups are often only understood as beneficiaries of climate action rather than participants, limiting opportunities for community participation.[71]

6.5.2 Gender Aspects and the Status of Women

Globally, it was estimated 247 million women aged 15 years and older will be living on less than 1.90 U.S. dollars per day in 2021, compared to 236 million men. The gender poverty gap is expected to increase by 2030 as women will still be the majority of the world's extreme poor. According to a survey from 2020, the COVID-19 crisis will increase female poverty worldwide[72]. Women make up 70% of people living in poverty in rural areas. In developing countries, women produce up to 80% of the food, however they own less than one fifth of the

[69] United Nations, Paris Agreement, 2015. Article 7, clause 5.
[70] International Development Research Centre (IDRC), Advancing gender equality and social inclusion through climate action, October 31, 2022
https://www.idrc.ca/en/research-in-action/advancing-gender-equality-and-social-inclusion-through-climate-action
[71] https://lgiu.org/social-inclusion-in-climate-resilience-planning/
[72] Statista, Gender poverty gaps worldwide in 2020 & 2021 by gender
https://www.statista.com/statistics/1219896/gender-poverty-gaps-worldwide-by-gender/#:~:text=Globally%2C%20247%20million%20women%20aged,of%20the%20world's%20extreme%20poor.

cultivation areas.[73] Most women are in low paid, informal and insecure work, the household responsibilities and care work limit their income earning and other opportunities. In most societies' women occupy a lower status socially, economically and politically.

According to research in developing countries across the globe, understanding how climate change risks, vulnerabilities and response options differ between men and women, and across different social groups and livelihoods is fundamental to supporting climate action[74].

Sri Lanka National Census 2012 reported 51.5% of the population are women, with a sex ratio of 106 women to 100 men. The World Gender Gap Report by the World Economic Forum ranked Sri Lanka amongst the top 20 countries (out of 115 assessed) in 2006[75]. However, the country has descended to be ranked at 110 out of 146 countries in 2022, despite performing well on indicators such as educational attainment and access to public health. Gender Inequality Index (GII), a composite measure of gender inequality using three dimensions: reproductive health, empowerment and the labour market for Sri Lanka is high, ranked at 73 (2021/2022 assessment), by the Human development Report[76]. The decline in the gender gap ranking and the high Gender Inequality Index value is attributed to the low share of seats in the parliament occupied by women, which stands at 5.3%, and low female labour force participation rate, 30.9% as opposed to 68.5% for men[77]. As the figures indicate, the labor force participation rate of women is over half that of men.

However, there are some fields that are dominated by women e.g.SLAS 64% of the administrators are women. In the all island public services (in 2016) 51.9% were males and 48.1% were females. In the combined services 61.2% were females and 38.8% were males (census & Stat). There are some sectors (labour intensive) such as the tea, garment, nursing occupations that are entirely dominated by women.

Sri Lanka has the 14th largest gender gap in labour force participation globally, despite achievements in education. It is noted that female participation rate has remained between 30 – 35 per cent over the past two decades. Unemployment rate in 2022 first quarter for women stood at 6.5%, more than double of that of men, 3.0 [78]. Similarly, the youth unemployment rate for women is at 36.3% compared with 21.1% for men. Also, women are underpaid relative to men for similar work. Women's labour force participation in the country is often compounded by many factors such as the lack of affordable and quality childcare services, lack of support in sharing household work and some workplace cultures that are not supportive of women

[73] Reliefweb, Women and Development: The world's poorest are women and girls, March 2016 https://reliefweb.int/report/world/women-and-development-worlds-poorest-are-women-and-girls?gclid=CjwKCAiAmuKbBhA2EiwAxQnt71Fyby-ODhvHjgqiqHNfkjTAVanDVAIa6VWGcVOETErGfKvInidWkBoC7LAQAvD_BwE
[74] ibid
[75] Gender Gap Index reflects 04 dimensions—Political Empowerment Gap, Economic Participation & Opportunity, Education Attainment and Health & Survival Gap. (https://economynext.com/sri-lanka-slips-in-global-gender-gap-rankings-wef-36501/)
[76] UNDP, Human Development Report 2021/2022
[77] Ibid (Labour Force Participation figures are for the year 2021)
[78] Department of Census and Statistics, Sri Lanka Labour Force Statistics, Quarterly Bulletin, First Quarter 2022

employees[79]. Female Headed Households (FHH)[80] account for 25.3% in Sri Lanka (Census & Statistics, 2016-2019) which is higher in the Central and North Central Provinces.

Implications of this situation also include increasing women's care responsibilities to those living with a disability.

Women rely more on natural resources which are affected by the impacts of climate change making women more vulnerable than men. The traditional knowledge and experience of women can be used inclimate change mitigation, adaptation and disaster risk reduction strategies. Women are agents of change and their responsibilities in households and communities, as stewards of natural and household resources, increase their coping capacities to adapt to changing environmental realities[81].

6.5.3 Poverty and Unemployment

The current crisis has doubled the poverty rate from 13.1 to 25.6 percent between 2021 and 2022, increasing the number of poor people by 2.7 million. The COVID-19 crisis had already increased poverty from 11.3 percent in 2019 to 12.7 percent in 2020, a change that translated into over 300,000 new poor people in that year. The country is now experiencing its highest poverty rate since 2009. While 80 percent of the poor still live in rural areas, the poverty rate in urban areas has tripled from 5 to 15 percent between 2021 and 2022, and half the population in estate areas is now living below the poverty line. Poverty is projected to remain above 25% in the next few years[82].

The number of unemployed persons is estimated as 439,783 during the year 2021. Out of this total, 47.1 percent are males and 52.9 percent are females. At the national level, the unemployment rate for females is more than two times higher than that of the male unemployment rate[83].

6.5.4 Other Socially Marginalized Groups

Disability:

According to the 2012 estimates by the Department of Census and Statistics, there were 1.6 million people with disabilities[84]. This makes up to 8.7 percent of the population. There are variations between men and women, 43 percent, and 57 percent respectively. Proportion of females with difficulties for both, vision and mobility are higher than that of males.

---

[79] https://asiapacific.unwomen.org/en/countries/sri-lanka

[80] http://www.statistics.gov.lk/GenderStatistics/StaticalInformation/SpecialConcerns/FemaleHeadedHouseholdsBySectorProvinceAndDistrict2016

[81] https://www.un.org/womenwatch/feature/climate_change/downloads/Women_and_Climate_Change_Factsheet.pdf

[82] World Bank, Poverty and Equity Brief, Sri Lanka, October 2022 https://databankfiles.worldbank.org/data/download/poverty/987B9C90-CB9F-4D93-AE8C-750588BF00QA/current/Global_POVEQ_LKA.pdf

[83] Department of Census and Statistics, Labour Force Survey, Annual Report 2021

[84] Definition: "Any person who, as a result of any deficiency in his physical or mental capabilities, whether congenital or not, is unable by himself to ensure for himself, wholly or partly, the necessities of life."

A majority of the disabled persons are reported as economically inactive (48% of the economically inactive) as they are unable to work due to old age[85]. Around 55.4% of the disabled population aged 15-19 and 86% of the disabled population aged 20-24 are not engaged in any educational activity or vocational training[86].

Elderly[87]

Population ageing in Sri Lanka is accelerating at a faster rate than other South Asian countries and has been increasing rapidly since 1980s. Between 1981 and 2012, the proportion of population aged 60 years and above has increased from 6.6 % to 12.4 %. Rapid demographic transition with marked decline in death rates and birth rates, increases in life expectancy are leading to important changes in age-sex structure. The life expectancy at birth for male and female has reported as 72 and 79 years respectively and female often lived six years longer than male counterparts in 2012. Women comprise the majority of the total older population. In 2012, females accounted for about 56 % of total aged population in Sri Lanka and for the oldest-old group (80 or over), this proportion was 61 %. There were 94 males for every 100 females for the total elderly population.

6.5.5 Commitments to Gender Equality and Social Inclusion in the 2021 NDC Communication

The 2021 NDC Communication[88] has acknowledged the importance of addressing gender issues in the mitigation and adaptation actions to enable contribution by women as well as to provide equal access to benefits. The NDC Communication recollects the call of the ''Paris Agreement for Climate Change'' for the member states for gender equality and women's empowerment by adopting gender-responsive approaches, and the GoSL commitments to this aspect in the national policy frameworks.

Mainstreaming gender and social safeguards into adaptation priorities is identified as an important strategy in the NDC Communication. Therefore, it is recommended that down-scaled risk assessments and sectoral plans integrate specific needs, vulnerabilities and capacities of women, young children, disabled and elderly populations.

The National Environment Policy (2022) section 4.7.7 (pg. 67) highlights the need to enhance female and youth participation and empowerment of gender and youth in environmental management and further states that they will be given special attention in all forms of community and stakeholder engagement activities.

85 Department of Census and Statistic, Disability in Sri Lanka, 2012
https://unstats.un.org/unsd/demographic-social/meetings/2016/bangkok--disability-measurement-and-statistics/Session-6/Sri%20Lanka.pdf
86 UNICEF, Every Mind, 'Learning Disabilities in Sri Lanka', 2016
https://www.unicef.org/srilanka/every-mind
87 Source: Ageing Population of Sri Lanka: Emerging Issues, Needs and Policy Implications, Thematic Report based on Census of Population and Housing 2012, UNFPA
88 Ministry of Environment, Updated Nationally Determined Contributions under the parisd Agreement on Climate Change, July 2021

The National Environmental Action Plan 2022-2030 recommends actions under the Strategy No 6, to increase women's participation to combat climate change with a target that gender aspects to be included in all the new policies and plans related to climate change. Strategy No 8, is ''Further social mobilization to ensure inclusion, empowerment and equity, recommending adopting and establish social indicators to measure and monitor social inclusion, empowerment, equity and cultural diversity''.[89]

The National Adaptation Plan Readiness Support Project (ongojng) funded by Green Climate Fund will prepare a Gender and Social Action Plan (GSAP) to effectively mainstream gender and social inclusion across NAP processes.

6.5.6 Identified Gender and Social Inclusion issues in Fisheries, Livestock, Water sectors (Adaptation), Power sector (Mitigation)

Sector analysis shows that women are a significant resource that contribute to each sector. There is gendered division of labour and gender norms in each sector, visible and evident in gender-differentiated roles and responsibilities. Accordingly, there are corresponding needs, priorities, and access to a) information and knowledge, b) technologies, c) training, d) support services, e) machinery and equipment, etc., which are different for men and women.

Gendered division of labour can often be complementary. However, women's contribution largely remains invisible due to the lack of sex disaggregated data, policy gaps, and gender-based perceptions and stereotypes.

6.5.7 Features Common to Every Sector

There are common features across sectors that marginalize the poor, women, and other groups in climate actions as given below.

(a) Sectoral planning at the national level focus on technical aspects, leaving out the community and social aspects that are part and parcel of the sectoral production and distribution outcomes.

(b) Women and other marginalized groups are not adequately represented or consulted in decision making (including at the local level), despite adequate levels of education and literacy, skills and experience they have.

(c) Farmer/Fisheries orgnisations, Cooperative societies are often dominated by men with land ownership at the decision-making level, women's voices are hardly considered. This is considered a customary practice.

(d) Sector level planning decisions often prioritise activities led by men, supported with technological advancements and services (such as fishing vessels, irrigation, cooling and processing techniques)

(e) In the sectoral value chains women are at the lower end, assigned to primary, stereotypical and often non- monetized tasks.

(f) There is no enabling policy and planning environment within the sectors to realise the optimum potential specifically of women, leading to a loss to the national economy

---

[89] Ministry of Environment, National Environment Action Plan 2022-2030: Pathway to sustainable development in Sri Lank, July 2022

(g) Rural women themselves lack awareness and insight into their situation, their rights, and the potential they have to move forward.
(h) Training, capacity building, knowledge sharing opportunities are less accessible to the poorer, marginalized groups and to women.
(i) Marginalized groups are constrained by lack of knowledge, poor access to productive resources, technology and financial capacity.
(j) Labour intensive and primary tasks get assigned to the resource poor and marginalized groups.
(k) Landownership is a critical factor for accessing production resources (inputs, subsidies, credit, access to irrigation water), traditionally land ownership remain with men, marginalizing women and the poorer groups, also due to their lower social positioning.
(l) Sectoral policies largely take a neutral approach towards gender issues and other marginalized groups.

6.5.8 Incorporation of Gender Aspects in NDC Implementation Plans

The incorporation of gender issues in the NDC implementation plans should be addressed as follows;

Conducting a sector gender assessment for each sector, with the aim of identifying and documenting:

- Gap analysis of gender-based division of labour specific to the sector, and contribution made by men and women
- Specific production related skills and expertise of men and women
- Requirements and support required by men and women for effective climate adaptation and mitigation
- Capacity building requirements of the institutions and communities on gender issues in the sector for enabling gender responsive climate change adaptation and mitigation

(a) Including gender expertise in the needs and feasibility assessments conducted for climate change adaptation,
(b) Incorporating modules/sessions capturing the gender issues specific to a sector and approaches to address the issues in all the capacity building programme planned in the NDC actions,
(c) Setting specific targets as well as a percentage for women's representation & participation/reaching out in climate change adaptation and mitigation activities,
(d) Enabling the collection of sex disaggregated data and analysis to review progress on achieving identified gender responsive targets,
(e) Assessing sectoral institutions (at the national level) on the awareness and application knowledge of gender issues in climate change in order to identify capacity gaps and needs.
(f) Identifying and recognizing women's role in reducing GHG emisions in NDC sectors
(g) Build sector institutional awareness and capacities on the key issues related to most vulnerable and marginalized groups and the need to address the same in mitigation and adaptation planning and implementation.

(h)Introduce the practice of consulting local communities, women, youth, and other marginalized and/or underrepresented groups at the local level planning and implementation of climate action.

(i)Identify and prioritise the activities that lead to increase adaptive capacity and build the resilience of the most marginalized groups, enabling equitable and sustainable investments and practices.

(j) Ensure issues of marginalized groups are considered/included in climate resilient technology development, promoting and knowledge sharing, providing access to adaptation resources.

6.6 Implementation Mechanisms

Sri Lanka needs funding, technology transfer, and capacity building in accordance with Article 4 of the UNFCCC and Articles 9, 10, and 11 of the Paris Agreement in order to properly implement the climate activities outlined in the NDC plans. These articles are explicit on supporting developing countries to implement climate change actions and increasing mitigation ambition, considering *'the common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances'*. Paragraph 5 of Article 4 of the Paris Agreement specifically states that *"support shall be provided to developing country Parties for the implementation of this Article, in accordance with Articles 9, 10 and 11, recognizing that enhanced support for developing country Parties will allow for higher ambition in their actions*."

While Sri Lanka seeks international assistance to realise its higher mitigation ambition in this Nationally Determined Contribution, it more urgently needs assistance for adapting and mitigating the losses and damages brought on by climate-related disasters. This covers agricultural adaptation, food production, water for irrigation and drinking, habitations and human health, biodiversity, and coastal protection. For a nation that faces numerous climate dangers, improved climate forecasting, risk communication, early warning, and comprehensive risk management framework are especially crucial.

Annex VIII

Summary of relevant SLYCAN Trust publications on climate-induced loss and damage in Sri Lanka

Climate-induced loss and damage severely impacts food systems in Sri Lanka and compounds other existing risks and vulnerabilities. While there are existing risk management, transfer, and finance mechanisms to support farmers and other food system stakeholders, they are currently funded mainly from the national budget, which is not sustainable in the context of increasing L&D and macroeconomic challenges faced by the country.

- *Research Report: Strengthening Sri Lanka's Ecosystem for Climate and Disaster Risk Management and Finance (Link)*
- *The Farmer's Perspective: Climate Risk and Risk Management in Sri Lanka's Agriculture Sector (Link)*
- *Summary Brief: Addressing Climate and Disaster Risk in Sri Lanka: Crop Insurance Schemes (Link)*
- *White Paper: Enhancing Innovative Climate Risk Transfer and Agricultural Insurance Mechanisms in Sri Lanka (Link)*
- *Working Paper: Household Profiles and Resilience Indicators for Climate Risk Transfer in Sri Lanka (Link)*
- *Discussion Brief: Climate Risk Management and Finance in Sri Lanka (Link)*

Approximately 20% of Sri Lanka's total land area is vulnerable to different types of landslides (including slides, slope failures, debris flows, and rockfalls), which are exacerbated by heavy rainfalls and cause both economic and non-economic loss and damage, including planned relocation of households out of high-risk areas.

- *Primer: Landslide Risk, Human Mobility, and Climate-Induced Loss and Damage in Sri Lanka (Link)*

A case study among labour migrants returning from Kuwait found that more than 60% of the surveyed migrants had experienced weather- or climate-related impacts to their livelihoods in Sri Lanka. Climate-induced L&D from heavy rains, droughts, water scarcity, floods, landslides, high temperatures, and/or saline intrusion are a key part of decision-making processes around migration on the individual or household level.

- *Policy Brief: Climate Change and Human Mobility in Sri Lanka: Climate Impacts on Labour Migration (Link)*

Human mobility (especially migration and displacement) in Sri Lanka is increasingly caused by or connected to climate impacts across multiple sectors, with severe repercussions on health, ecosystems, gender, youth, and livelihoods. A case study in Trincomalee district found that 80% of surveyed households had at least one family member migrating due to economic difficulties, which were predominantly connected to erratic rainfall patterns, drought, and water scarcity.

- *Working Paper: Climate Change and Human Mobility. Impacts and Actions Across Sectors (Link)*

- *Policy Brief: Climate Change and Human Mobility in Sri Lanka. Policies, Laws, and Processes* (*Link*)
- *Case Study: Climate Displacement and Internal Migration in Sri Lanka* (*Link*)

Animals—including wildlife, livestock, and stray animals—are impacted by climate-related disasters in Sri Lanka, which can have impacts on human health and livelihoods as well as natural ecosystems, and is connected to a range of needs for actions before, during, and after disasters.

- *Policy Brief: Animals and Disaster Management in Sri Lanka* (*Link*)
- *Policy Brief: Sri Lanka's Livestock Sector and Climate Change* (*Link*)

Annex IX

Climate Change Vulnerability Data Book

Maps and Data by Sector

Data Book Development Team:
Mahakumarage Nandana - GIS Specialist, Nayana Mawilmada - Team Leader/Strategic Planning Specialist, Sithara Atapattu - Deputy Team Leader/Coastal Ecologist, Jinie Dela - Environmental Specialist, Aloka Bellanawithana - Project Assistant.

Acknowledgements
The team appreciates and would like to acknowledge all the support provided by the Climate Change Secretariat, Ministry of Environment and the Asian Development Bank on this initiative. The team would also like to extend their sincere gratitude to all the stakeholders who have worked with, guided, and encouraged them over the past months.

Climate Change Vulnerability Data Book

Ministry of Environment, Sri Lanka

January 2011

Contents Page

Abbreviations & Acronyms

ADB	Asian Development Bank
CC	Climate Change
CCS	Climate Change Secretariat
DMC	Disaster Management Center
DSD	Divisional Secretariat Divisions
GDP	Gross Domestic Product
GN	Grama Niladari
GIS	Geographic Information Systems
GOSL	Government of Sri Lanka
IEC	Information, Education and Communication
IPCC	Intergovernmental Panel on Climate Change
IWMI	International Water Management Institute
MOH	Medical Office for Health
NCCAS	National Climate Change Adaptation Strategy
SLTDA	Sri Lanka Tourism Development Authority
SVP	Sector Vulnerability Profile
TA	Technical Assistance

INTRODUCTION

In 2009, responding to a request from the Government of Sri Lank (GOSL), the Asian Development Bank (ADB) initiated a technical assistance (TA) project titled "Strengthening Capacity for Climate Change Adaptation". The TA was implemented through the Climate Change Secretariat (CCS) of the Ministry of Environment. Working with and through the CCS, the project aimed to increase Sri Lanka's resilience to climate change impacts, whilst pursuing sustainable economic development and natural environment conservation. It also was expected to stimulate improved effectiveness and better organization of stakeholders to address climate change adaptation in Sri Lanka. The primary goal of the TA was to support the GOSL initiative to adapt key sectors in the economy and safeguard Sri Lanka's national interest against climate change threats. The primary outputs of the TA were Sector Vulnerability Profiles (SVPs), the National Climate Change Adaptation Strategy (NCCAS), and the Information Education and Communications (IEC) Strategy.

One of the key components of the SVPs, which forms much of the background for the NCCAS, was a GIS vulnerability mapping exercise, carried out to get a sense of the scale and spatial distribution of potential climate change vulnerabilities in the country. Vulnerability mapping was carried out for the five key sector groupings considered critical for national development:

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

Each sub-sector's vulnerability to expected increases in floods, droughts, landslides as well as sea level rise have been considered in the mapping process. The mapping methodology and indices used are discussed in detail later on.

The purpose of this data book is to make the data collected and processed for this exercise readily available to all interested. It is also expected that such data availability will encourage interested parties to refine the findings and methodology further, and also to ensure that there is a base line for future comparisons.

MAPPING METHODOLOGY

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 to moderate potential damages, to take advantage of new opportunities or to cope with the consequences

The vulnerability mapping exercise undertaken[1] as part of NCCAS development process builds on this IPCC assertion and definition of vulnerability.

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

The basic methodology involved in the GIS mapping was to develop indices for exposure, sensitivity, and adaptive capacity 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. Areas where complete and comparable data sets of relevant indicators could not be obtained (such as the North and East where census data is not available) were not analyzed, and will need to be evaluated at a future stage, perhaps after the 2011 census is complete. The mapping process involved several key steps:

1. Developing Common Exposure Indices:

Separate Exposure Indices for flood, drought, and landslide exposure up to a DS division level of detail were developed based on historic data on the frequency and scale of disaster events (assessed in terms of number of people affected) from the Disaster Management Centre (DMC). Available data ranging from 1974 to 2008 were used.

The Exposure Index for sea level rise was based on a ratio of the area of land within 2M above sea level as a percentage of total land area within 5km from the coastline in each DS Division. Topography data for the index was obtained from the ASTER 30M Digital Elevation Model.

The above Exposure Indices are common across all sectors. (see Appendix A)

2. Developing Sector-specific Sensitivity and Adaptive Capacity Indices

While exposure levels to hazards (i.e. floods, landslides, droughts and sea level rise) are common to all sectors, sensitivity and adaptive capacity vary substantially. 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.

The primary challenge in developing the sector specific Sensitivity and Adaptive Capacity Indices was obtaining complete and comparable datasets of relevant indicators that covered the entire nation at the required level of detail. Most of the demographic data used in developing these indices was extracted from the 2001 National Census—in which no data were available for the North and East of the country. No viable and reliable alternative source of comparable demographic data exists. Therefore, vulnerability of the North and East could not be clearly assessed in some sectors.

3. Deriving the Vulnerability Indices

As IPCC asserts, vulnerability is a combination of exposure, sensitivity, and adaptive capacity. Therefore, to arrive at sector-specific assessments of vulnerability to various exposure types, the three relevant indices were combined by taking their averages. For example, to understand vulnerability of the drinking water sector to drought exposure, the following indices were combined: Drought Exposure Index, Drinking Water Sensitivity Index, and Drinking Water Adaptive Capacity Index.

[1]IWMI's CC Vulnerability Index as in Eriyagama et. al., 2010 was used as a starting point and substantially refined for finer grain and sector specific analysis.[19]

Certain exposure types (i.e. landslides, floods, droughts, and sea level rise) do not substantially impact some sectors. Therefore, only exposure types relevant to each sector were analyzed and illustrated.

4. Filtering and Refining the Indices

The raw indices include distortions. Some DSDs have little or no exposure to certain hazards, while others have little or no sensitivity. For example, some DSDs did not have any incidence of landslides historically, and hence had a zero value for exposure. Similar instances apply to sensitivity. For example, a DSDs with no hotel or guest house rooms will have a zero value in its Sensitivity Index, while a DSD with just 10 rooms will be negligible in terms of its sensitivity. Yet when values from all indices for such a DSD are combined, some level of vulnerability is indicated.

To remedy this distortion, the datasets were filtered. All DSDs with either exposure or sensitivity falling within the lowest 5th percentile were removed. The Vulnerability Indices were then recomputed. So DSDs with negligible levels of sensitivity or exposure were excluded from the refined Vulnerability Indices.

5. Classification and Data Mining

Once Vulnerability Indices for specific sectors to specific exposure types were established, each index was then ranked and DS divisions classified into four categories based on natural breaks in the index values. These were then mapped geographically, to illustrate rather clearly, the geographic distribution of vulnerability across key sectors.

Besides being able to visually illustrate the distribution of vulnerability, the mapping exercise also enables us to unlock a wealth of data about the scale of vulnerability in given sectors. For example, once we know which DSDs have transport sectors highly vulnerable to flood exposure—we can then, through simple assessment of public data sets, uncover how many kilometres of roads and railroads are in those DSDs, understand the demographics of the underlying communities, etc.

Limitations

As with most similar initiatives, this mapping exercise is limited in scope and should be refined on an ongoing basis, based on detailed data which may become available from various agencies. The DSD-level analysis performed for most sectors, is useful as a macro-level planning tool. However, it is not fine-grain enough to do local-level planning or detailed assessments. Demographic data was from the 2001 National Census, the best source available at the time of the study, but lacked effective coverage of the North and East (due to the conflict).

It was not possible to get DSD level data for the health and biodiversity sectors. The Ministry of Health collects data by what it calls “MOH Areas”, boundaries of which are poorly defined and not congruent with DSD boundaries. Therefore, the District level—where data were available—was used as the unit of analysis. Biodiversity data was also very limited, and again analysis was only performed up to a district level, where data were available.

It is noted that relevant agencies are carrying out detailed hazard mapping at the national and regional levels.[2] Also, more up-to-date demographic and other information, covering the entire country will be available when the 2011 is complete. It is strongly recommended, therefore, that the vulnerability mapping exercise is repeated in a few years.

[2]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, Irrigation Department, the National Building Research Organization, and several others. The maps generated through the DMC exercise would provide much finer grain information for exposure indices.

MAPS AND DATA BY SECTOR

INFORMATION INCLUDED IN THE DATABOOK

This databook is intended as a resource for researchers and planners involved in understanding and developing responses to climate change in Sri Lanka. It includes the complete set of climate change vulnerability maps and pertinent data produced by the ADB-financed consulting team as part of Sri Lanka's NCCAS development process.

The following pages are organized into several sections, in line with the Sector Vulnerability Profiles, also produced as part of the NCCAS process:

- Urban Development, Human Settlements and Economic Infrastructure
    - Human Settlements
    - Transport
    - Tourism
- Water
    - Drinking Water
    - Irrigation
- Agriculture and Fisheries
    - Paddy
    - Plantations
    - Fishery
    - Livestock
- Health
    - Dengue
    - Dysentary
    - Leptospirosis
- Biodiversity and Ecosystem Services

Each subsection starts with a very brief introduction to the sector concerned. This is followed by the indicators used in the Sensitivity and Adaptive Capacity Indices used, as well as some key findings from analysis of the map on each facing page.

The data table following each map lists rankings and classifications of the DSDs as illustrated. A range of comparable data on physical characteristics, demographics, and sector-specific indicators for each DSD are also provided.

A wealth of additional data on the characteristics of specific DSDs can be found in the statistics released by the Department of Census and Statistics. District level data for all indicators included in this databook are available in Appendix B to allow for easy comparisons as required.

It must be noted that each map illustrates the potential vulnerability of one given sub-sector, to one particular exposure-type (i.e. sea level rise, floods, droughts, or landslides) based purely on historical data. Only exposure types considered relevant to a particular sub-sector are analyzed and illustrated.

Areas in white indicate that adequate comparable data was not available to perform the analysis to establish levels of vulnerability. Areas indicated as (no vulnerability) are DSDs eliminated from the indices either because they had insignificant exposure (historically) to the type of exposure concerned, or had minimal sensitivity to impacts on the sector being mapped (refer to methodology for further explanation).

DATA SOURCES:

The raw data sources used for the mapping exercise are given below and will be indicated by the respective letter in the data tables.

a - Calculated by the TA team

b - Census of Population and Housing -2001, Department of Census and Statistics

c - Household Income and Expenditure Survey - 2006/07 Department of Census and Statistics, http://www.statistics.gov.lk/poverty/PovertyIndicators.pdf

d - Census of Agriculture, 2002, Department of Census & Statistics

e - 1:50,000 Topographic Maps – Department of Survey

f - Sri Lanka Tourism Development Authority

g - Asweddumized Extent of Paddy by Mode of Irrigation and DS Division 2005/06 Maha, http://www.statistics.gov.lk/agriculture/Paddy%20Statistics/PaddyStats.htm Department of Census and Statistics

h - Department of Coast Conservation

i - Estimated Mid-year Population by Sex and District - 2010, Department of Census and Statistics, http://www.statistics.gov.lk/PopHouSat/Mid%20Year%20Population/midyearsex%20&district.pdf

h - Statistical Abstract – 2009, Department of Census & Statistics http://www.statistics.gov.lk/abstract2009/chapters/Chap1/AB1-1.pdf

j - Ministry of Health

k - Epidemiology Unit

l - Red List of Threatened Fauna and Flora of Sri Lanka , 2007

m - World Health Organization

Note: Some maps and statistics in this data book are different from those published in the Sector Vulnerability Profiles as some data have been updated.

URBAN DEVELOPMENT, HUMAN SETTLEMENTS AND ECONOMIC INFRASTRUCTURE

Human Settlements

As Sri Lanka moves into a trajectory of aggressive development, evaluating climate change vulnerability becomes important to identify potential threats to slated development goals. By doing so, any risks could be addressed early, ensuring that development targets can be achieved in a timely and sustainable manner.

Increase in the frequency and intensity of natural disasters will have immense socio-economic impacts on urban areas and human settlements. This makes climate change vulnerability a rather serious concern to be addressed in the development process. As 70% of Sri Lanka's population is expected to reside in urban settlements by 2030, it is crucial to ensure that such developments are adequately climate-proofed to ensure long term sustainability.

The main vulnerabilities associated with sea level rise on human settlements include inundation of land, saltwater intrusion, and increased frequency of storm surges along the coastal belt. Land, settlements, and coastal infrastructure including housing, roads, tourism infrastructure, etc, may be affected with substantial loss/damage of assets, disruption of economic opportunities and threats to the physical and social wellbeing of coastal communities, especially since the coastal zone accounts for about 43% of the nations GDP. Salt water intrusion will reduce the availability of fresh water for both drinking and irrigation, again undermining the viability of settlements in certain coastal areas and some downstream human settlements (including urban areas), well beyond the coastal zone.

With rising temperature, the need for adequate ventilation and cooling in residential and commercial buildings will increase. This can increase the energy demand at the national level and increase energy costs at the household level too. Health concerns in settlements are also expected to worsen.

Some of the implications associated with changes in rainfall regimes include increased frequency and duration of droughts, floods and increased rainfall intensity. Future urban development and planned expansion of human settlements could be highly vulnerable to drought, particularly if local economies are sustained by industries highly sensitive such as agriculture. Flood conditions will cause erosion and physical damage to infrastructure and public utilities imposing significant burdens on both individual households and the national economy. More frequent and severe flooding from flood prone rivers will exacerbate problems already faced by many communities in low-lying areas, especially where natural drainage paths and flood retention areas have been blocked or reclaimed. Increase in rainfall intensity may overwhelm urban storm-water drainage systems, resulting in more frequent flooding and damage to household and community level assets and infrastructure. The quantity and quality of water available for domestic use will also be affected.

The incidence of landslides caused by heavy and continuous rain is on the rise, and the resultant loss/damage to housing and related infrastructure, livelihoods and lives need to be anticipated. The central hill region of the country would be particularly affected by this hazard. Communities highly vulnerable to landslide risks may seek to relocate. The economic costs and social issues related to such potential migration could be significant.

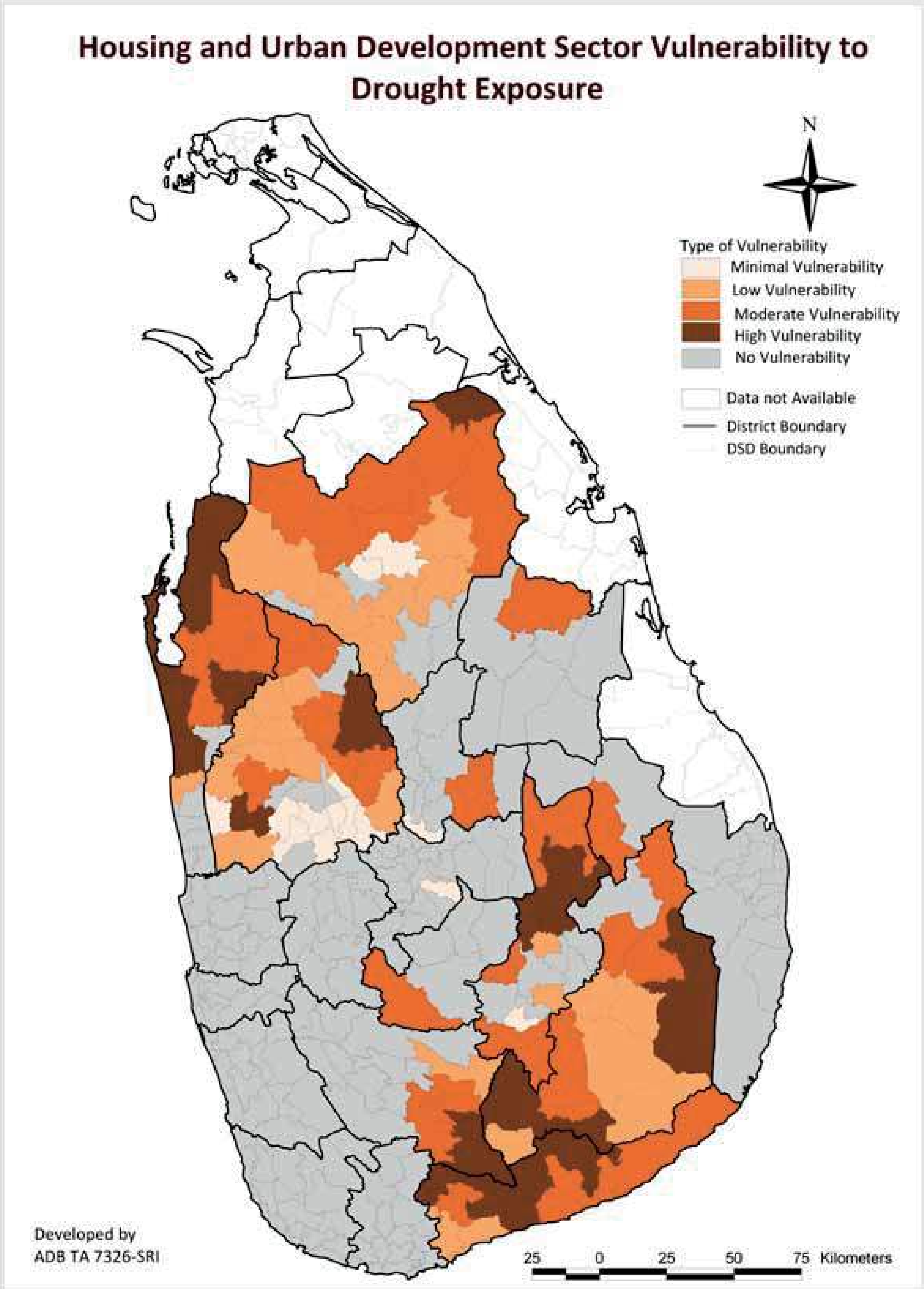
Housing and Urban Development Sector Vulnerability to Drought Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • Population density • Number of housing units • % of housing units classified as temporary structures	A composite of data (at DSD level) on: • percentage of people above the poverty line • percentage of people who have completed secondary education
Raw data source: 2001 National Census	

Some of the key findings include:

- Vulnerability of housing and human settlements to drought is widespread in the island, but more concentrated in the North-central and Southern regions of the country.
- 19 DS Divisions (DSDs) emerge as having settlements highly sensitive to drought. These DSDs combined, have:
  - A total population of 871,830 people, of whom 33.8% are below the poverty line.
  - A total housing stock of 219,231 housing units, of which 107,440 (49%) are of temporary construction.
  - 67.59% of their population (or 148,174 households) using wells and another 8.27% (18,138 households) using tube wells as their primary source of water.
- The three most vulnerable DSDs are Embilipitiya (Ratnapura District), Siyambalanduwa (Moneragala District), and Kalpitiya (Puttalam District).
  - Siyambalanduwa and Kalpitiya are highly sensitive as 68% of the housing stock in those DSD's comprise of temporary structures, while in Embilipitiya this figure is 38%.
  - Siyambalanduwa and Kalpitiya also have very high incidence of poverty (50% and 44%) among areas historically exposed to droughts.
  - Populations in Kalpitiya and Siyambalanduwa are heavily dependent on groundwater, with over 89% of the respective populations using wells or tube wells as their primary source of water.
  - Embilipitiya emerges as highly vulnerable because it has a relatively high population of 119,563, and a substantial volume of housing --29,027-- of which 11,000 are temporary structures. Embilipitiya is also among the DSDs that have historically recorded the highest exposure to droughts; 54% of the population at Embilipitiya depend on groundwater.
- A further 32 DSDs are in the moderately vulnerable category. They have:
  - A total population of about 1,494,810 people, of whom 388,416 are below the poverty line.
  - A total of 371,327 housing units of which 159,967 are of temporary construction.


Housing and Urban Development Sector Vulnerability to Drought Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Housing and Urban Development Sector Vulnerability to Drought Exposure

High   Moderate   Low   Minimal

Rank	District Name	DSD Name	Physical Characteristics: Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Demographics: Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Rathnapura	Embilipitiya	383.4799	119563	312	29126	0	119490	73	31.60	21.16
2	Moneragala	Siyambalanduwa	1065.6754	47438	45	10808	0	47438	0	51.80	13.52
3	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
4	Hambantota	Suriyawewa	189.7447	35529	187	9031	0	35529	0	34.80	17.37
5	Badulla	Rideemaliyadda	438.2808	45759	104	10681	0	45582	177	51.15	14.89
6	Kurunegala	Polpithigama	417.5552	67263	161	18926	0	67263	0	30.00	18.13
7	Puttalam	Anamaduwa	259.0095	33302	129	9039	0	33302	0	16.77	22.53
8	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
9	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
10	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
11	Moneragala	Thanamalwila	661.4470	23172	35	5893	0	23172	0	35.80	14.18
12	Badulla	Meegahakivula	108.7195	18650	172	4558	0	16316	2334	46.50	12.52
13	Puttalam	Vanathavilluwa	736.5317	16460	22	4024	0	16410	50	40.31	12.25
14	Hambantota	Lunugamvehera	300.3473	25226	84	6922	0	25226	0	33.50	17.85
15	Anuradhapura	Padaviya	242.5157	21146	87	5452	0	21146	0	34.33	14.43
16	Hambantota	Katuwana	103.7065	41392	399	10025	0	62344	0	34.30	17.11
17	Kurunegala	Kuliyapitiya West	163.9366	71483	436	18666	6290	65102	91	16.62	32.77
18	Hambantota	Angunukolapeles	174.0781	42426	244	10394	0	42426	0	33.00	16.83
19	Badulla	Kandaketiya	152.6207	22494	147	5425	0	21428	1066	46.10	14.56
20	Rathnapura	Kolonna	183.0319	43693	239	10661	0	38930	4763	37.70	14.65
21	Puttalam	Karuwalagaswewa	503.9380	20225	40	5550	0	20225	0	23.77	14.80
22	Rathnapura	Godakawela	155.7512	69123	444	16962	0	57669	11454	38.20	20.31
23	Hambantota	Tissamaharama	783.8008	60982	78	14829	0	60486	496	32.20	22.31
24	Moneragala	Madulla	722.5206	28358	39	6678	0	28358	0	40.70	19.44
25	Rathnapura	Weligepola	203.5279	29099	143	7690	0	28720	379	39.20	19.60
26	Puttalam	Mahakumbuk kadawala	175.8432	16905	96	4686	0	16905	0	28.65	15.18
27	Polonnaruwa	Medirigiriya	570.3679	57899	102	15189	0	57899	0	13.37	14.73
28	Badulla	Mahiyanganaya	598.4674	67301	112	16499	0	67301	0	38.57	20.02
29	Anuradhapura	Rambewa	303.6555	31604	104	8230	0	31592	12	20.57	19.54
30	Kurunegala	Ganewatta	147.1195	36812	250	9830	0	36770	42	23.20	22.57
31	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
32	Kurunegala	Ibbagamuwa	219.4878	76344	348	19589	0	75913	431	24.30	26.50
33	Moneragala	Wellawaya	585.9537	50768	87	12698	0	50768	0	24.90	17.79
34	Kurunegala	Galgamuwa	273.2962	47844	175	12759	0	47844	0	25.70	22.00
35	Badulla	Uva Paranagama	137.2816	76524	557	19213	0	65809	10715	33.35	19.52
36	Ampara	Padiyathalawa	386.8510	15971	41	3642	0	15971	0		11.66
37	Nuwara Eliya	Ambagamuwa	487.9105	203717	418	47145	14204	47474	142039	22.90	16.74
38	Anuradhapura	Medawachchiya	492.1070	40469	82	10338	0	40469	0	21.34	24.09
39	Kurunegala	Panduwasnuwara	216.0387	69888	323	18130	0	69888	0	18.90	28.69
40	Anuradhapura	Horowpothana	845.8179	29642	35	7578	0	29642	0	24.95	14.78
41	Matale	Laggala-Pallegama	373.8370	12399	33	3305	0	12055	344	34.60	19.05
42	Anuradhapura	Nuwaragam Palatha Central	389.4952	53665	138	13055	11598	42067	0	20.14	20.32
43	Hambantota	Weeraketiya	115.4094	37401	324	9208	0	55459	0	32.50	21.20
44	Moneragala	Medagama	241.1373	32467	135	7664	0	32467	0	30.20	14.89
45	Kurunegala	Giribawa	207.1489	28093	136	7831	0	28093	0	24.00	19.56
46	Anuradhapura	Kebithigollewa	611.9821	19457	32	4903	0	19457	0	27.74	18.03
47	Badulla	Haldummulla	414.9996	38223	92	9855	0	23207	15016	31.65	18.09
48	Puttalam	Nawagattegama	171.9949	12956	75	3519	0	12956	0	26.44	13.19
49	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
50	Kurunegala	Mahawa	260.6953	50576	194	13674	0	50576	0	20.90	21.83
51	Anuradhapura	Maha Vilachchiya	624.8276	18557	30	4630	0	18557	0	31.16	17.85

Accessibility			Housing Characteristics					DSD Name	Rank
Main Roads (km) [a & e]	Secondary Roads (km) [a & e]	Other Roads (km) [a & e] **	Permanent[b]	Semi-Permanent[b]	Improvised[b]	Not Classified[b]	Total Housing Units[b]		
70	130	476	18027	10755	45	200	29027	Embilipitiya	1
52	23	551	3382	7282	43	50	10757	Siyambalanduwa	2
39	13	177	5722	8845	3091	225	17883	Kalpitiya	3
0	105	209	4117	4768	26	80	8991	Suriyawewa	4
50	82	414	4187	6390	6	70	10653	Rideemaliyadda	5
36	63	469	7349	11135	104	154	18742	Polpithigama	6
42	27	321	4968	3898	47	64	8977	Anamaduwa	7
31	182	287	9743	5250	49	59	15101	Ambalantota	8
30	46	291	6464	5356	1289	186	13295	Mundalama	9
26	42	294	5834	3324	637	68	9863	Arachchikattuwa	10
21	54	256	2574	3246	11	40	5871	Thanamalwila	11
18	18	136	1985	2497	7	25	4514	Meegahakivula	12
0	35	417	1405	2307	237	36	3985	Vanathavilluwa	13
29	54	296	2886	3891	37	66	6880	Lunugamvehera	14
0	38	235	2761	2425	182	40	5408	Padaviya	15
18	31	128	8455	6525	13	107	15100	Katuwana	16
37	68	288	13850	4264	289	137	18540	Kuliyapitiya West	17
0	149	272	5328	4936	13	56	10333	Angunukolapeles	18
14	42	181	2754	2508	2	47	5311	Kandaketiya	19
47	42	161	5068	5430	10	49	10557	Kolonna	20
36	31	343	2572	2789	79	44	5484	Karuwalagaswewa	21
45	45	175	8831	7753	26	121	16731	Godakawela	22
53	60	622	9789	4625	156	94	14664	Tissamaharama	23
32	46	226	2751	3844	15	45	6655	Madulla	24
20	27	162	3484	4069	23	58	7634	Weligepola	25
7	22	251	2075	2427	159	7	4668	Mahakumbuk kadawala	26
0	32	713	8771	6223	49	95	15138	Medirigiriya	27
57	102	602	8972	7254	31	154	16411	Mahiyanganaya	28
23	30	461	3876	4120	26	28	8050	Rambewa	29
25	38	198	5394	4208	86	44	9732	Ganewatta	30
26	106	397	7614	3083	83	52	10832	Hambantota	31
40	75	250	11022	8026	209	105	19362	Ibbagamuwa	32
58	15	321	6369	6072	65	92	12598	Wellawaya	33
41	70	423	6542	5846	63	122	12573	Galgamuwa	34
17	55	301	10830	7438	13	206	18487	Uva Paranagama	35
23	6	198	1088	2513	19	10	3630	Padiyathalawa	36
167	70	1149	33627	11560	81	883	46151	Ambagamuwa	37
72	8	550	4811	5037	28	114	9990	Medawachchiya	38
37	56	414	12480	5193	322	77	18072	Panduwasnuwara	39
48	43	548	3604	3663	33	73	7373	Horowpothana	40
26	36	255	1535	1680	15	17	3247	Laggala-Pallegama	41
28	90	537	7532	5216	57	114	12919	Nuwaragam Palatha Central	42
18	61	179	7136	6120	37	41	13334	Weeraketiya	43
21	42	144	3820	3718	20	53	7611	Medagama	44
0	46	349	3451	4214	31	31	7727	Giribawa	45
55	10	600	1926	2762	25	55	4768	Kebithigollewa	46
50	56	321	5544	4075	37	59	9715	Haldummulla	47
22	21	167	1680	1751	13	32	3476	Nawagattegama	48
38	18	210	9305	4989	1107	244	15645	Puttalam	49
34	74	337	7561	5856	43	32	13492	Mahawa	50
0	40	410	2300	2235	15	51	4601	Maha Vilachchiya	51

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
52	Kurunegala	Rideegama	222.5431	80473	362	21118	0	78808	1665	32.76	26.28
53	Kurunegala	Bingiriya	195.2943	55763	286	15223	0	55613	150	16.80	24.53
54	Kurunegala	Kobeigane	130.8780	32230	246	8581	0	32230	0	19.10	24.70
55	Moneragala	Moneragala	292.5414	42457	145	10071	0	39112	3345	29.30	23.23
56	Badulla	Soranathota	80.8879	22760	281	5667	0	18160	4600	34.24	17.35
57	Anuradhapura	Palagala	226.9676	29837	131	8196	0	29837	0	23.83	21.98
58	Anuradhapura	Thalawa	220.5999	50919	231	13375	0	50919	0	19.44	22.25
59	Anuradhapura	Kahatagasdigiliya	366.6055	33572	92	8619	0	33572	0	19.63	20.03
60	Hambantota	Okewela	41.9560	18247	435	4266	0	18247	0	34.10	25.51
61	Kurunegala	Wariyapola	201.7589	56880	282	15207	0	56832	48	18.90	29.42
62	Kurunegala	Nikaweratiya	152.4124	36370	239	9549	0	36370	0	19.40	24.93
63	Anuradhapura	Nochchiyagama	843.5736	41601	49	11239	0	41601	0	16.98	19.61
64	Moneragala	Buttala	735.5660	47324	64	11843	0	47324	0	21.20	22.01
65	Moneragala	Sewanagala	191.9569	36820	192	9221	0	35739	1081	19.30	20.35
66	Kurunegala	Rasnayakapura	125.8909	18814	149	5071	0	18678	136	23.00	20.46
67	Kurunegala	Kotawehera	182.1192	19273	106	5323	0	19273	0	21.70	26.07
68	Badulla	Ella	109.3657	42894	392	10775	0	29156	13738	28.04	21.90
69	Anuradhapura	Galnewa	140.2283	30344	216	8165	0	30344	0	18.46	20.55
70	Rathnapura	Balangoda	274.1594	77303	282	18720	11402	58032	7869	27.30	27.22
71	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
72	Anuradhapura	Galenbidunuwawe	288.1528	40888	142	10454	0	40888	0	18.56	21.42
73	Moneragala	Badalkumbura	235.9900	36784	156	9030	0	32733	4051	27.90	23.53
74	Kurunegala	Pannala	284.9191	114438	402	29467	0	113726	712	17.80	31.16
75	Kurunegala	Ambanpola	142.5265	19964	140	5488	0	19964	0	23.10	23.46
76	Anuradhapura	Thambuttegama	111.4855	36524	328	9448	0	36524	0	19.05	22.52
77	Anuradhapura	Thirappane	278.9562	23378	84	6143	0	23378	0	18.59	23.27
78	Hambantota	Beliatta	102.5034	52283	510	12630	0	52283	0	28.30	36.26
79	Moneragala	Katharagama	536.3836	16297	30	3875	0	16297	0	19.80	19.56
80	Anuradhapura	Ipalogama	142.4270	32933	231	8730	0	31992	941	17.41	25.86
81	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
82	Kurunegala	Polgahawela	97.3861	58762	603	14506	0	57940	822	22.91	35.64
83	Kandy	Pathahewaheta	83.5016	53843	645	13229	0	51531	2312	26.60	30.92
84	Kurunegala	Kuliyapitiya East	113.2748	46966	415	11728	0	46839	127	20.32	27.57
85	Kurunegala	Narammala	108.3197	51244	473	13092	0	51244	0	21.40	33.36
86	Anuradhapura	Mihintale	234.9169	26786	114	6657	1523	25263	0	18.97	29.03
87	Matale	Ukuwela	77.9074	61568	790	14856	977	54983	5608	21.40	29.55
88	Kurunegala	Mawathagama	109.6233	56820	518	14191	0	55013	1807	24.92	33.95
89	Badulla	Haputhale	70.3267	50735	721	11565	3235	29372	18128	24.42	29.37
90	Kurunegala	Udubaddawa	117.5985	48800	415	12669	0	48742	58	17.70	29.43
91	Kurunegala	Mallawapitiya	79.9307	46575	583	11574	0	46240	335	19.50	33.19
92	Kurunegala	Kurunegala	111.0680	88944	801	20292	28401	60369	174	14.70	44.87
93	Kurunegala	Weerambugedara	91.3110	30311	332	8085	0	30311	0	20.11	39.05
94	Anuradhapura	Nuwaragam Palatha East	90.6614	65671	724	14504	40030	25641	0	11.97	44.47

** except cart tracks and foot paths

Accessibility			Housing Characteristics					DSD Name	Rank
Main Roads (km) [a & e]	Secondary Roads (km) [a & e]	Other Roads (km) [a & e] **	Permanent[b]	Semi-Permanent[b]	Improvised[b]	Not Classified[b]	Total Housing Units[b]		
38	63	317	12899	7736	97	118	20850	Rideegama	52
21	71	336	9921	4783	437	64	15205	Bingiriya	53
14	38	270	5708	2701	98	44	8551	Kobeigane	54
29	31	161	4946	4927	48	73	9994	Moneragala	55
10	44	138	3456	2009	7	53	5525	Soranathota	56
24	46	216	3301	4618	81	49	8049	Palagala	57
32	28	402	6324	6725	39	72	13160	Thalawa	58
53	34	409	4522	3918	21	42	8503	Kahatagasdigiliya	59
9	14	48	2302	1921	5	10	4238	Okewela	60
43	31	366	9407	5478	140	57	15082	Wariyapola	61
28	32	248	5775	3565	39	29	9408	Nikaweratiya	62
32	69	657	5934	5020	39	76	11069	Nochchiyagama	63
65	4	319	6223	5397	71	40	11731	Buttala	64
19	65	217	4363	4784	18	35	9200	Sewanagala	65
3	29	226	2709	2200	41	64	5014	Rasnayakapura	66
10	45	194	2543	2578	11	48	5180	Kotawehera	67
46	29	172	6834	3503	9	115	10461	Ella	68
20	29	208	3555	4474	21	19	8069	Galnewa	69
39	84	261	11711	6589	15	133	18448	Balangoda	70
36	102	208	10394	4002	108	63	14567	Tangalle	71
16	51	460	5441	4756	12	69	10278	Galenbidunuwawe	72
44	28	227	5210	3682	7	48	8947	Badalkumbura	73
38	175	503	21502	7004	686	161	29353	Pannala	74
24	30	182	2970	2406	17	17	5410	Ambanpola	75
34	7	272	4447	4819	53	80	9399	Thambuttegama	76
25	38	321	2733	3291	19	29	6072	Thirappane	77
26	40	114	7956	4246	63	57	12322	Beliatta	78
18	24	177	2563	1193	47	45	3848	Katharagama	79
25	40	154	4626	3879	37	34	8576	Ipalogama	80
25	28	112	9210	4076	951	60	14297	Chilaw	81
27	52	94	10591	3571	122	76	14360	Polgahawela	82
24	67	102	9031	3811	27	98	12967	Pathahewaheta	83
15	46	185	8318	3092	192	61	11663	Kuliyapitiya East	84
34	26	177	8909	3834	222	41	13006	Narammala	85
33	25	311	4011	2411	40	79	6541	Mihintale	86
37	45	99	9825	4512	12	92	14441	Ukuwela	87
34	16	171	10298	3558	70	100	14026	Mawathagama	88
21	53	134	8370	2616	10	268	11264	Haputhale	89
28	41	179	9244	2961	345	65	12615	Udubaddawa	90
20	40	83	8226	2994	65	80	11365	Mallawapitiya	91
33	61	142	15191	4242	183	329	19945	Kurunegala	92
20	30	122	5490	2317	109	42	7958	Weerambugedara	93
32	41	177	11744	2326	25	196	14291	Nuwaragam Palatha East	94

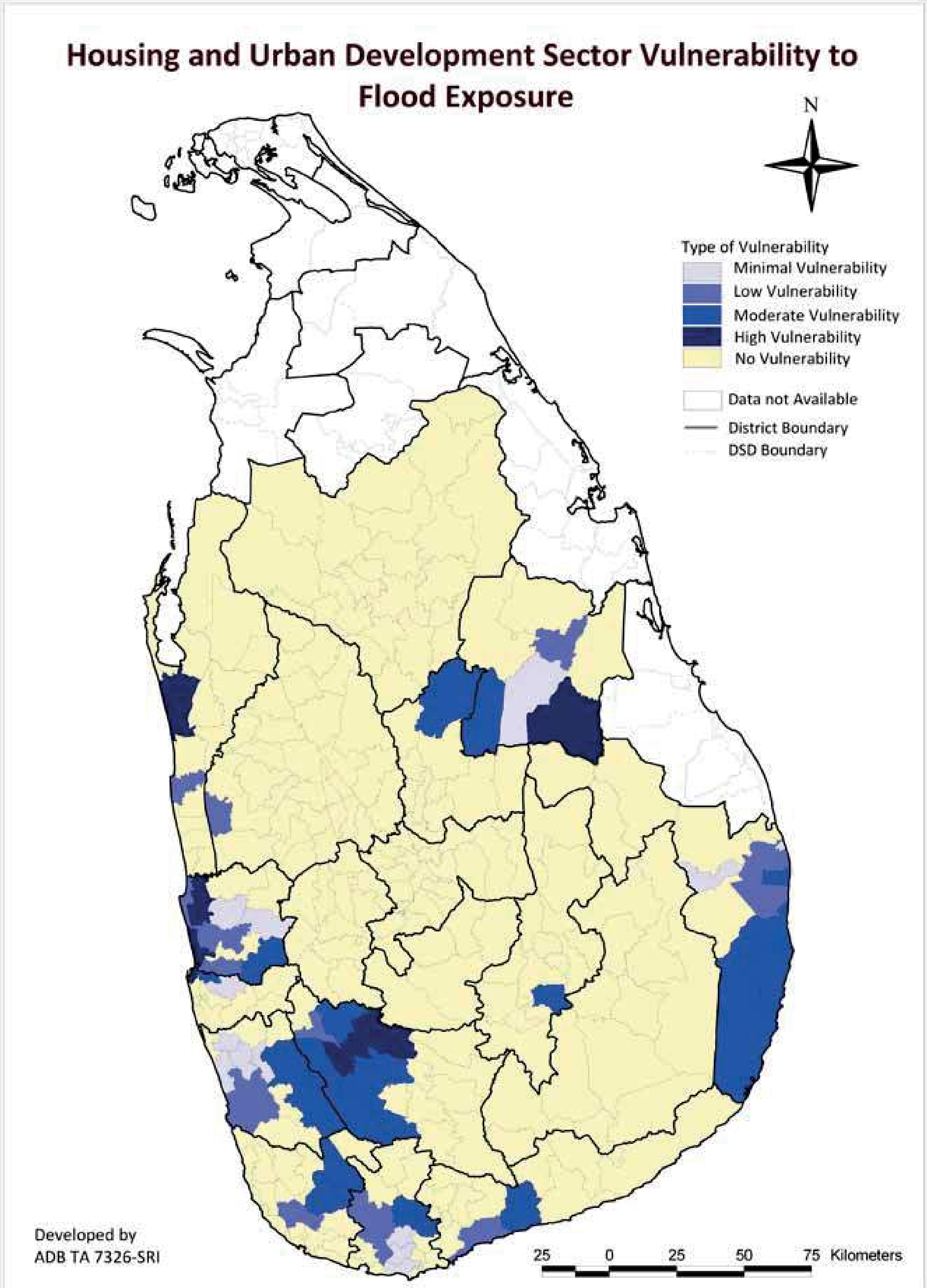
Housing and Urban Development Sector Vulnerability to Flood Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	**The Adaptive Capacity Index**
A composite of data (at DSD level) on: • Population density • Number of housing units • % of housing units classified as temporary structures	A composite of data (at DSD level) on: • percentage of people above the poverty line • percentage of people who have completed secondary education
Raw data source: 2001 National Census	

Some of the key findings include:

- Vulnerability of housing and human settlements to the expected increase in floods appears to be concentrated in the Western region of the country, although smaller pockets of high vulnerability are also seen elsewhere.
- 7 DSDs emerge as having settlements highly vulnerable to flood exposure. These DSDs combined have:
  - A population of 1,034,944, with poverty incidence of 13.3%, which is lower than the national average.
  - 214,473 housing units of which almost a quarter (53,330) are temporary structures.
  - 37% of their population (81,775 households) using wells as their primary source of water.
- Colombo (Colombo District) and Katana (Gampaha District) emerge as the two most vulnerable DSDs. These DSDs are home to 603,629 people living in 113,848 housing units. Colombo, the most vulnerable DSD, has the highest population density in the country.
- 21 additional DSDs emerge as having settlements that are moderately vulnerable to flood exposure. These DSDs combined have a population of 1,168,658 living in 276,442 housing units, over a third of which are temporary structures. 57.7% of these households use wells as their primary source of water.



Housing and Urban Development Sector Vulnerability to Flood Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Housing and Urban Development Sector Vulnerability to Flood Exposure

High Moderate Low Minimal

Rank	District Name	DSD Name	Physical Characteristics: Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Demographics: Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Colombo	Colombo	17.8538	380946	21337	70735	380946	0	0	12.10	32.53
2	Gampaha	Katana	124.9577	222683	1782	50765	73318	149365	0	7.70	41.14
3	Polonnaruwa	Dimbulagala	552.3964	63349	115	16757	0	63339	10	22.59	18.60
4	Rathnapura	Elapatha	86.8547	36322	418	8828	0	34219	2103	40.10	22.39
5	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
6	Rathnapura	Rathnapura	326.7894	115223	353	26549	45623	53219	16381	21.90	30.01
7	Gampaha	Wattala	57.6911	160127	2776	36368	28740	131387	0	6.10	40.21
8	Rathnapura	Ayagama	157.6893	28637	182	7357	0	25160	3477	33.70	21.37
9	Rathnapura	Kalawana	384.7488	48669	126	11905	0	44632	4037	36.40	23.93
10	Matara	Mulatiyana	119.4139	46066	386	11169	0	45501	565	30.90	21.41
11	Gampaha	Dompe	182.1586	130021	714	31962	0	130021	0	21.10	31.48
12	Rathnapura	Nivithigala	157.9051	59092	374	13989	0	47942	11150	32.80	17.57
13	Ampara	Pothuvil	271.8310	28480	105	6693	0	28480	0		13.45
14	Rathnapura	Pelmadulla	144.8430	84966	587	19906	560	73480	10926	30.20	26.35
15	Ampara	Lahugala	923.3049	7623	8	1888	0	7623	0		15.57
16	Rathnapura	Kuruwita	174.6734	85882	492	20460	0	80326	5556	28.90	23.57
17	Kalutara	Bulathsinhala	209.4387	59787	285	15611	0	53331	6456	27.40	22.09
18	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
19	Colombo	Kolonnawa	26.0388	161247	6193	35803	56396	104851	0	8.20	35.95
20	Polonnaruwa	Elahera	353.1772	39908	113	10446	0	39908	0	18.45	17.46
21	Galle	Thawalama	174.1470	31803	183	7710	0	30789	1014	29.50	19.99
22	Kalutara	Palindanuwara	283.2330	45911	162	11597	0	40298	5613	30.70	22.88
23	Matale	Dambulla	455.1342	60976	134	15285	0	60959	17	19.90	23.88
24	Matara	Hakmana	49.6219	30201	609	7190	0	30201	0	32.00	29.15
25	Ampara	Thirukkovil	187.0859	23700	127	5427	0	23700	0		20.88
26	Ampara	Addalachchenai	56.9586	36020	632	7640	0	36020	0		17.64
27	Badulla	Ella	109.3657	42894	392	10775	0	29156	13738	28.04	21.90
28	Galle	Nagoda	174.6178	52414	300	13028	0	46707	5707	28.70	23.04
29	Ampara	Alayadiwembu	82.5912	22627	274	4956	0	22627	0		22.67
30	Rathnapura	Kiriella	79.5653	30881	388	7666	0	29748	1133	25.60	26.58
31	Ampara	Ninthavur	36.3016	24625	678	6235	0	24625	0		22.78
32	Matara	Akuressa	148.6167	49806	335	11825	0	48508	1298	21.90	24.28
33	Gampaha	Kelaniya	21.9313	134364	6127	30272	29820	104544	0	6.90	41.85
34	Polonnaruwa	Lankapura	200.7756	33676	168	8611	0	33676	0	14.54	19.42
35	Gampaha	Negombo	46.1424	144274	3127	31915	121413	22861	0	7.10	30.04
36	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
37	Matara	Malimbada	47.9781	31524	657	7577	0	31384	140	24.30	31.38
38	Ampara	Eragama	66.6480	11344	170	2632	0	11344	0		13.35
39	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20
40	Gampaha	Biyagama	60.2668	161300	2676	36655	0	161300	0	11.30	41.68
41	Ampara	Sainthamarathu	3.0272	24114	7966	5144	24114	0	0		21.81
42	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
43	Kalutara	Mathugama	134.3624	73269	545	17604	0	66781	6488	29.40	28.65
44	Gampaha	Gampaha	90.6959	171040	1886	41357	9284	161756	0	9.90	43.27
45	Matara	Athuraliya	65.9339	30179	458	7039	0	29380	799	27.80	26.77
46	Kalutara	Dodangoda	112.8241	55052	488	13646	0	47970	7082	21.20	27.42
47	Ampara	Akkaraipattu	60.4089	34939	578	7649	0	34939	0		26.00
48	Galle	Baddegama	114.4507	68634	600	16761	0	66249	2385	21.70	30.17
49	Ampara	Samanthurai	123.0101	51510	419	11729	0	51510	0		20.13
50	Gampaha	Ja-Ela	61.4202	184666	3007	42975	30791	153875	0	7.80	44.60
51	Kurunegala	Udubaddawa	117.5985	48800	415	12669	0	48742	58	17.70	29.43

Accessibility		Housing Characteristics					DSD Name	Rank
Secondary Roads(km) a & e	Other Roads (km) a & e **	Permanent[b]	Semi-Permanent[b]	Improvised[b]	Not Classified[b]	Total Housing Units[b]		
105	0	54588	8459	41	1930	65018	Colombo	1
116	203	40211	6295	901	1423	48830	Katana	2
34	455	6694	9738	105	132	16669	Dimbulagala	3
54	77	5614	2992	18	68	8692	Elapatha	4
46	291	6464	5356	1289	186	13295	Mundalama	5
52	350	18283	7606	37	326	26252	Rathnapura	6
94	47	29289	5548	180	700	35717	Wattala	7
44	142	4013	3242	20	35	7310	Ayagama	8
21	240	6603	5128	17	116	11864	Kalawana	9
36	143	7737	3330	4	46	11117	Mulatiyana	10
162	222	24870	6214	351	175	31610	Dompe	11
52	163	8155	5540	14	72	13781	Nivithigala	12
13	114	3468	2282	485	82	6317	Pothuvil	13
37	210	12187	7230	27	242	19686	Pelmadulla	14
14	321	613	1119	52	4	1788	Lahugala	15
71	237	14014	6029	58	99	20200	Kuruwita	16
101	242	10686	4446	45	164	15341	Bulathsinhala	17
182	287	9743	5250	49	59	15101	Ambalantota	18
76	21	27611	6307	125	406	34449	Kolonnawa	19
26	312	5381	4880	29	59	10349	Elahera	20
33	99	4620	3000	7	51	7678	Thawalama	21
44	273	7465	3924	17	99	11505	Palindanuwara	22
66	397	7092	7761	171	99	15123	Dambulla	23
13	53	4297	2746	19	27	7089	Hakmana	24
11	155	2618	1774	904	47	5343	Thirukkovil	25
30	71	5693	1154	409	99	7355	Addalachchenai	26
29	172	6834	3503	9	115	10461	Ella	27
43	300	9087	3711	27	150	12975	Nagoda	28
12	88	3106	953	677	80	4816	Alayadiwembu	29
31	70	4842	2671	23	42	7578	Kiriella	30
41	20	4962	433	199	76	5670	Ninthavur	31
24	154	8269	3386	32	44	11731	Akuressa	32
74	23	23196	4926	69	431	28622	Kelaniya	33
37	201	6153	2219	98	82	8552	Lankapura	34
57	52	26910	3558	417	333	31218	Negombo	35
28	112	9210	4076	951	60	14297	Chilaw	36
30	53	5722	1734	32	23	7511	Malimbada	37
13	108	1708	605	74	29	2416	Eragama	38
88	125	22392	5516	238	374	28520	Beruwala	39
132	69	29276	4501	175	803	34755	Biyagama	40
2	4	4651	193	41	33	4918	Sainthamarathu	41
102	208	10394	4002	108	63	14567	Tangalle	42
66	172	12860	4230	55	130	17275	Mathugama	43
87	141	32735	7491	179	238	40643	Gampaha	44
28	88	4796	2129	33	21	6979	Athuraliya	45
69	159	9969	3380	40	78	13467	Dodangoda	46
5	102	6414	599	228	56	7297	Akkaraipattu	47
39	230	12021	4449	79	109	16658	Baddegama	48
21	159	9279	1395	126	171	10971	Samanthurai	49
116	107	35929	4735	186	1013	41863	Ja-Ela	50
41	179	9244	2961	345	65	12615	Udubaddawa	51

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
52	Matara	Kaburupitiya	59.7187	37347	625	9079	0	37347	0	24.90	31.28
53	Gampaha	Minuwangoda	133.2225	151661	1138	37683	7567	144084	10	12.50	38.36
54	Ampara	Ampara	139.2692	38166	274	8713	17957	20209	0		30.45
55	Matara	Thihagoda	50.9425	30909	607	7529	0	30909	0	27.20	30.07
56	Gampaha	Attanagalla	154.3057	154967	1004	36838	0	154821	146	15.40	39.55
57	Polonnaruwa	Thamankaduwa	465.7376	74224	159	17920	0	73956	268	14.15	28.23
58	Kalutara	Millaniya	82.0638	44476	542	11035	0	43110	1366	16.90	30.71
59	Colombo	Kaduwela	87.7537	209251	2385	48849	0	209251	0	6.00	48.78
60	Ampara	Karativu	8.9392	16365	1831	3641	0	16365	0		28.99
61	Kalutara	Kaluthara	77.6779	141829	1826	31857	37451	104378	0	12.50	38.35
62	Kalutara	Madurawala	62.9158	29750	473	7552	0	27129	2621	18.60	34.30
63	Kalutara	Bandaragama	57.4085	86886	1513	20579	0	86886	0	8.20	37.31
64	Matara	Matara	56.1514	108238	1928	23705	42663	65575	0	16.90	42.45

Accessibility		Housing Characteristics					DSD Name	Rank
Secondary Roads(km) [a & e]	Other Roads (km) [a & e] **	Permanent[b]	Semi-Permanent[b]	Improvised[b]	Not Classified[b]	Total Housing Units[b]		
17	46	7026	1890	23	52	8991	Kaburupitiya	52
109	232	28524	7913	498	236	37171	Minuwangoda	53
28	262	5818	2758	21	71	8668	Ampara	54
11	52	5601	1748	21	34	7404	Thihagoda	55
98	201	27846	7974	339	274	36433	Attanagalla	56
61	351	13507	3948	75	199	17729	Thamankaduwa	57
64	129	8341	2446	64	59	10910	Millaniya	58
165	106	42647	4327	172	758	47904	Kaduwela	59
18	8	3045	236	110	21	3412	Karativu	60
83	126	25607	5009	206	322	31144	Kaluthara	61
65	58	5945	1454	28	31	7458	Madurawala	62
36	115	17367	2459	71	178	20075	Bandaragama	63
76	59	19444	3237	222	106	23009	Matara	64

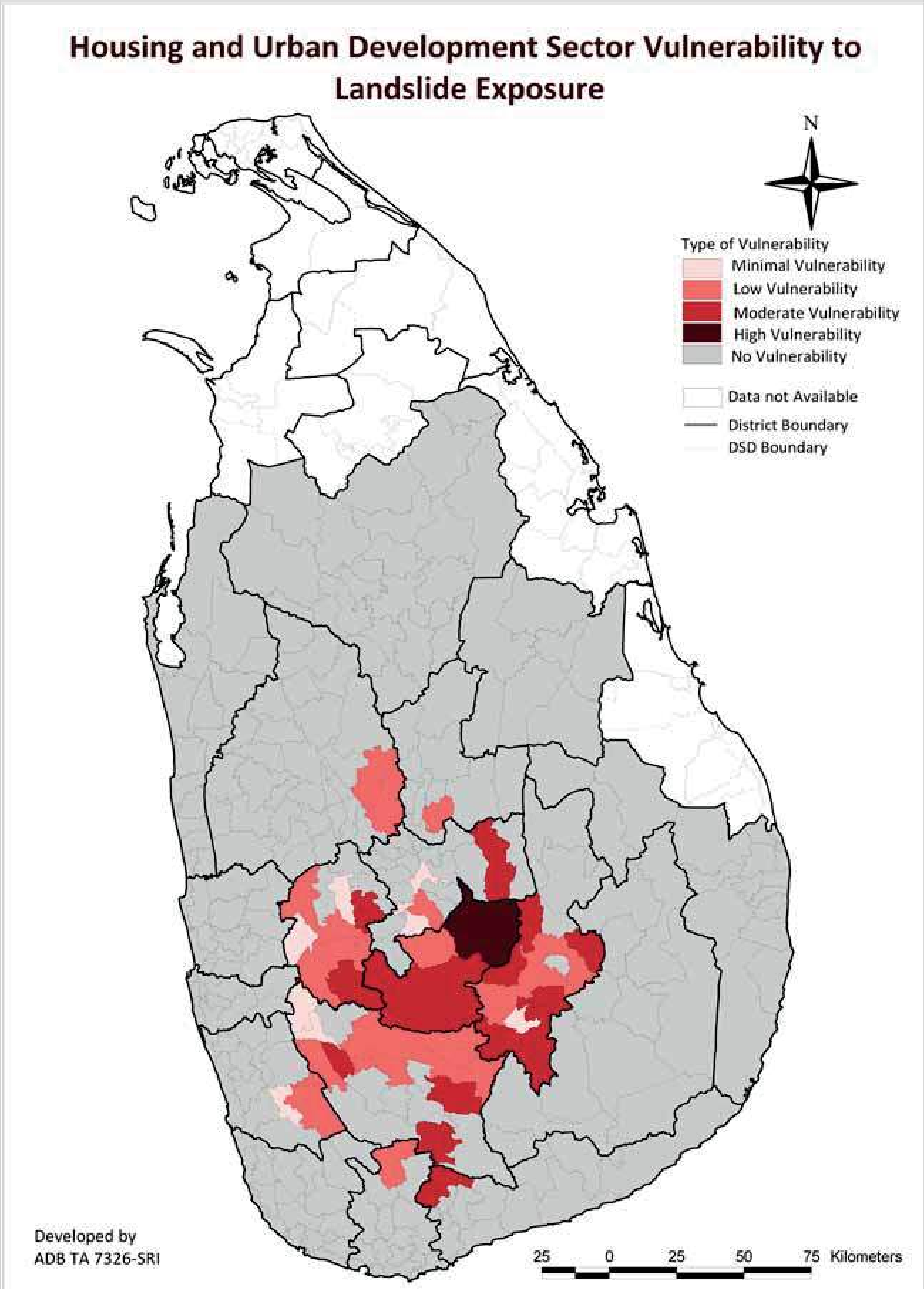
Housing and Urban Development Sector Vulnerability to Landslide Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • Population density • Number of housing units • % of housing units classified as temporary structures	A composite of data (at DSD level) on: • percentage of people above the poverty line • percentage of people who have completed secondary education
Raw data source: 2001 National Census	

Some of the key findings include:

- Vulnerability of housing and human settlements to the expected increase in landslides due to climate change is concentrated in the central hills of Sri Lanka.
- Walapane and Hanguranketha DSDs (both in the Nuwara Eliya District) emerge as having highly sensitive settlements to landslide exposure on their human settlements. These 2 DSDs have:
  - A total population of 194,194 people, of whom 29.4% are below the poverty line.
  - A total housing stock of 47,693 housing units, of which 19,715 (41.3%) are of temporary construction.
  - The highest exposure to landslides, historically in terms of frequency and people affected.
- A further 15 DSDs are expected to be moderately vulnerable to landslides as a result of climate change. These DSDs combined have:
  - A population of 969,660, of whom 275,276 (28.4%) are below the poverty line.
  - 235,667 housing units of which 36.5% are temporary structures.


Housing and Urban Development Sector Vulnerability to Landslide Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Housing and Urban Development Sector Vulnerability to Landslide Exposure

High | Moderate | Low | Minimal

Rank	District Name	DSD Name	Physical Characteristics: Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Demographics: Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Nuwara Eliya	Walapane	321.5229	106434	331	26645	0	66727	39707	26.50	15.66
2	Nuwara Eliya	Hanguranketha	228.6220	87760	384	22524	0	74355	13405	34.60	19.18
3	Badulla	Kandaketiya	152.6207	22494	147	5425	0	21428	1066	46.10	14.56
4	Badulla	Lunugala	141.8095	33079	233	8260	0	14585	18494	38.82	13.78
5	Rathnapura	Elapatha	86.8547	36322	418	8828	0	34219	2103	40.10	22.39
6	Badulla	Haldummulla	414.9996	38223	92	9855	0	23207	15016	31.65	18.09
7	Kegalle	Aranayaka	124.4190	66198	532	16850	0	64894	1304	36.10	29.31
8	Kegalle	Deraniyagala	222.0806	44735	201	11336	0	34377	10358	33.60	19.57
9	Badulla	Uva Paranagama	137.2816	76524	557	19213	0	65809	10715	33.35	19.52
10	Rathnapura	Kolonna	183.0319	43693	239	10661	0	38930	4763	37.70	14.65
11	Nuwara Eliya	Ambagamuwa	487.9105	203717	418	47145	14204	47474	142039	22.90	16.74
12	Nuwara Eliya	Nuwara Eliya	483.5716	208190	431	49385	28869	36922	142399	21.90	18.93
13	Badulla	Bandarawela	70.0596	60269	860	14379	7296	44049	8924	21.61	32.66
14	Rathnapura	Weligepola	203.5279	29099	143	7690	0	28720	379	39.20	19.60
15	Hambantota	Katuwana	103.7065	41392	399	10025	0	62344	0	34.30	17.11
16	Kandy	Udadumbara	277.0667	22831	82	6001	0	21322	1509	37.50	17.35
17	Badulla	Ella	109.3657	42894	392	10775	0	29156	13738	28.04	21.90
18	Badulla	Passara	135.9205	49190	362	12245	0	29457	19733	31.88	19.27
19	Kegalle	Bulathkohupitiya	127.2471	45573	358	11729	0	37396	8177	32.50	22.74
20	Rathnapura	Imbulpe	255.2644	55546	218	14086	660	46388	8498	32.00	24.58
21	Badulla	Soranathota	80.8879	22760	281	5667	0	18160	4600	34.24	17.35
22	Badulla	Hali Ela	170.1437	87476	514	21835	0	58715	28761	34.58	24.29
23	Matara	Kotapola	179.3289	64012	357	15073	0	51875	12137	22.60	15.42
24	Rathnapura	Ayagama	157.6893	28637	182	7357	0	25160	3477	33.70	21.37
25	Nuwara Eliya	Kothmale	223.7228	97509	436	23841	0	58181	39328	22.30	19.01
26	Kurunegala	Rideegama	222.5431	80473	362	21118	0	78808	1665	32.76	26.28
27	Kegalle	Dehiovita	193.2396	73991	383	18460	0	62883	11108	29.30	24.21
28	Rathnapura	Rathnapura	326.7894	115223	353	26549	45623	53219	16381	21.90	30.01
29	Badulla	Welimada	193.9032	94399	487	22838	0	84180	10219	29.19	28.14
30	Rathnapura	Pelmadulla	144.8430	84966	587	19906	560	73480	10926	30.20	26.35
31	Kegalle	Yatiyanthota	178.0749	57239	321	14197	0	45071	12168	30.10	23.81
32	Matale	Rattota	105.2255	49382	469	13068	0	40015	9367	23.40	25.32
33	Kalutara	Palindanuwara	283.2330	45911	162	11597	0	40298	5613	30.70	22.88
34	Kegalle	Warakapola	195.5200	106038	542	26503	0	103087	2951	26.00	30.93
35	Rathnapura	Balangoda	274.1594	77303	282	18720	11402	58032	7869	27.30	27.22
36	Kurunegala	Ibbagamuwa	219.4878	76344	348	19589	0	75913	431	24.30	26.50
37	Kandy	Doluwa	100.1685	45270	452	11651	0	37392	7878	26.50	21.04
38	Kegalle	Kegalle	109.0590	87637	804	21327	17139	68733	1765	26.70	37.80
39	Rathnapura	Eheliyagoda	141.9292	63870	450	15566	0	61593	2277	26.90	26.60
40	Kegalle	Ruwanwella	138.6165	58892	425	14461	0	54679	4213	28.50	28.11
41	Rathnapura	Kiriella	79.5653	30881	388	7666	0	29748	1133	25.60	26.58
42	Badulla	Haputhale	70.3267	50735	721	11565	3235	29372	18128	24.42	29.37
43	Kandy	Udapalatha	90.6003	86145	951	19936	24116	48242	13787	21.40	29.35
44	Kalutara	Agalawatta	89.7814	33962	378	8423	0	32768	1194	26.40	33.03
45	Kandy	Gangawata Korale	58.6941	160630	2737	33196	104252	54472	1906	10.10	48.49

** Included all other road types without Rail roads (Cart track, Foot path etc)

Accessibility			Housing Characteristics					DSD Name	Rank
Main Roads (km) [a & e]	Secondary Roads (km) [a & e]	Other Roads (km) [a & e] [**]	Permanent[b]	Semi-Permanent[b]	Improvised[b]	Not Classified[b]	Total Housing Units[b]		
81	88	604	14602	10815	59	237	25713	Walapane	1
49	84	337	13376	8350	28	226	21980	Hanguranketha	2
14	42	181	2754	2508	2	47	5311	Kandaketiya	3
31	72	111	5048	2987	4	55	8094	Lunugala	4
0	54	77	5614	2992	18	68	8692	Elapatha	5
50	56	321	5544	4075	37	59	9715	Haldummulla	6
23	51	183	11064	5379	30	107	16580	Aranayaka	7
17	99	326	6533	4494	103	67	11197	Deraniyagala	8
17	55	301	10830	7438	13	206	18487	Uva Paranagama	9
47	42	161	5068	5430	10	49	10557	Kolonna	10
167	70	1149	33627	11560	81	883	46151	Ambagamuwa	11
143	124	1128	30512	15571	76	1638	47797	Nuwara Eliya	12
35	35	143	11274	2381	3	305	13963	Bandarawela	13
20	27	162	3484	4069	23	58	7634	Weligepola	14
18	31	128	8455	6525	13	107	15100	Katuwana	15
17	68	206	2939	2933	1	55	5928	Udadumbara	16
46	29	172	6834	3503	9	115	10461	Ella	17
48	55	173	8019	3735	10	112	11876	Passara	18
31	33	184	7708	3883	25	44	11660	Bulathkohupitiya	19
44	48	329	8363	5317	12	84	13776	Imbulpe	20
10	44	138	3456	2009	7	53	5525	Soranathota	21
49	66	456	15154	5794	19	192	21159	Hali Ela	22
32	50	126	9574	5258	15	97	14944	Kotapola	23
0	44	142	4013	3242	20	35	7310	Ayagama	24
90	86	548	14649	8322	56	218	23245	Kothmale	25
38	63	317	12899	7736	97	118	20850	Rideegama	26
40	68	311	12314	5726	117	161	18318	Dehiovita	27
58	52	350	18283	7606	37	326	26252	Rathnapura	28
70	67	243	15433	6454	15	282	22184	Welimada	29
28	37	210	12187	7230	27	242	19686	Pelmadulla	30
48	40	251	9512	4336	90	113	14051	Yatiyanthota	31
41	52	164	7462	5252	5	85	12804	Rattota	32
24	44	273	7465	3924	17	99	11505	Palindanuwara	33
45	97	223	17655	8139	206	258	26258	Warakapola	34
39	84	261	11711	6589	15	133	18448	Balangoda	35
40	75	250	11022	8026	209	105	19362	Ibbagamuwa	36
39	28	225	7702	3664	4	75	11445	Doluwa	37
36	74	105	15325	5452	86	176	21039	Kegalle	38
26	60	164	10969	4319	45	61	15394	Eheliyagoda	39
42	69	155	10402	3802	99	57	14360	Ruwanwella	40
24	31	70	4842	2671	23	42	7578	Kiriella	41
21	53	134	8370	2616	10	268	11264	Haputhale	42
47	50	204	14423	4793	23	203	19442	Udapalatha	43
6	40	86	6612	1627	13	64	8316	Agalawatta	44
44	100	44	28340	3395	16	496	32247	Gangawata Korale	45

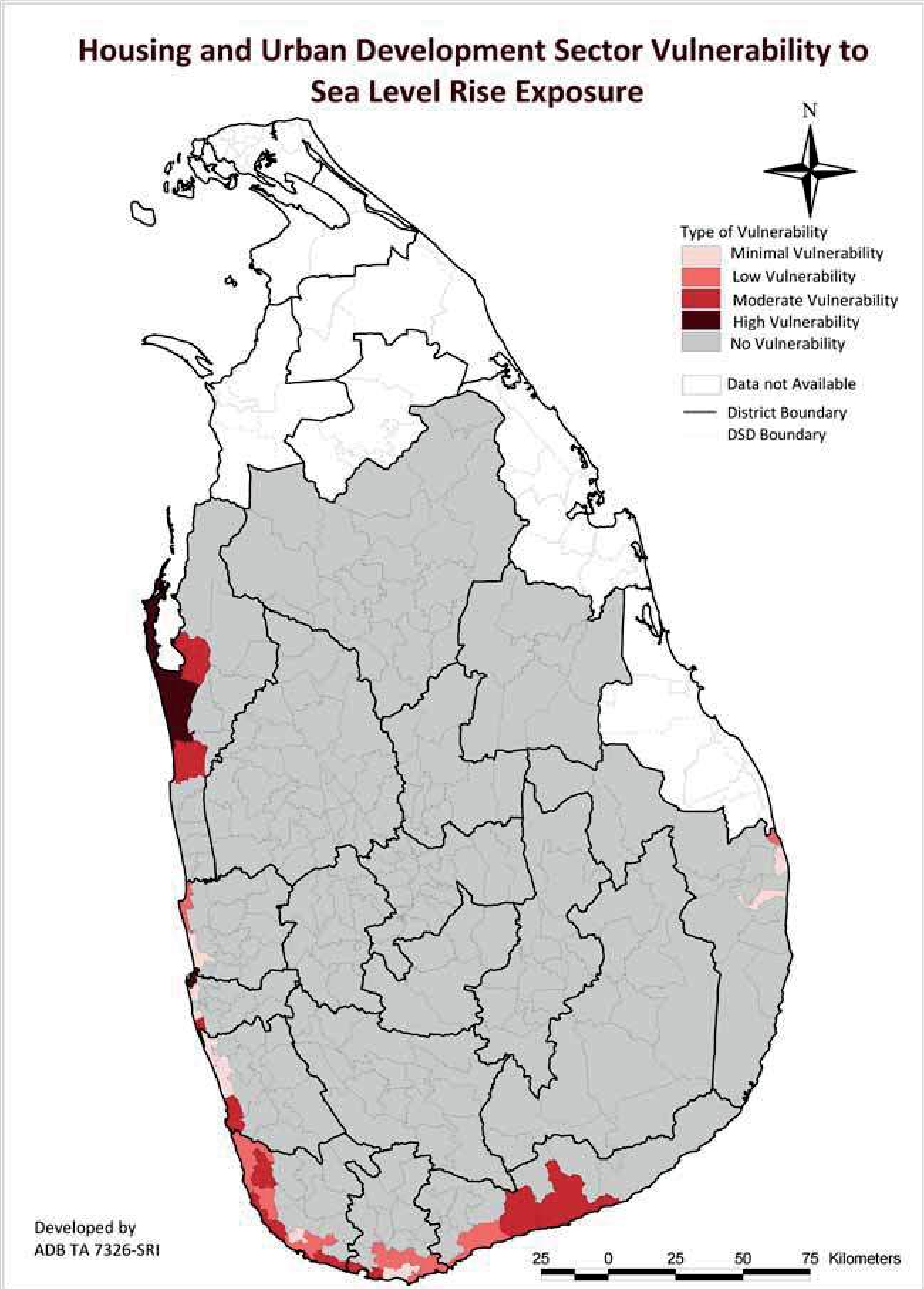
Housing and Urban Development Sector Vulnerability to Sea Level Rise Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • Population density • Number of housing units • % of housing units classified as temporary structures	A composite of data (at DSD level) on: • percentage of people above the poverty line • percentage of people who have completed secondary education
Raw data source: 2001 National Census	

Some of the key findings include:

- Vulnerability of housing and human settlements to sea level rise exposure appears to be highest in the Western and Southern regions of the island. Although "exposure" was high in the North and East, detailed vulnerability assessment of this region could not be done because of the lack of census data.
- Among the DSDs where data was available and could be mapped, Colombo (Colombo District), and Kalpitiya and Mundalama (both Puttalam District) show high levels of vulnerability. These 3 DSDs have:
  - A population of 519,020 people, of which almost a 100,000 are below the poverty line.
  - 96,196 housing units of which 29,422 are temporary structures.
- The housing stock in Kalpitiya and Mundalama comprise primarily of temporary structures (68% and 51% respectively). This is the worst situation among all coastal DSDs where data were available. These two DSDs are also heavily dependent on groundwater, as over 87% of their populations use wells or tube wells as their primary source of water.
- A further 10 DSDs emerge as being moderately vulnerable to sea level rise exposure. These DSDs have a total population of 822,814 living in 183,867 housing units. 28% of these homes are temporary structures.


Housing and Urban Development Sector Vulnerability to 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
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

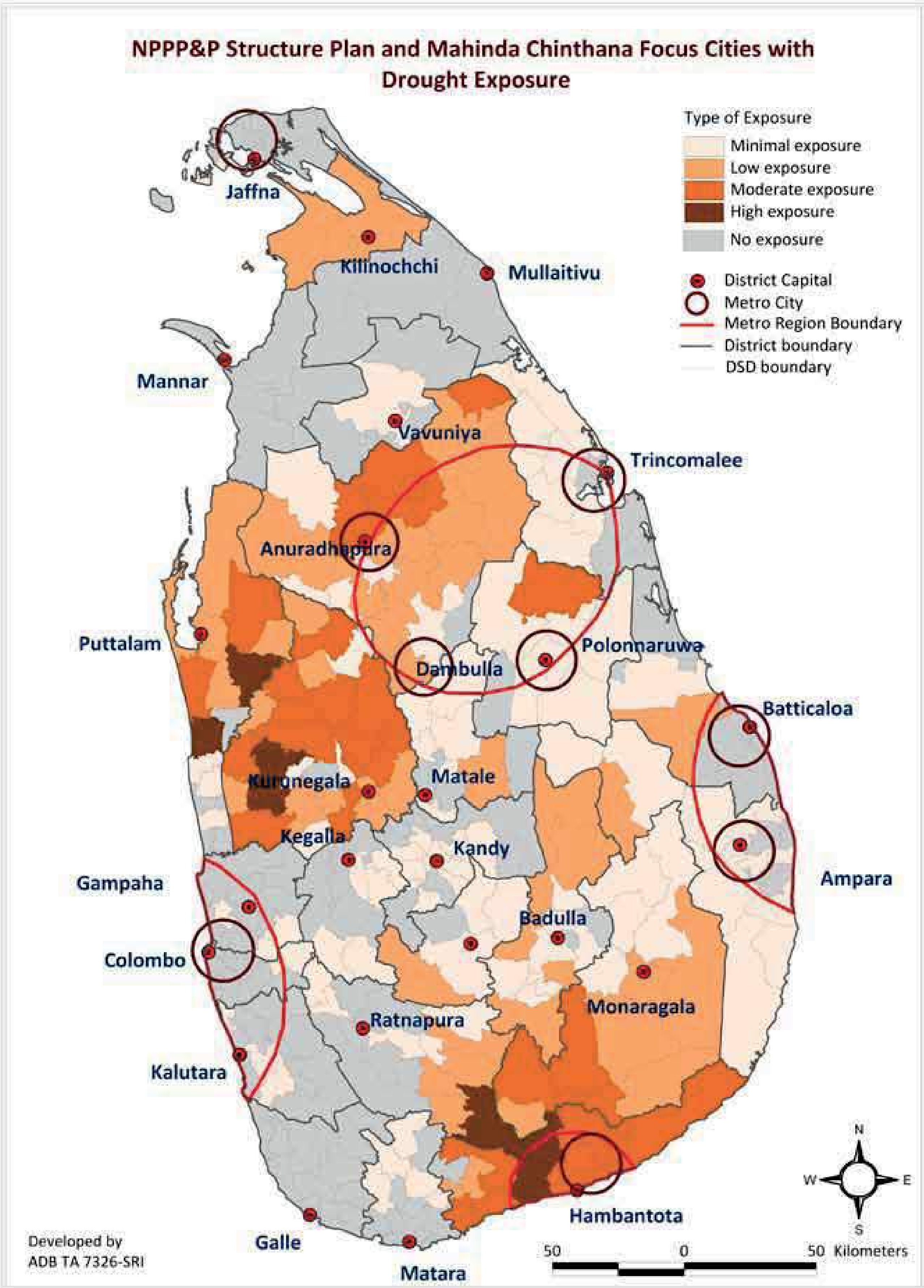
Housing and Urban Development Sector Vulnerability to Sea Level Rise Exposure

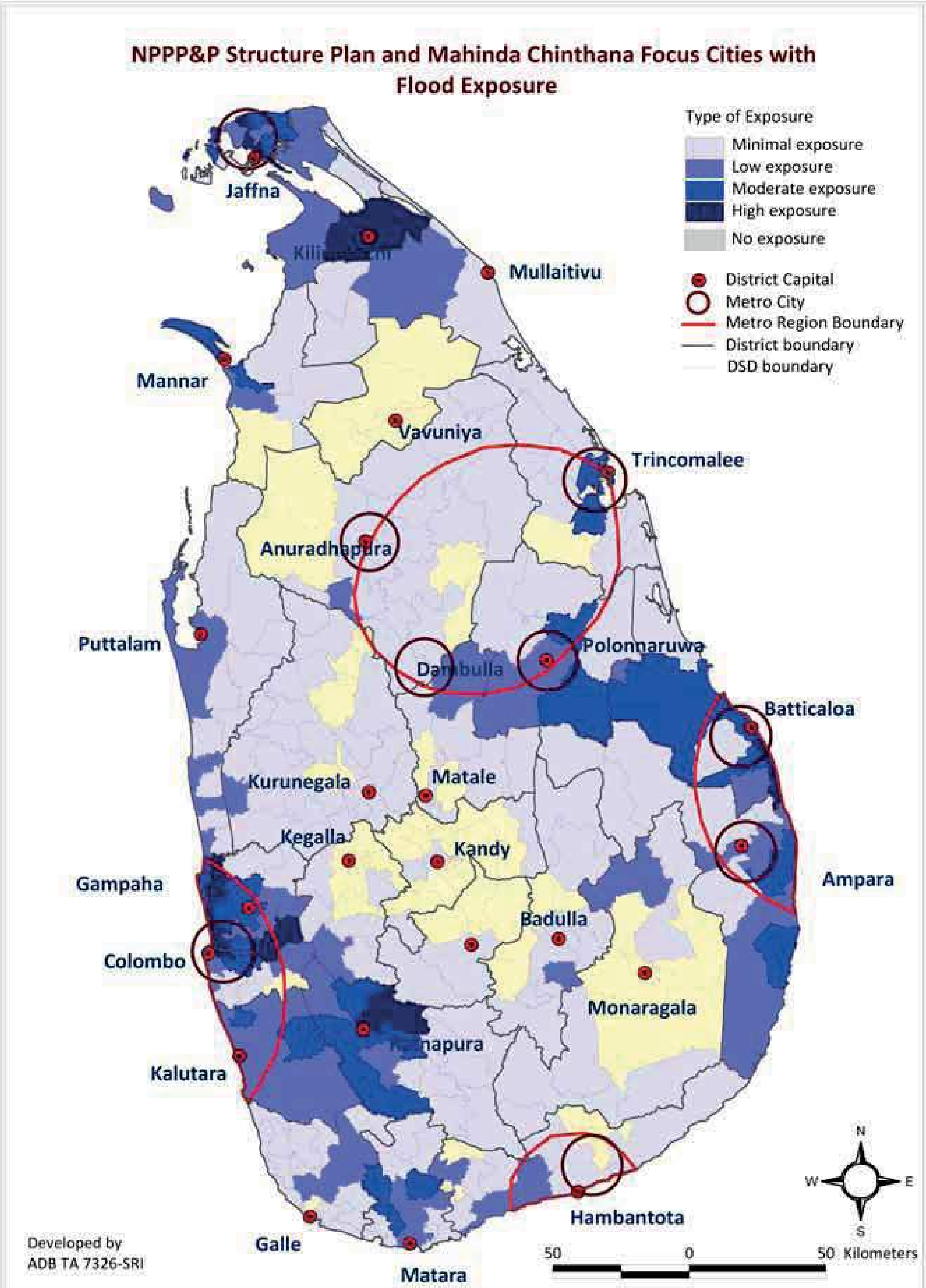
High · Moderate · Low · Minimal

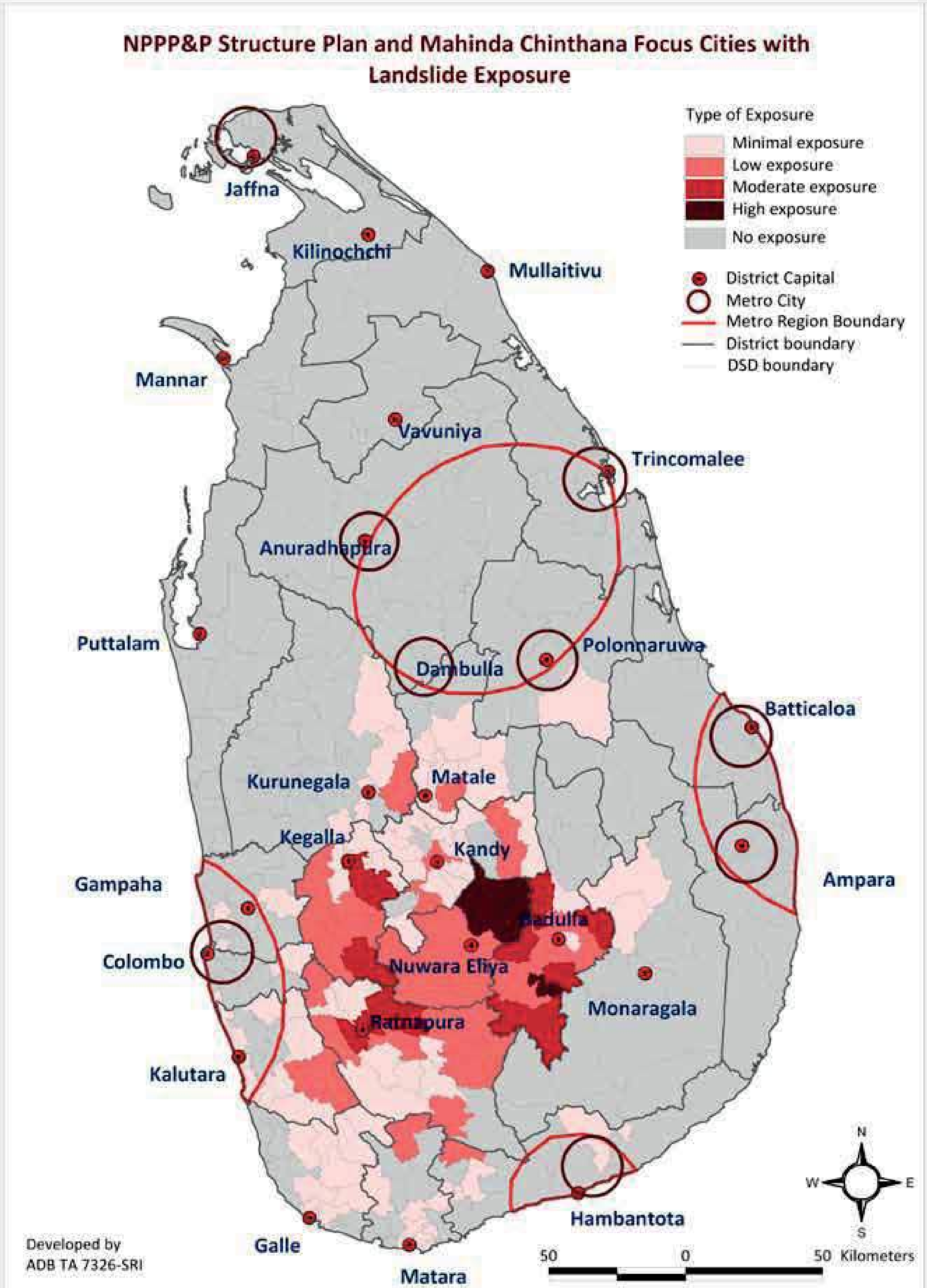
Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
2	Colombo	Colombo	17.8538	380946	21337	70735	380946	0	0	12.10	32.53
3	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
4	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
5	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
6	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
7	Galle	Habaraduwa	49.5183	59041	1192	13567	0	59041	0	28.70	29.53
8	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
9	Matara	Weligama	43.1469	66459	1540	14825	21698	44761	0	21.50	30.48
10	Galle	Karandeniya	88.0055	56128	638	14913	0	56128	0	21.90	20.63
11	Galle	Hikkaduwa	66.0971	98589	1492	22820	0	98539	50	24.90	33.61
12	Colombo	Moratuwa	19.2051	177563	9246	41282	177563	0	0	10.30	40.58
13	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20
14	Matara	Malimbada	47.9781	31524	657	7577	0	31384	140	24.30	31.38
15	Matara	Devinuwara	37.6183	44199	1175	9988	0	44199	0	20.90	26.80
16	Gampaha	Negombo	46.1424	144274	3127	31915	121413	22861	0	7.10	30.04
17	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
18	Galle	Galle Four Gravets	23.7565	103246	4346	19425	90270	12976	0	19.30	39.96
19	Galle	Akmeemana	65.4509	63881	976	15110	0	63239	642	22.00	32.21
20	Galle	Ambalangoda	70.2467	71047	1011	17122	39302	51396	0	20.30	32.73
21	Galle	Balapitiya	54.5727	65346	1197	15054	0	65346	0	22.00	27.89
22	Matara	Thihagoda	50.9425	30909	607	7529	0	30909	0	27.20	30.07
23	Ampara	Kalmunai	19.6568	70465	3585	15821	70465	0	0		28.44
24	Galle	Bentota	72.3358	46442	642	11015	0	46442	0	22.30	31.14
25	Matara	Dickwella	50.9687	51314	1007	11592	0	51314	0	22.70	31.87
26	Ampara	Ninthavur	36.3016	24625	678	6235	0	24625	0		22.78
27	Ampara	Akkaraipattu	60.4089	34939	578	7649	0	34939	0		26.00
28	Kalutara	Kaluthara	77.6779	141829	1826	31857	37451	104378	0	12.50	38.35
29	Ampara	Karativu	8.9392	16365	1831	3641	0	16365	0		28.99
30	Colombo	Thimbirigasyaya	22.3754	266154	11895	52397	266154	0	0	4.40	49.35
31	Galle	Bope-Poddala	29.1730	41612	1426	9732	0	41461	151	18.10	42.27
32	Matara	Matara	56.1514	108238	1928	23705	42663	65575	0	16.90	42.45
33	Gampaha	Wattala	57.6911	160127	2776	36368	28740	131387	0	6.10	40.21
34	Kalutara	Panadura	45.0310	163492	3631	37245	33514	129978	0	7.40	40.07
35	Colombo	Rathmalana	13.1472	108716	8269	25013	108716	0	0	4.20	47.88

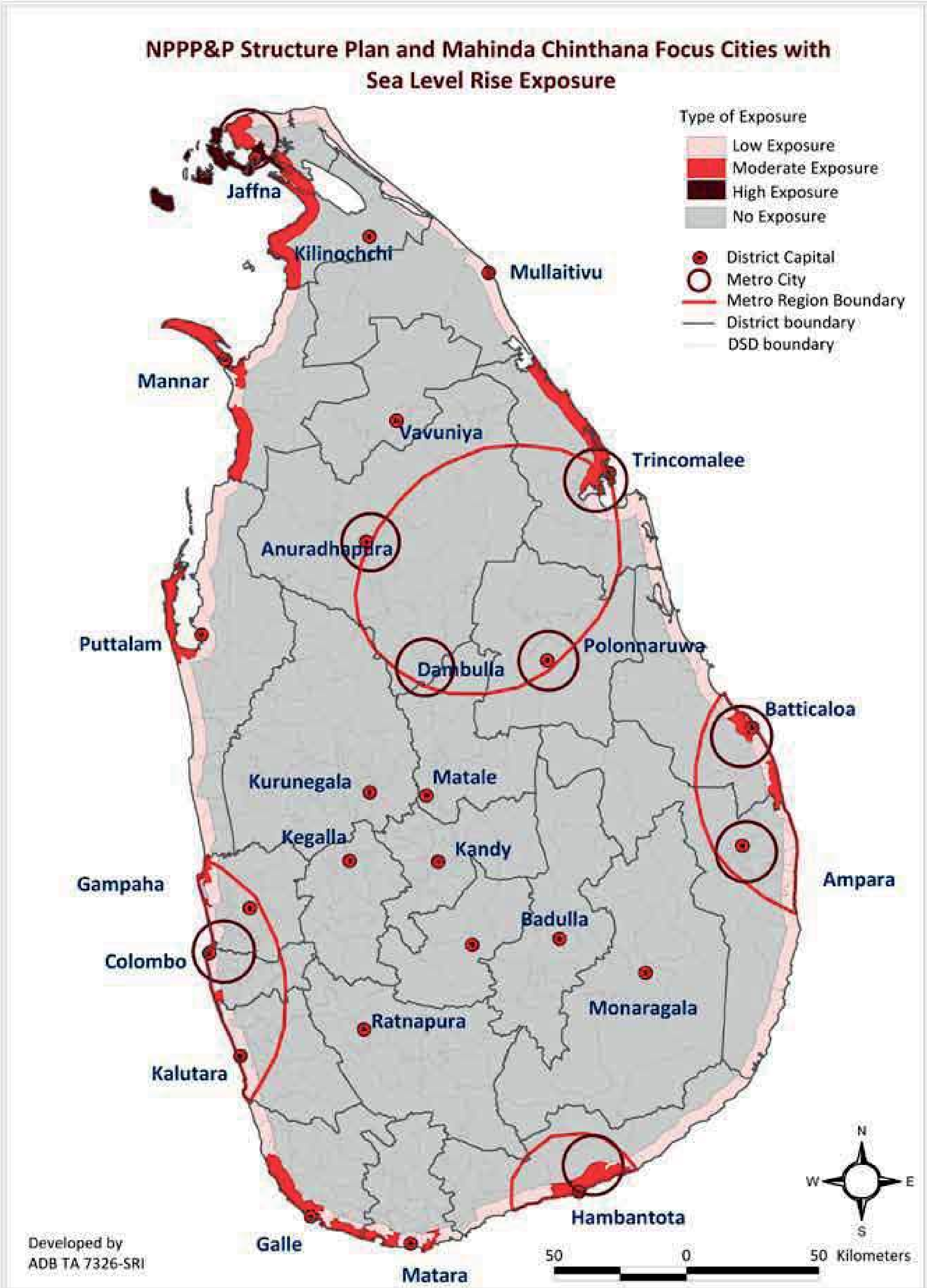
** except cart track and foot paths

Accessibility			Housing Characteristics					DSD Name	Rank
Main Roads (km) [a & e]	Secondary Roads (km) [a & e]	Other Roads (km) [a & e] **	Permanent[b]	Semi-Permanent[b]	Improvised[b]	Not Classified[b]	Total Housing Units[b]		
39	13	177	5722	8845	3091	225	17883	Kalpitiya	1
11	105	0	54588	8459	41	1930	65018	Colombo	2
30	46	291	6464	5356	1289	186	13295	Mundalama	3
38	18	210	9305	4989	1107	244	15645	Puttalam	4
26	106	397	7614	3083	83	52	10832	Hambantota	5
31	182	287	9743	5250	49	59	15101	Ambalantota	6
21	62	66	9472	3308	384	72	13236	Habaraduwa	7
26	42	294	5834	3324	637	68	9863	Arachchikattuwa	8
18	48	53	10957	2942	329	94	14322	Weligama	9
23	32	219	10614	4134	27	64	14839	Karandeniya	10
32	60	80	16527	5211	322	185	22245	Hikkaduwa	11
17	73	2	30170	8344	175	575	39264	Moratuwa	12
19	88	125	22392	5516	238	374	28520	Beruwala	13
12	30	53	5722	1734	32	23	7511	Malimbada	14
14	17	52	7756	1826	110	36	9728	Devinuwara	15
34	57	52	26910	3558	417	333	31218	Negombo	16
36	102	208	10394	4002	108	63	14567	Tangalle	17
26	55	27	15798	2619	131	210	18758	Galle Four Gravets	18
19	57	112	10578	4067	179	63	14887	Akmeemana	19
21	50	121	12441	4274	66	92	16873	Ambalangoda	20
20	32	95	10961	3385	165	120	14631	Balapitiya	21
16	11	52	5601	1748	21	34	7404	Thihagoda	22
7	51	43	11813	1815	472	186	14286	Kalmunai	23
19	51	102	7295	3339	144	34	10812	Bentota	24
17	31	58	8668	2428	108	47	11251	Dickwella	25
7	41	20	4962	433	199	76	5670	Ninthavur	26
14	5	102	6414	599	228	56	7297	Akkaraipattu	27
48	83	126	25607	5009	206	322	31144	Kaluthara	28
6	18	8	3045	236	110	21	3412	Karativu	29
19	131	2	43115	4604	24	1793	49536	Thimbirigasyaya	30
12	30	47	7768	1674	66	37	9545	Bope-Poddala	31
26	76	59	19444	3237	222	106	23009	Matara	32
21	94	47	29289	5548	180	700	35717	Wattala	33
22	85	83	30644	4763	150	488	36045	Panadura	34
5	65	2	20677	2675	43	439	23834	Rathmalana	35


NPPP&P Structure Plan and Mahinda Chinthana Focus Cities with Drought Exposure
Type of Exposure
Minimal exposure
Low exposure
Moderate exposure
High exposure
No exposure
District Capital
Metro City
Metro Region Boundary
District boundary
DSD boundary
Jaffna
Kilinochchi
Mullaitivu
Mannar
Vavuniya
Trincomalee
Anuradhapura
Puttalam
Dambulla
Polonnaruwa
Batticaloa
Kurunegala
Matale
Kegalla
Kandy
Gampaha
Ampara
Colombo
Badulla
Monaragala
Ratnapura
Kalutara
Hambantota
Galle
Matara
N
W
E
S
50
0
50 Kilometers
Developed by
ADB TA 7326-SRI


NPPP&P Structure Plan and Mahinda Chinthana Focus Cities with Flood Exposure
Type of Exposure
Minimal exposure
Low exposure
Moderate exposure
High exposure
No exposure
District Capital
Metro City
Metro Region Boundary
District boundary
DSD boundary
Jaffna
Mullaitivu
Mannar
Vavuniya
Trincomalee
Anuradhapura
Puttalam
Polonnaruwa
Dambulla
Batticaloa
Kurunegala
Matale
Kegalla
Kandy
Gampaha
Ampara
Badulla
Colombo
Monaragala
Kalutara
Hambantota
Galle
Matara
N
W
E
S
50
0
50 Kilometers
Developed by
ADB TA 7326-SRI


NPPP&P Structure Plan and Mahinda Chinthana Focus Cities with Landslide Exposure
Type of Exposure
Minimal exposure
Low exposure
Moderate exposure
High exposure
No exposure
District Capital
Metro City
Metro Region Boundary
District boundary
DSD boundary
Jaffna
Kilinochchi
Mullaitivu
Mannar
Vavuniya
Trincomalee
Anuradhapura
Puttalam
Dambulla
Polonnaruwa
Batticaloa
Kurunegala
Matale
Kegalla
Kandy
Gampaha
Ampara
Badulla
Colombo
Nuwara Eliya
Monaragala
Ratnapura
Kalutara
Hambantota
Galle
Matara
N
W
E
S
50
0
50 Kilometers
Developed by
ADB TA 7326-SRI


NPPP&P Structure Plan and Mahinda Chinthana Focus Cities with Sea Level Rise Exposure
Type of Exposure
Low Exposure
Moderate Exposure
High Exposure
No Exposure
District Capital
Metro City
Metro Region Boundary
District boundary
DSD boundary
Jaffna
Kilinochchi
Mullaitivu
Mannar
Vavuniya
Trincomalee
Anuradhapura
Puttalam
Dambulla
Polonnaruwa
Batticaloa
Kurunegala
Matale
Kegalla
Kandy
Ampara
Gampaha
Badulla
Colombo
Monaragala
Ratnapura
Kalutara
Hambantota
Galle
Matara
Developed by
ADB TA 7326-SRI
50
0
50 Kilometers
N
W
E
S

Transport Infrastructure

The main transport infrastructure in Sri Lanka consisting of roads, railways, airports and sea ports are vulnerable to some impact of climate change, especially as most have not been designed to accommodate the consequences.

There is a high probability that the island's coastal zone will be affected by sea level rise and will have to face associated inundation of land, saltwater intrusion, and increased frequency of storm surges. The coastal region (i.e. DSDs with a coastal boundary) contains nearly 20% of the island's Class A and B roads, and 33.3% of its railroads. This infrastructure is particularly vulnerable to sea level rise. Already, the railway lines from Colombo to the South have been affected by coastal erosion at some places. Sea level rise and more frequent and intense storm surges may also impact harbours and ports, and consequently on the service facilities they offer.

The main roads in the country are generally surfaced with pre-mix bitumen or asphalt. Increased ambient temperatures could cause surface flow of asphalt, distortion of road markings, and bleeding of bitumen making old road surfaces brittle. This may necessitate heavy investment on repair and maintenance. Similarly, increased rainfall intensity as a result of climate change could exacerbate flooding of roadways, particularly as many canals and drainage outfalls are already in disrepair or have been planned for lower rates of flow. Increased levels of damage to land-transportation infrastructure will cause direct costs for repair and rehabilitation, and also result in substantial losses across many other sectors that are dependent on the road and rail network. More details on the transport sector including information on vulnerability enhancing factors are provided in Section 1, Part II, *SVP on Urban Development, Human Settlements and Economic Infrastructure*.

For the purpose of the mapping exercise, only roads and railroads were considered for transport infrastructure vulnerability.

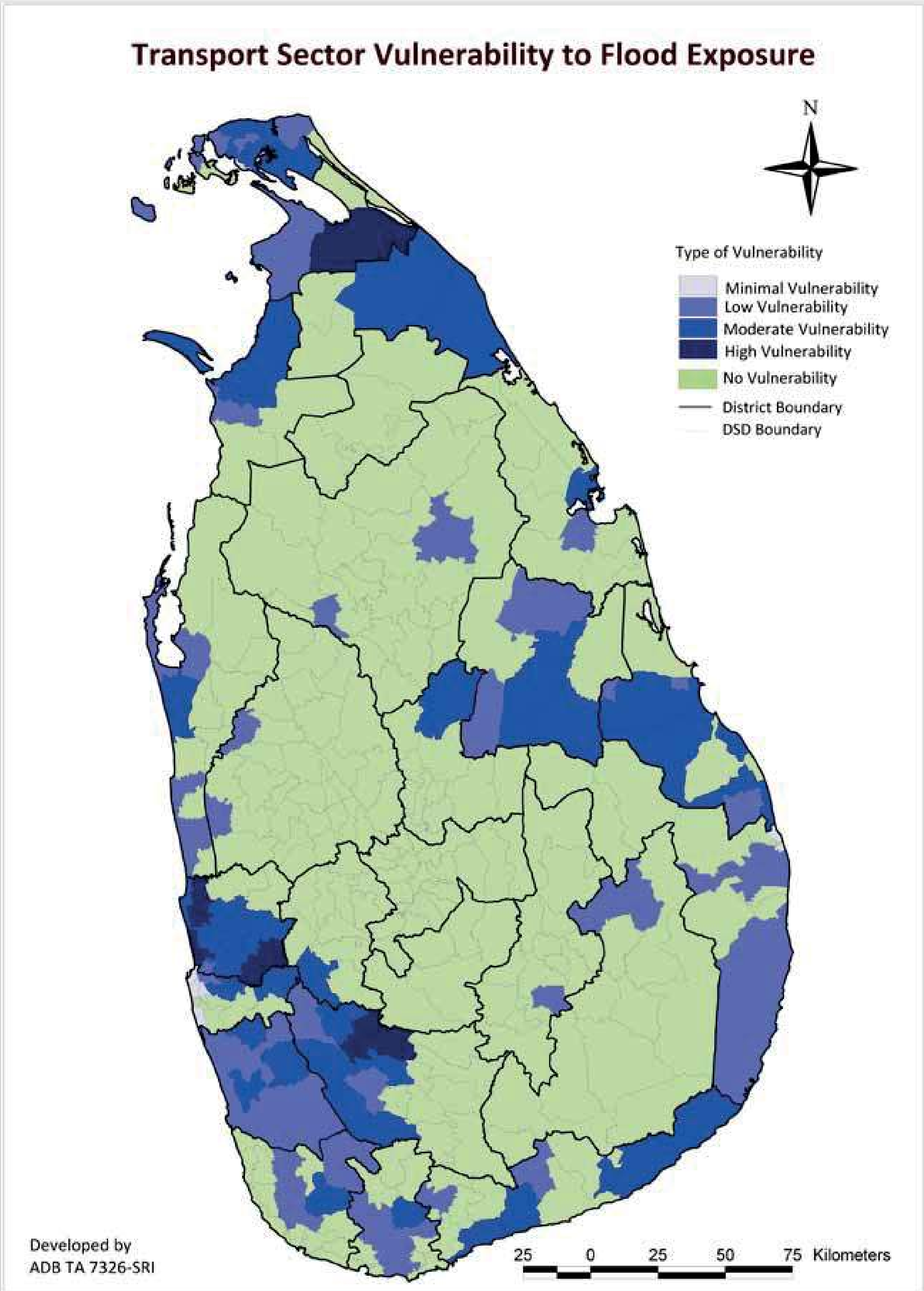
Vulnerability of the Transport Sector to Flood Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • Length of main roads • Length of secondary roads • Length of rail	• Road density (length of main roads, secondary roads, and rail roads per square kilometre in each DSD.
Sources of data: 1:50,000 map sheets from Survey Dept. of Sri Lanka	

Some of the key findings include:

- Vulnerability of transport infrastructure to the expected increase in frequency and intensity of floods due to climate change is widespread and prevalent in many parts of the country.
- 5 DSDs emerge as being highly vulnerable in this regard to flood exposure. These DSDs combined have 235 km of main roads, 531 km of secondary roads and 33 km of railroads.
- A further 43 DSDs emerge as moderately vulnerable. These DSDs have 1,381 km of main roads, 2,906 km of secondary roads, and 278 km of railroads.
- Of the 13 DSDs in Gampaha District, 3 emerge as highly vulnerable, and another 7 emerge as moderately vulnerable, making this the most vulnerable district in this regard. Gampaha District has a population of 2,063,684 and a total of 475,847 housing units.


Transport Sector Vulnerability to Flood Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Transport Sector Vulnerability to Flood Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics: Area (Sq. km)[a]	Total Population[b]	No. of Households[b]	Demographics: Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Gampaha	Katana	124.9577	222683	50765	73318	149365	0	7.70	41.14
2	Kilinochchi	Karachchi	621.6203							
3	Gampaha	Dompe	182.1586	130021	31962	0	130021	0	21.10	31.48
4	Gampaha	Wattala	57.6911	160127	36368	28740	131387	0	6.10	40.21
5	Rathnapura	Rathnapura	326.7894	115223	26549	45623	53219	16381	21.90	30.01
6	Hambantota	Ambalantota	211.3413	64361	15334	0	63426	935	33.30	21.36
7	Gampaha	Minuwangoda	133.2225	151661	37683	7567	144084	10	12.50	38.36
8	Gampaha	Gampaha	90.6959	171040	41357	9284	161756	0	9.90	43.27
9	Jaffna	Chavakachcheri	222.1802							
10	Colombo	Kaduwela	87.7537	209251	48849	0	209251	0	6.00	48.78
11	Mannar	Mannar Town	207.1215							
12	Gampaha	Attanagalla	154.3057	154967	36838	0	154821	146	15.40	39.55
13	Batticaloa	Eravur Pattu	612.3070							
14	Jaffna	Sandilipay	48.1604							
15	Batticaloa	Koralai Pattu (Valach.)	593.7964							
16	Gampaha	Ja-Ela	61.4202	184666	42975	30791	153875	0	7.80	44.60
17	Gampaha	Biyagama	60.2668	161300	36655	0	161300	0	11.30	41.68
18	Polonnaruwa	Dimbulagala	552.3964	63349	16757	0	63339	10	22.59	18.60
19	Batticaloa	Manmunai S. and Eruvilpattu	59.7398							
20	Polonnaruwa	Thamankaduwa	465.7376	74224	17920	0	73956	268	14.15	28.23
21	Kalutara	Bulathsinhala	209.4387	59787	15611	0	53331	6456	27.40	22.09
22	Hambantota	Tangalle	152.5016	62800	14981	10437	52363	0	27.10	30.04
23	Matale	Dambulla	455.1342	60976	15285	0	60959	17	19.90	23.88
24	Rathnapura	Elapatha	86.8547	36322	8828	0	34219	2103	40.10	22.39
25	Trincomalee	Town & Gravets	132.1348							
26	Jaffna	Tellipallai	61.1745							
27	Mulattivu	Pudukudi yirippu	1002.7885							
28	Rathnapura	Kuruwita	174.6734	85882	20460	0	80326	5556	28.90	23.57
29	Rathnapura	Kalawana	384.7488	48669	11905	0	44632	4037	36.40	23.93
30	Batticaloa	Manmunai South - West	150.8018							
31	Jaffna	Kopay	102.0337							
32	Matara	Mulatiyana	119.4139	46066	11169	0	45501	565	30.90	21.41
33	Hambantota	Tissamaharama	783.8008	60982	14829	0	60486	496	32.20	22.31
34	Jaffna	Nallur	34.4074							
35	Gampaha	Mahara	94.2988	176870	41639	0	176870	0	12.10	37.86
36	Mannar	Manthai West	609.4103							
37	Puttalam	Mundalama	241.4497	56294	13534	0	56294	0	41.08	14.73
38	Batticaloa	Manmunai North	66.4719							
39	Polonnaruwa	Lankapura	200.7756	33676	8611	0	33676	0	14.54	19.42
40	Kalutara	Horana	112.7795	90690	22048	9127	80042	1521	8.40	42.98
41	Rathnapura	Pelmadulla	144.8430	84966	19906	560	73480	10926	30.20	26.35
42	Colombo	Hanwella	145.8825	94001	22689	21601	66446	5954	14.20	34.61
43	Gampaha	Negombo	46.1424	144274	31915	121413	22861	0	7.10	30.04
44	Rathnapura	Ayagama	157.6893	28637	7357	0	25160	3477	33.70	21.37
45	Kegalle	Dehiovita	193.2396	73991	18460	0	62883	11108	29.30	24.21
46	Kalutara	Dodangoda	112.8241	55052	13646	0	47970	7082	21.20	27.42
47	Galle	Nagoda	174.6178	52414	13028	0	46707	5707	28.70	23.04
48	Mulattivu	Maritimepattu	756.2531							

Land Use			Sector Specific Data					DSD Name	Rank
Agriculture Land Area (Acres)[d]	Forest Land (Acres)[d]	Other Land Uses (Acres)[a]	Main Roads[e]	Secondary Roads[e]	Rail Roads[e]	Other Roads (km)[e]	Road Density[a **]		
6612	81	24184.605	63.23	115.73	8.82	203.11	1.50	Katana	1
17720	419	135466.100	48.20	107.34	22.88	1082.67	0.29	Karachchi	2
20538	421	24053.187	43.80	162.09	0.00	221.70	1.13	Dompe	3
1498	140	12617.728	21.48	93.98	1.57	47.46	2.03	Wattala	4
13687	1504	65560.086	57.85	51.82	0.00	349.72	0.34	Rathnapura	5
19232	487	32504.363	31.20	181.67	0.00	286.51	1.01	Ambalantota	6
16148	192	16579.853	75.76	108.82	0.00	232.25	1.39	Minuwangoda	7
8491	77	13843.352	49.33	87.43	9.34	140.96	1.61	Gampaha	8
9385	452	45064.714	73.43	97.03	24.22	735.30	0.88	Chavakachcheri	9
3569	116	17999.317	13.71	164.97	0.00	106.49	2.04	Kaduwela	10
3295	162	47723.622	53.93	45.15	39.41	232.93	0.67	Mannar Town	11
15028	362	22739.604	70.85	97.53	9.57	200.87	1.15	Attanagalla	12
17962	192	133149.753	49.86	33.55	10.98	556.28	0.15	Eravur Pattu	13
2626	6	9268.638	16.13	59.79	0.00	120.95	1.58	Sandilipay	14
9983	36	136710.706	22.81	36.09	26.32	491.98	0.14	Koralai Pattu (Valach.)	15
2368	43	12766.210	23.02	116.36	16.19	107.31	2.53	Ja-Ela	16
4743	143	10006.193	15.31	131.69	0.00	69.28	2.44	Biyagama	17
35644	1737	99118.583	6.04	33.73	6.17	454.70	0.08	Dimbulagala	18
1807	17	12937.966	19.28	1.97	0.00	157.75	0.36	Manmunai S. and Eruvilpattu	19
18061	831	96193.798	33.55	61.08	16.95	350.91	0.24	Thamankaduwa	20
16292	1202	34259.229	0.00	100.96	0.00	241.60	0.48	Bulathsinhala	21
15465	1846	20372.810	36.36	102.18	0.00	207.50	0.91	Tangalle	22
22407	2218	87840.666	40.15	65.96	0.00	396.85	0.23	Dambulla	23
6328	529	14605.175	0.00	54.37	0.00	77.08	0.63	Elapatha	24
305	18	32328.078	41.39	55.10	17.00	292.57	0.86	Town & Gravets	25
986	0	14130.499	25.07	56.49	7.62	176.84	1.46	Tellipallai	26
11749	132	235912.454	77.96	16.43	24.22	1041.45	0.12	Pudukudi yirippu	27
10758	678	31726.570	19.07	70.77	0.00	237.14	0.51	Kuruwita	28
15589	2853	76631.119	57.06	20.86	0.00	239.91	0.20	Kalawana	29
8508	12	28743.799	10.93	30.58	0.00	203.58	0.28	Manmunai South - West	30
3396	115	21701.987	28.40	65.17	0.16	250.91	0.92	Kopay	31
14610	774	14123.700	23.12	35.64	0.00	143.30	0.49	Mulatiyana	32
17224	1145	175311.632	52.84	59.53	0.00	622.12	0.14	Tissamaharama	33
339	1	8162.207	16.84	55.56	9.90	122.07	2.39	Nallur	34
9971	157	13173.644	36.05	128.84	1.76	117.17	1.77	Mahara	35
4821	168	145598.950	37.64	74.55	0.00	341.19	0.18	Manthai West	36
10154	1183	48326.270	29.71	45.67	23.70	291.05	0.41	Mundalama	37
728	1	15696.499	13.42	31.91	6.61	106.38	0.78	Manmunai North	38
15584	449	33579.526	14.69	36.80	0.00	200.75	0.26	Lankapura	39
10552	227	17089.315	24.82	108.12	0.00	146.15	1.18	Horana	40
10329	619	24843.341	28.00	36.72	0.00	209.80	0.45	Pelmadulla	41
8158	544	27346.217	46.08	51.38	16.01	218.07	0.78	Hanwella	42
889	17	10495.985	33.87	56.62	11.53	51.57	2.21	Negombo	43
9520	1255	28190.717	0.00	44.31	0.00	142.38	0.28	Ayagama	44
10718	947	36085.352	39.69	68.35	0.00	310.71	0.56	Dehiovita	45
5882	207	21790.339	21.56	68.90	0.00	158.91	0.80	Dodangoda	46
17297	585	25266.828	38.88	43.22	0.00	300.05	0.47	Nagoda	47
7826	99	178948.455	33.16	64.14	0.00	794.53	0.13	Maritimepattu	48

Rank	District Name	DSD Name	Physical Characteristics			Demographics				
			Area (Sq. km)[a]	Total Population[b]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
49	Kalutara	Kaluthara	77.6779	141829	31857	37451	104378	0	12.50	38.35
50	Trincomalee	Kinniya	151.4995							
51	Galle	Baddegama	114.4507	68634	16761	0	66249	2385	21.70	30.17
52	Ampara	Pothuvil	271.8310	28480	6693	0	28480	0		13.45
53	Kalutara	Mathugama	134.3624	73269	17604	0	66781	6488	29.40	28.65
54	Kurunegala	Udubaddawa	117.5985	48800	12669	0	48742	58	17.70	29.43
55	Hambantota	Suriyawewa	189.7447	35529	9031	0	35529	0	34.80	17.37
56	Kalutara	Palindanuwara	283.2330	45911	11597	0	40298	5613	30.70	22.88
57	Jaffna	Kayts	55.2340							
58	Moneragala	Bibila	483.5204	35490	8817	0	34818	672	26.00	17.05
59	Matara	Akuressa	148.6167	49806	11825	0	48508	1298	21.90	24.28
60	Badulla	Ella	109.3657	42894	10775	0	29156	13738	28.04	21.90
61	Kalutara	Walallawita	213.2047	50676	12793	0	47579	3097	31.40	25.28
62	Anuradhapura	Kahatagas digiliya	366.6055	33572	8619	0	33572	0	19.63	20.03
63	Kalutara	Beruwala	71.6785	144733	29635	33096	111637	0	22.10	28.20
64	Rathnapura	Nivithigala	157.9051	59092	13989	0	47942	11150	32.80	17.57
65	Kalutara	Millaniya	82.0638	44476	11035	0	43110	1366	16.90	30.71
66	Ampara	Ampara	139.2692	38166	8713	17957	20209	0		30.45
67	Kilinochchi	Poonakary	558.4683							
68	Matara	Malimbada	47.9781	31524	7577	0	31384	140	24.30	31.38
69	Ampara	Ninthavur	36.3016	24625	6235	0	24625	0		22.78
70	Kalutara	Bandaragama	57.4085	86886	20579	0	86886	0	8.20	37.31
71	Rathnapura	Eheliyagoda	141.9292	63870	15566	0	61593	2277	26.90	26.60
72	Galle	Thawalama	174.1470	31803	7710	0	30789	1014	29.50	19.99
73	Ampara	Addalachchenai	56.9586	36020	7640	0	36020	0		17.64
74	Rathnapura	Kiriella	79.5653	30881	7666	0	29748	1133	25.60	26.58
75	Jaffna	Karaveddy	90.6898							
76	Puttalam	Puttalam	178.4049	71091	15898	41761	29330	0	25.08	21.59
77	Ampara	Lahugala	923.3049	7623	1888	0	7623	0		15.57
78	Galle	Elpitiya	151.2593	60292	15049	0	58153	2139	22.70	26.49
79	Ampara	Thirukkovil	187.0859	23700	5427	0	23700	0		20.88
80	Polonnaruwa	Elahera	353.1772	39908	10446	0	39908	0	18.45	17.46
81	Ampara	Samanthurai	123.0101	51510	11729	0	51510	0		20.13
82	Colombo	Kolonnawa	26.0388	161247	35803	56396	104851	0	8.20	35.95
83	Puttalam	Chilaw	93.6034	59890	14448	23533	36357	0	20.11	21.74
84	Matara	Matara	56.1514	108238	23705	42663	65575	0	16.90	42.45
85	Batticaloa	Porativu Pattu	174.9570							
86	Kalutara	Madurawala	62.9158	29750	7552	0	27129	2621	18.60	34.30
87	Matara	Hakmana	49.6219	30201	7190	0	30201	0	32.00	29.15
88	Hambantota	Walasmulla	109.0750	39010	9443				33.40	23.96
89	Matara	Kaburupitiya	59.7187	37347	9079	0	37347	0	24.90	31.28
90	Puttalam	Kalpitiya	158.7548	81780	18185	0	81627	153	45.34	13.63
91	Puttalam	Nattandiya	75.3430	57686	14528	0	57535	151	15.54	28.96
92	Anuradhapura	Thambuttegama	111.4855	36524	9448	0	36524	0	19.05	22.52
93	Puttalam	Mahawewa	75.3055	48861	12600	0	48405	456	14.78	26.88
94	Mannar	Nanaddan	147.6092							
95	Kalutara	Ingiriya	94.0498	45726	11314	0	43590	2136	17.40	26.56
96	Polonnaruwa	Medirigiriya	570.3679	57899	15189	0	57899	0	13.37	14.73
97	Kalutara	Agalawatta	89.7814	33962	8423	0	32768	1194	26.40	33.03
98	Jaffna	Chankanai	48.0547							
99		Koralai P.W. (Oddamavadi)	39.1499							
100	Matara	Athuraliya	65.9339	30179	7039	0	29380	799	27.80	26.77
101	Ampara	Eragama	66.6480	11344	2632	0	11344	0		13.35
102	Gampaha	Kelaniya	21.9313	134364	30272	29820	104544	0	6.90	41.85
103	Jaffna	Uduvil	32.3749							
104	Galle	Neluwa	152.2868	27501	6445	0	27251	250	33.40	16.54

Land Use			Sector Specific Data					DSD Name	Rank
Agriculture Land Area (Acres)[d]	Forest Land (Acres)[d]	Other Land Uses (Acres)[a]	Main Roads	Secondary Roads[e]	Rail Roads[e]	Other Roads (km)[e]	Road Density[a **]		
5288	235	13671.544	48.12	82.86	12.76	125.56	1.85	Kaluthara	49
2380	26	35030.188	15.25	7.39	0.00	288.57	0.15	Kinniya	50
15827	690	11764.261	46.49	38.74	0.00	229.68	0.74	Baddegama	51
3781	51	63338.632	28.18	13.13	0.00	114.07	0.15	Pothuvil	52
8883	619	23699.538	38.53	65.72	0.00	172.38	0.78	Mathugama	53
12883	173	16003.109	27.98	41.10	0.00	178.57	0.59	Udubaddawa	54
17182	1105	28599.743	0.00	105.24	0.00	208.99	0.55	Suriyawewa	55
15808	2009	52171.122	24.30	43.94	0.00	272.90	0.24	Palindanuwara	56
2177	1	11470.561	10.85	51.68	0.00	205.44	1.13	Kayts	57
13890	1322	104268.005	45.73	38.14	0.00	235.22	0.17	Bibila	58
11959	593	24171.836	26.20	23.61	0.00	153.91	0.34	Akuressa	59
3924	524	22576.736	45.96	28.57	13.24	171.56	0.80	Ella	60
18416	1700	32567.808	32.11	54.42	0.00	239.56	0.41	Walallawita	61
16808	1198	72583.820	53.29	34.14	0.08	408.95	0.24	Kahatagas digiliya	62
6334	377	11001.073	18.87	88.49	13.57	125.38	1.69	Beruwala	63
8266	855	29898.032	20.80	52.45	0.00	163.10	0.46	Nivithigala	64
7087	226	12965.324	5.60	64.00	0.00	129.33	0.85	Millaniya	65
7808	800	25806.026	40.70	28.38	0.00	262.10	0.50	Ampara	66
8314	254	129431.960	53.24	5.54	0.00	693.10	0.11	Poonakary	67
5631	135	6089.610	11.54	30.04	0.00	52.51	0.87	Malimbada	68
4650	1	4319.288	7.34	41.07	0.00	20.46	1.33	Ninthavur	69
4220	150	9815.890	22.58	36.41	0.00	115.02	1.03	Bandaragama	70
10422	639	24010.328	26.32	59.66	0.00	164.22	0.61	Eheliyagoda	71
15974	1032	26026.489	34.91	32.90	0.00	98.89	0.39	Thawalama	72
4981	30	9063.721	8.22	29.90	0.00	70.64	0.67	Addalachchenai	73
7472	483	11705.932	24.37	30.63	0.00	69.61	0.69	Kiriella	74
2868	16	19525.858	25.27	48.44	0.00	135.45	0.81	Karaveddy	75
5189	965	37930.636	38.46	17.79	19.14	209.65	0.42	Puttalam	76
4668	234	223250.691	19.50	13.58	0.00	321.23	0.04	Lahugala	77
18602	1040	17734.834	30.76	46.66	0.00	225.02	0.51	Elpitiya	78
3218	4	43007.751	20.43	11.45	0.00	155.45	0.17	Thirukkovil	79
16695	938	69638.639	6.05	26.09	0.00	312.27	0.09	Elahera	80
11201	2	19193.342	27.26	20.52	0.00	158.81	0.39	Samanthurai	81
770	32	5632.309	8.98	75.75	5.70	21.33	3.47	Kolonnawa	82
7252	316	15561.806	24.88	28.40	13.29[e]	111.79	0.71	Chilaw	83
3948	133	9794.253	26.38	75.77	4.76	59.07	1.90	Matara	84
9812	59	33361.652	20.23	17.78	0.00	354.83	0.22	Porativu Pattu	85
4409	274	10863.781	0.00	64.64	0.00	57.52	1.03	Madurawala	86
8445	196	3620.786	23.43	12.62	0.00	53.02	0.73	Hakmana	87
15179	631	11142.899	14.62	49.30	0.00	122.45	0.59	Walasmulla	88
8089	223	6444.750	20.99	16.95	0.00	46.37	0.64	Kaburupitiya	89
8480	265	30484.011	38.53	12.62	0.00	177.43	0.32	Kalpitiya	90
7597	71	10949.595	22.56	58.39	7.42	150.60	1.17	Nattandiya	91
13844	240	13464.567	34.43	7.14	14.56	272.48	0.50	Thambuttegama	92
5354	56	13198.323	15.00	55.51	5.10	123.92	1.00	Mahawewa	93
8591	64	27819.887	12.02	14.14	18.99	166.95	0.31	Nanaddan	94
6464	552	16224.130	21.97	32.86	0.00	129.62	0.58	Ingiriya	95
25240	1544	114156.408	0.00	32.23	7.22	712.58	0.07	Medirigiriya	96
8113	716	13356.368	6.12	39.88	0.00	86.36	0.51	Agalawatta	97
2405	2	9467.527	21.75	31.71	0.00	134.16	1.11	Chankanai	98
2018	2	7654.124	7.23	21.79	8.38	29.50	0.54	Koralai P.W. (Oddamavadi)	99
6707	382	9203.549	8.52	28.26	0.00	87.76	0.56	Athuraliya	100
2878	2	13589.023	21.54	12.66	0.00	107.55	0.51	Eragama	101
472	17	4930.320	14.79	73.91	5.21	22.90	4.28	Kelaniya	102
1356	1	6642.972	8.69	37.16	4.47	96.52	1.55	Uduvil	103
15570	886	21174.734	17.68	14.46	0.00	99.04	0.21	Neluwa	104

Rank	District Name	DSD Name	Physical Characteristics Area (Sq. km)[a]	Total Population[b]	No. of Households[b]	Demographics Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
105	Kalutara	Panadura	45.0310	163492	37245	33514	129978	0	7.40	40.07
106	Matara	Thihagoda	50.9425	30909	7529	0	30909	0	27.20	30.07
107	Kurunegala	Rasnayakapura	125.8909	18814	5071	0	18678	136	23.00	20.46
108	Jaffna	Delft	47.4332							
109	Jaffna	Point Pedro	36.9669							
110	Puttalam	Wennappuwa	40.9400	70817	18180	0	70487	330	14.88	25.79
111	Galle	Welivitiya-Divithura	54.9823	26599	6622	0	25059	1540	25.50	23.29
112	Ampara	Kalmunai	19.6568	70465	15821	70465	0	0		28.44
113	Ampara	Karativu	8.9392	16365	3641	0	16365	0		28.99
114	Colombo	Colombo	17.8538	380946	70735	380946	0	0	12.10	32.53
115	Colombo	Sri Jayawardana pura Kotte	16.5150	116366	25822	116366	0	0	2.70	55.07
116	Colombo	Moratuwa	19.2051	177563	41282	177563	0	0	10.30	40.58
117	Colombo	Thimbirigasyaya	22.3754	266154	52397	266154	0	0	4.40	49.35
118	Colombo	Rathmalana	13.1472	108716	25013	108716	0	0	4.20	47.88
119	Jaffna	Jaffna	10.6967							

** except cart tracks and foot paths

Land Use			Sector Specific Data					DSD Name	Rank
Agriculture Land Area (Acres)[d]	Forest Land (Acres)[d]	Other Land Uses (Acres)[a]	Main Roads [e]	Secondary Roads [e]	Rail Roads [e]	Other Roads (km) [e]	Road Density [a **]		
2001	68	9058.369	21.56	84.84	8.16	82.70	2.54	Panadura	105
6608	118	5862.125	15.94	10.96	0.00	52.46	0.53	Thihagoda	106
9723	2099	19286.197	3.48	29.43	0.00	226.36	0.26	Rasnayakapura	107
614	35	11071.946	0.00	37.11	0.00	107.61	0.78	Delft	108
1111	6	8017.695	18.93	28.42	0.00	94.57	1.28	Point Pedro	109
2494	39	7583.446	13.84	58.14	10.82	93.56	2.02	Wennappuwa	110
7271	306	6009.376	8.90	26.45	0.00	133.71	0.64	Welivitiya-Divithura	111
0	0	4857.293	6.86	50.62	0.00	43.02	2.92	Kalmunai	112
796	2	1410.914	5.54	17.57	0.00	7.79	2.59	Karativu	113
0	0	4411.760	11.45	105.21	21.00	0.18	7.71	Colombo	114
0	0	4080.936	4.63	72.65	3.42	1.48	4.89	Sri Jayawardanapura Kotte	115
0	26	4719.672	17.05	72.98	10.69	2.21	5.24	Moratuwa	116
0	0	5529.063	18.55	131.50	14.36	1.97	7.35	Thimbirigasyaya	117
0	0	3248.735	5.00	65.36	7.94	1.98	5.96	Rathmalana	118
65	12	2566.207	12.04	59.60	4.84	23.64	7.15	Jaffna	119

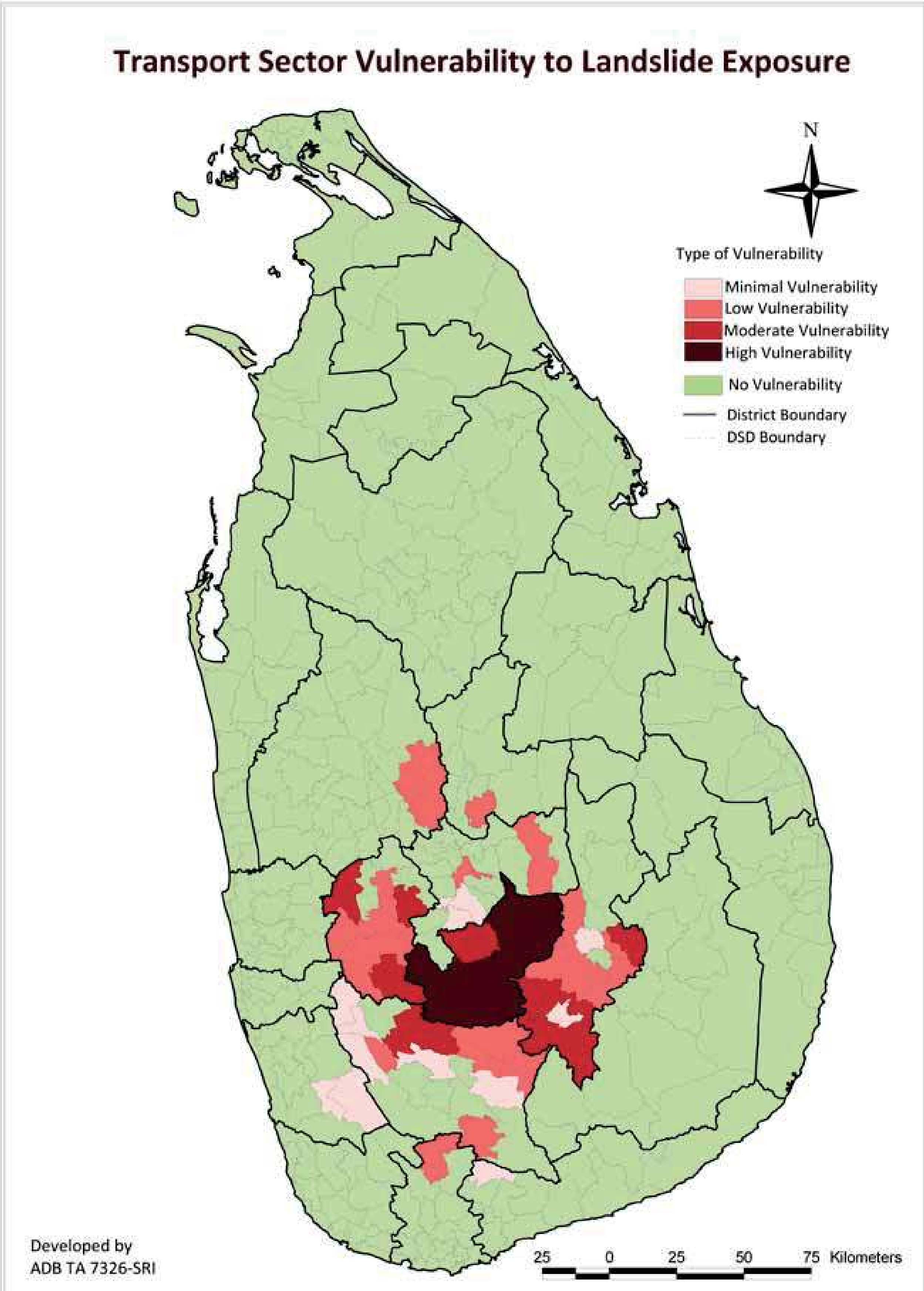
Vulnerability of the Transport Sector to Landslide Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • Length of main roads • Length of secondary roads • Length of rail	• Road density (length of main roads, secondary roads, and rail roads per square kilometre in each DSD.
Sources of data: 1:50,000 map sheets from Survey Dept. of Sri Lanka	

Some of the key findings include:

- Vulnerability of transport infrastructure to landslides is expected increase in frequency and intensity and is focused mainly in the central hills.
- The four highly vulnerable DSDs that emerge from the analysis in this regard are all in the Nuwara Eliya District. These DSDs have 439 km of main roads, 366 km of secondary roads, and 66 km of railroads.
- Within the Nuwara Eliya District, the Nuwara Eliya DSD alone has 46.7 km of railroads.
- 9 DSDs fall into the moderately vulnerable category, and collectively have 419 km of main roads, 615 km of secondary roads, and 28 km of railroads.



Transport Sector Vulnerability to Landslide Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Transport Sector Vulnerability to Landslide Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Nuwara Eliya	Walapane	321.5229	106434	331	26645	0	66727	39707	26.50	15.66
2	Nuwara Eliya	Nuwara Eliya	483.5716	208190	431	49385	28869	36922	142399	21.90	18.93
3	Nuwara Eliya	Ambagamuwa	487.9105	203717	418	47145	14204	47474	142039	22.90	16.74
4	Nuwara Eliya	Hanguranketha	228.6220	87760	384	22524	0	74355	13405	34.60	19.18
5	Badulla	Haldummulla	414.9996	38223	92	9855	0	23207	15016	31.65	18.09
6	Badulla	Bandarawela	70.0596	60269	860	14379	7296	44049	8924	21.61	32.66
7	Badulla	Lunugala	141.8095	33079	233	8260	0	14585	18494	38.82	13.78
8	Kegalle	Deraniyagala	222.0806	44735	201	11336	0	34377	10358	33.60	19.57
9	Nuwara Eliya	Kothmale	223.7228	97509	436	23841	0	58181	39328	22.30	19.01
10	Rathnapura	Rathnapura	326.7894	115223	353	26549	45623	53219	16381	21.90	30.01
11	Badulla	Welimada	193.9032	94399	487	22838	0	84180	10219	29.19	28.14
12	Kegalle	Aranayaka	124.4190	66198	532	16850	0	64894	1304	36.10	29.31
13	Kegalle	Warakapola	195.5200	106038	542	26503	0	103087	2951	26.00	30.93
14	Rathnapura	Elapatha	86.8547	36322	418	8828	0	34219	2103	40.10	22.39
15	Badulla	Ella	109.3657	42894	392	10775	0	29156	13738	28.04	21.90
16	Badulla	Hali Ela	170.1437	87476	514	21835	0	58715	28761	34.58	24.29
17	Rathnapura	Balangoda	274.1594	77303	282	18720	11402	58032	7869	27.30	27.22
18	Kegalle	Kegalle	109.0590	87637	804	21327	17139	68733	1765	26.70	37.80
19	Badulla	Passara	135.9205	49190	362	12245	0	29457	19733	31.88	19.27
20	Rathnapura	Imbulpe	255.2644	55546	218	14086	660	46388	8498	32.00	24.58
21	Kegalle	Dehiovita	193.2396	73991	383	18460	0	62883	11108	29.30	24.21
22	Badulla	Kandaketiya	152.6207	22494	147	5425	0	21428	1066	46.10	14.56
23	Badulla	Uva Paranagama	137.2816	76524	557	19213	0	65809	10715	33.35	19.52
24	Kurunegala	Ibbagamuwa	219.4878	76344	348	19589	0	75913	431	24.30	26.50
25	Kurunegala	Rideegama	222.5431	80473	362	21118	0	78808	1665	32.76	26.28
26	Kegalle	Ruwanwella	138.6165	58892	425	14461	0	54679	4213	28.50	28.11
27	Kegalle	Yatiyanthota	178.0749	57239	321	14197	0	45071	12168	30.10	23.81
28	Matara	Kotapola	179.3289	64012	357	15073	0	51875	12137	22.60	15.42
29	Kegalle	Bulathkohupitiya	127.2471	45573	358	11729	0	37396	8177	32.50	22.74
30	Matale	Rattota	105.2255	49382	469	13068	0	40015	9367	23.40	25.32
31	Kandy	Gangawata Korale	58.6941	160630	2737	33196	104252	54472	1906	10.10	48.49
32	Kandy	Udadumbara	277.0667	22831	82	6001	0	21322	1509	37.50	17.35
33	Rathnapura	Kolonna	183.0319	43693	239	10661	0	38930	4763	37.70	14.65
34	Rathnapura	Eheliyagoda	141.9292	63870	450	15566	0	61593	2277	26.90	26.60
35	Kandy	Udapalatha	90.6003	86145	951	19936	24116	48242	13787	21.40	29.35
36	Kalutara	Palindanuwara	283.2330	45911	162	11597	0	40298	5613	30.70	22.88
37	Badulla	Haputhale	70.3267	50735	721	11565	3235	29372	18128	24.42	29.37
38	Rathnapura	Pelmadulla	144.8430	84966	587	19906	560	73480	10926	30.20	26.35
39	Hambantota	Katuwana	103.7065	41392	399	10025	0	62344	0	34.30	17.11
40	Rathnapura	Weligepola	203.5279	29099	143	7690	0	28720	379	39.20	19.60
41	Kandy	Doluwa	100.1685	45270	452	11651	0	37392	7878	26.50	21.04
42	Badulla	Soranathota	80.8879	22760	281	5667	0	18160	4600	34.24	17.35
43	Rathnapura	Ayagama	157.6893	28637	182	7357	0	25160	3477	33.70	21.37
44	Kalutara	Agalawatta	89.7814	33962	378	8423	0	32768	1194	26.40	33.03
45	Rathnapura	Kiriella	79.5653	30881	388	7666	0	29748	1133	25.60	26.58

** Not considering other roads

Land Use			Sector Specific Data					DSD Name	Rank
Agriculture Land Area (Acres)[d]	Forest Land (Acres)[d]	Other Land Uses (Acres)[a]	Main Roads[e]	Secondary Roads[e]	Rail Roads[e]	Other Roads (km)[e]	Road Density[a] **		
14588	1800	63061.710	80.71	87.65	0.00	603.54	0.52	Walapane	1
3201	58	116233.668	142.53	124.28	46.69	1128.37	0.65	Nuwara Eliya	2
6636	785	113143.835	167.25	69.72	19.61	1148.92	0.53	Ambagamuwa	3
15713	1063	39717.508	48.51	83.90	0.00	336.82	0.58	Hanguranketha	4
7817	2144	92587.227	49.72	56.43	0.00	321.31	0.26	Haldummulla	5
3397	347	13568.033	34.72	35.27	10.43	143.18	1.15	Bandarawela	6
3286	609	31146.756	31.41	72.02	0.00	111.47	0.73	Lunugala	7
9068	1172	44637.099	17.48	98.77	0.00	326.11	0.52	Deraniyagala	8
10275	894	44113.894	90.02	85.76	0.00	547.92	0.79	Kothmale	9
13687	1504	65560.086	57.85	51.82	0.00	349.72	0.34	Rathnapura	10
13340	205	34369.327	69.89	67.07	17.84	243.47	0.80	Welimada	11
12715	310	17719.472	23.29	51.45	0.00	182.66	0.60	Aranayaka	12
19215	608	28490.839	44.93	96.65	0.00	223.46	0.72	Warakapola	13
6328	529	14605.175	0.00	54.37	0.00	77.08	0.63	Elapatha	14
3924	524	22576.736	45.96	28.57	13.24	171.56	0.80	Ella	15
8278	814	32951.244	48.91	65.88	11.31	456.20	0.74	Hali Ela	16
13208	1569	52968.986	38.78	83.62	0.00	260.98	0.45	Balangoda	17
11129	321	15498.956	35.59	73.68	0.00	104.81	1.00	Kegalle	18
5303	889	27394.565	47.54	54.79	0.00	173.29	0.75	Passara	19
10523	1663	50890.955	43.53	47.57	0.00	328.90	0.36	Imbulpe	20
10718	947	36085.352	39.69	68.35	0.00	310.71	0.56	Dehiovita	21
6757	981	29975.243	13.97	42.24	0.00	180.78	0.37	Kandaketiya	22
13010	322	20590.887	17.45	54.90	0.00	301.20	0.53	Uva Paranagama	23
21146	516	32574.410	40.44	75.41	0.00	249.93	0.53	Ibbagamuwa	24
23601	860	30530.380	38.46	63.02	0.00	317.44	0.46	Rideegama	25
12004	725	21523.745	41.63	68.78	0.00	154.97	0.80	Ruwanwella	26
7957	818	35228.090	47.70	40.16	0.00	250.65	0.49	Yatiyanthota	27
11602	312	32398.968	31.72	49.95	0.00	125.74	0.46	Kotapola	28
7532	497	23414.313	31.21	33.10	0.00	183.85	0.51	Bulathkohupitiya	29
6670	364	18967.687	40.52	51.80	0.00	164.37	0.88	Rattota	30
2190	222	12091.582	43.71	100.48	11.81	44.06	2.66	Gangawata Korale	31
9919	1867	56678.392	16.68	68.12	0.00	205.86	0.31	Udadumbara	32
13366	2560	29301.996	46.73	41.51	0.00	161.37	0.48	Kolonna	33
10422	639	24010.328	26.32	59.66	0.00	164.22	0.61	Eheliyagoda	34
5485	347	16555.725	47.24	50.35	5.51	204.49	1.14	Udapalatha	35
15808	2009	52171.122	24.30	43.94	0.00	272.90	0.24	Palindanuwara	36
2120	198	15060.030	21.37	52.60	13.31	133.91	1.24	Haputhale	37
10329	619	24843.341	28.00	36.72	0.00	209.80	0.45	Pelmadulla	38
13335	938	11353.332	18.48	30.54	0.00	127.78	0.47	Katuwana	39
12565	1232	36495.627	20.22	27.27	0.00	162.44	0.23	Weligepola	40
5796	907	18049.082	39.01	28.21	0.00	224.91	0.67	Doluwa	41
3999	746	15242.744	10.22	43.91	0.00	137.70	0.67	Soranathota	42
9520	1255	28190.717	0.00	44.31	0.00	142.38	0.28	Ayagama	43
8113	716	13356.368	6.12	39.88	0.00	86.36	0.51	Agalawatta	44
7472	483	11705.932	24.37	30.63	0.00	69.61	0.69	Kiriella	45

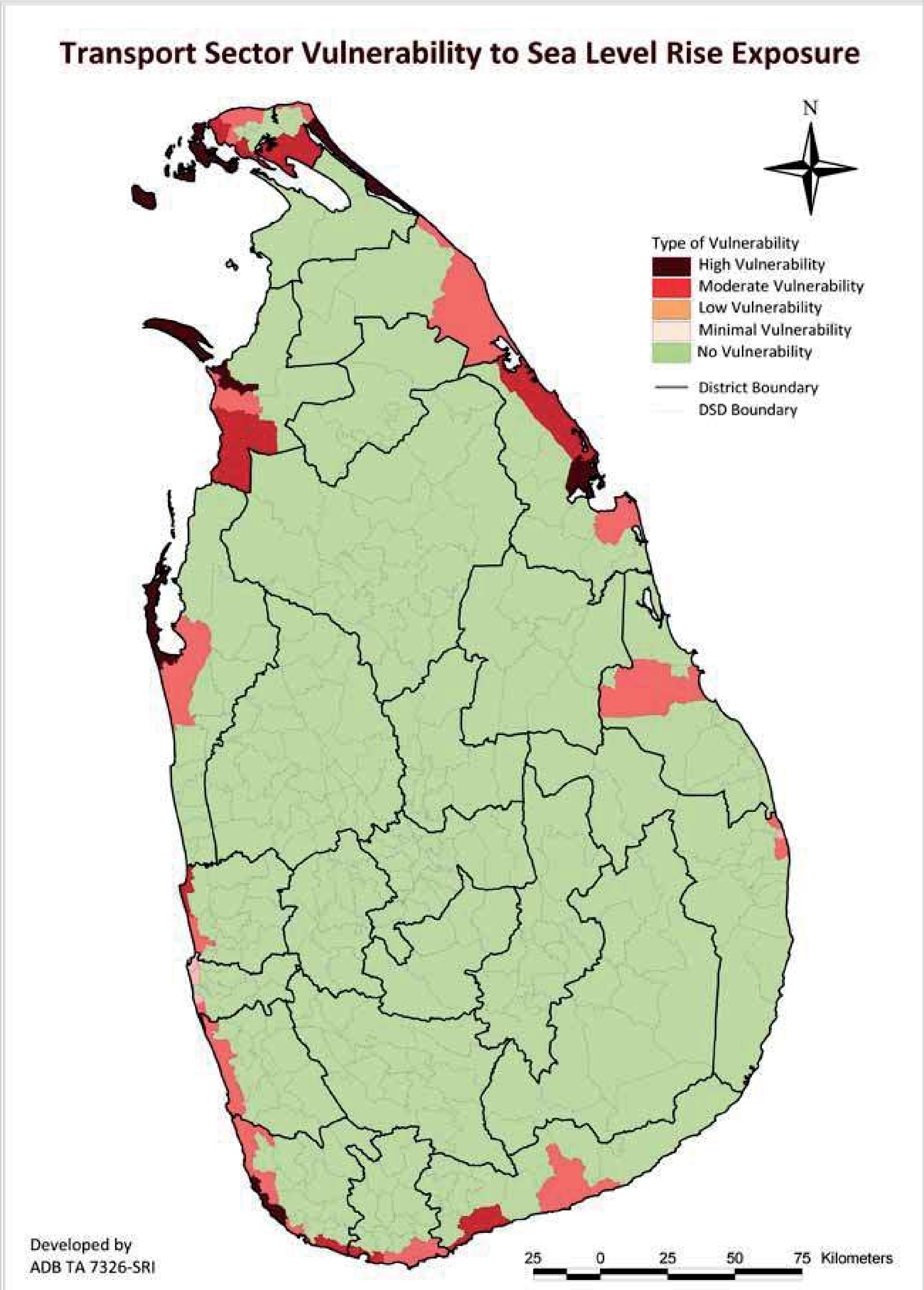
Vulnerability of the Transport Sector to Sea Level Rise Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • Length of main roads within 500m from shoreline • Length of secondary roads within 500m of shoreline • Length of railroads within 500m of shoreline	• Road density (length of main roads, secondary roads, and rail roads per square kilometre in each DSD.
Sources of data: 1:50,000 map sheets from Survey Dept. of Sri Lanka	

Some of the key findings include:

- Vulnerability of the transport sector to sea level rise impacts due to climate change is highest in the Northern and South-western coastal region of the island. The impact of sea level rise could be critical to national development as a substantial segment of our national transportation network runs parallel to the coastline.
- 8 DSDs emerge as being highly vulnerable based on the analysis. These DSDs combined have 117 km of main roads, 183 km of secondary roads, and 38 km of railroads all within 500 m from the coastline.
- The 10 DSDs that fall in the moderately vulnerable category together have another 75 km of main roads, 143 km of secondary roads, and 24 km of railroads, again within 500 m from the coastline.
- Of the 14 DSDs in Jaffna District, 4 are highly vulnerable, while another 4 are moderately vulnerable making it one of the most vulnerable districts overall. Jaffna is an area where substantial investments are expected to be expended over the next few years.


Transport Sector Vulnerability to Sea Level Rise Exposure
N
Type of Vulnerability
High Vulnerability
Moderate Vulnerability
Low Vulnerability
Minimal Vulnerability
No Vulnerability
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Transport Sector Vulnerability to Sealevel Rise Exposure

High Vulnerability — Moderate Vulnerability — Low Vulnerability — Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Jaffna	Velanai	85.4797								
2	Trincomalee	Town & Gravets	132.1348								
3	Jaffna	Delft	47.4332								
4	Jaffna	Kayts	55.2340								
5	Mannar	Mannar Town	207.1215								
6	Jaffna	Maruthnkerny	135.0921								
7	Galle	Hikkaduwa	66.0971	98589	1492	22820	0	98539	50	24.90	33.61
8	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
9	Trincomalee	Kuchaveli	434.4600								
10	Jaffna	Jaffna	10.6967								
11	Galle	Habaraduwa	49.5183	59041	1192	13567	0	59041	0	28.70	29.53
12	Matara	Weligama	43.1469	66459	1540	14825	21698	44761	0	21.50	30.48
13	Jaffna	Chankanai	48.0547								
14	Jaffna	Chavakachcheri	222.1802								
15	Gampaha	Negombo	46.1424	144274	3127	31915	121413	22861	0	7.10	30.04
16	Jaffna	Nallur	34.4074								
17	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
18	Mannar	Musalai	478.8201								
19	Kalutara	Kaluthara	77.6779	141829	1826	31857	37451	104378	0	12.50	38.35
20	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
21	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20
22	Jaffna	Point Pedro	36.9669								
23	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
24	Jaffna	Tellipallai	61.1745								
25	Galle	Balapitiya	54.5727	65346	1197	15054	0	65346	0	22.00	27.89
26	Matara	Devinuwara	37.6183	44199	1175	9988	0	44199	0	20.90	26.80
27	Mulattivu	Maritimepattu	756.2531								
28	Gampaha	Wattala	57.6911	160127	2776	36368	28740	131387	0	6.10	40.21
29	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
30	Galle	Bentota	72.3358	46442	642	11015	0	46442	0	22.30	31.14
31	Galle	Galle Four Gravets	23.7565	103246	4346	19425	90270	12976	0	19.30	39.96
32	Batticaloa	Koralai Pattu (Valach.)	593.7964								
33	Trincomalee	Muttur	194.6406								
34	Matara	Matara	56.1514	108238	1928	23705	42663	65575	0	16.90	42.45
35	Colombo	Moratuwa	19.2051	177563	9246	41282	177563	0	0	10.30	40.58
36	Galle	Ambalangoda	70.2467	71047	1011	17122	39302	51396	0	20.30	32.73
37	Matara	Dickwella	50.9687	51314	1007	11592	0	51314	0	22.70	31.87
38	Mannar	Nanaddan	147.6092								
39	Kalutara	Panadura	45.0310	163492	3631	37245	33514	129978	0	7.40	40.07
40	Jaffna	Sandilipay	48.1604								
41	Ampara	Ninthavur	36.3016	24625	678	6235	0	24625	0		22.78
42	Ampara	Kalmunai	19.6568	70465	3585	15821	70465	0	0		28.44
43	Ampara	Karativu	8.9392	16365	1831	3641	0	16365	0		28.99
44	Colombo	Colombo	17.8538	380946	21337	70735	380946	0	0	12.10	32.53
45	Colombo	Rathmalana	13.1472	108716	8269	25013	108716	0	0	4.20	47.88
46	Colombo	Thimbirigasyaya	22.3754	266154	11895	52397	266154	0	0	4.40	49.35

** Not considering other roads

Land Use			Sector Specific Data					DSD Name	Rank
Agriculture Land Area (Acres)[d]	Forest Land (Acres)[d]	Other Land Uses (Acres)[a]	Main Roads[e]	Secondary Roads[e]	Rail Roads[e]	Other Roads (km)[e]	Road Density[a] **		
893	10	20219.397	21.94	26.88	0.00	157.30	0.98	Velanai	1
305	18	32328.078	17.70	42.98	8.43	98.75	0.86	Town & Gravets	2
614	35	11071.946	0.00	14.19	0.00	34.87	0.78	Delft	3
2177	1	11470.561	5.92	23.60	0.00	94.43	1.13	Kayts	4
3295	162	47723.622	19.04	13.00	5.69	52.53	0.67	Mannar Town	5
770	15	32596.854	0.00	50.60	0.00	63.09	0.49	Maruthnkerny	6
6512	300	9520.874	25.57	7.81	23.88	11.30	1.76	Hikkaduwa	7
8480	265	30484.011	27.25	4.10	0.00	67.53	0.32	Kalpitiya	8
1399	6	105951.968	0.00	34.60	0.00	121.82	0.17	Kuchaveli	9
65	12	2566.207	5.94	26.02	0.56	9.94	7.15	Jaffna	10
6562	209	5465.181	16.75	12.37	14.71	15.39	2.03	Habaraduwa	11
4315	111	6235.785	16.43	8.35	7.75	13.94	1.89	Weligama	12
2405	2	9467.527	7.18	2.16	0.00	20.87	1.11	Chankanai	13
9385	452	45064.714	9.73	9.45	0.58	95.40	0.88	Chavakachcheri	14
889	17	10495.985	12.09	18.91	0.00	12.44	2.21	Negombo	15
339	1	8162.207	1.38	3.64	0.88	20.46	2.39	Nallur	16
15465	1846	20372.810	5.99	20.46	0.00	14.56	0.91	Tangalle	17
358	45	117915.553	0.00	7.13	0.00	12.01	0.10	Musalai	18
5288	235	13671.544	5.95	11.41	11.55	7.57	1.85	Kaluthara	19
9087	1059	73618.859	8.12	2.95	0.00	18.17	0.39	Hambantota	20
6334	377	11001.073	8.54	10.49	6.94	14.36	1.69	Beruwala	21
1111	6	8017.695	12.64	6.48	0.00	23.78	1.28	Point Pedro	22
5189	965	37930.636	3.97	5.03	2.32	11.46	0.42	Puttalam	23
986	0	14130.499	15.83	4.33	1.68	14.81	1.46	Tellipallai	24
7227	93	6165.164	11.70	3.84	5.23	13.70	1.21	Balapitiya	25
3860	153	5282.647	4.04	6.15	0.00	3.29	0.84	Devinuwara	26
7826	99	178948.455	0.00	9.86	0.00	81.11	0.13	Maritimepattu	27
1498	140	12617.728	5.31	19.89	0.00	2.86	2.03	Wattala	28
10154	1183	48326.270	0.00	11.07	0.00	6.88	0.41	Mundalama	29
8597	240	9037.489	7.18	2.91	7.27	3.56	1.08	Bentota	30
1564	71	4235.335	12.58	12.59	3.32	5.17	3.83	Galle Four Gravets	31
9983	36	136710.706	0.00	4.59	0.00	10.12	0.14	Koralai Pattu (Valach.)	32
5562	23	42511.549	2.66	4.05	0.00	39.24	0.25	Muttur	33
3948	133	9794.253	7.04	10.78	0.00	7.20	1.90	Matara	34
0	26	4719.672	12.32	18.38	9.92	1.96	5.24	Moratuwa	35
10933	128	6297.275	3.36	2.32	0.91	1.56	1.03	Ambalangoda	36
6411	260	5923.599	7.71	1.48	0.00	8.90	0.96	Dickwella	37
8591	64	27819.887	0.00	0.78	3.44	12.14	0.31	Nanaddan	38
2001	68	9058.369	6.99	7.77	7.73	13.85	2.54	Panadura	39
2626	6	9268.638	5.77	1.56	0.00	9.79	1.58	Sandilipay	40
4650	1	4319.288	0.00	9.87	0.00	0.10	1.33	Ninthavur	41
0	0	4857.293	0.00	20.13	0.00	8.51	2.92	Kalmunai	42
796	2	1410.914	0.00	6.60	0.00		2.59	Karativu	43
0	0	4411.760	3.76	30.99	5.79		7.71	Colombo	44
0	0	3248.735	1.63	16.97	6.58		5.96	Rathmalana	45
0	0	5529.063	7.06	22.18	6.56		7.35	Thimbirigasyaya	46

Tourism

Tourism has been recognized as a high priority area capable of effectively driving the country's economic development. The Government's vision is to make Sri Lanka the most sought after tourist destination in South Asia. Tourism development in Sri Lanka has occurred in pockets throughout the country over the last several decades, but over 62% of the tourist hotels and about 41% of guesthouses/hotel rooms in the country are in the coastal zone. The main tourist areas on the coast were located in the Colombo City and Greater Colombo, the South-west coast, and the East coast. The country's positioning as a tourist destination, however, over the last decade has been shifting to a more diversified product base, with increasing emphasis on nature and cultural tourism inland. Nevertheless, the coastline will remain the focus of most major planned tourism developments in the foreseeable future, particularly considering the unexploited potential of the North and East which were effectively not marketed for the last 30 years.

The tourist industry in the coastal region would be heavily exposed to potential risks from sea level rise, storm surges and related coastal flooding. In these areas, tourist hotels are concentrated along the beach, where setbacks may not be adequate to address sea level rise, or are not adequately enforced to ensure safety from storms and hurricanes. Left unaddressed, this could result in loss of assets, tourism revenue, and employment opportunities as climate change impacts worsen. The impacts of more frequent storms can accelerate coastal erosion and cause flooding and loss of prime land too. Areas with a concentration of tourism related infrastructure at present, as well as other areas projected for tourism development, are vulnerable.

Rising ocean temperatures and changing weather patterns could have substantial impacts on Sri Lanka's coastal habitats that underpin Sri Lanka's tourism product. Changing temperatures may negatively impact terrestrial forest cover, and the flora and fauna they contain, diminishing Sri Lanka's appeal to eco-tourists as a biodiversity hotspot. Energy consumption in the tourist industry may increase, as cooling requirements will increase with rising ambient temperatures.

Other climate change related natural disasters affecting the tourism industry include floods and landslides. Disruption of transportation networks due to these natural disasters can significantly impact the tourism sector when mobility is reduced periodically. In addition, areas affected by natural hazards frequently may be avoided by tourists. More details on climate change vulnerabilities to the tourism sector including vulnerability enhancing issues are provided in Section 2, Part II, *SVP on Urban Development, Human Settlements and Economic Infrastructure.*

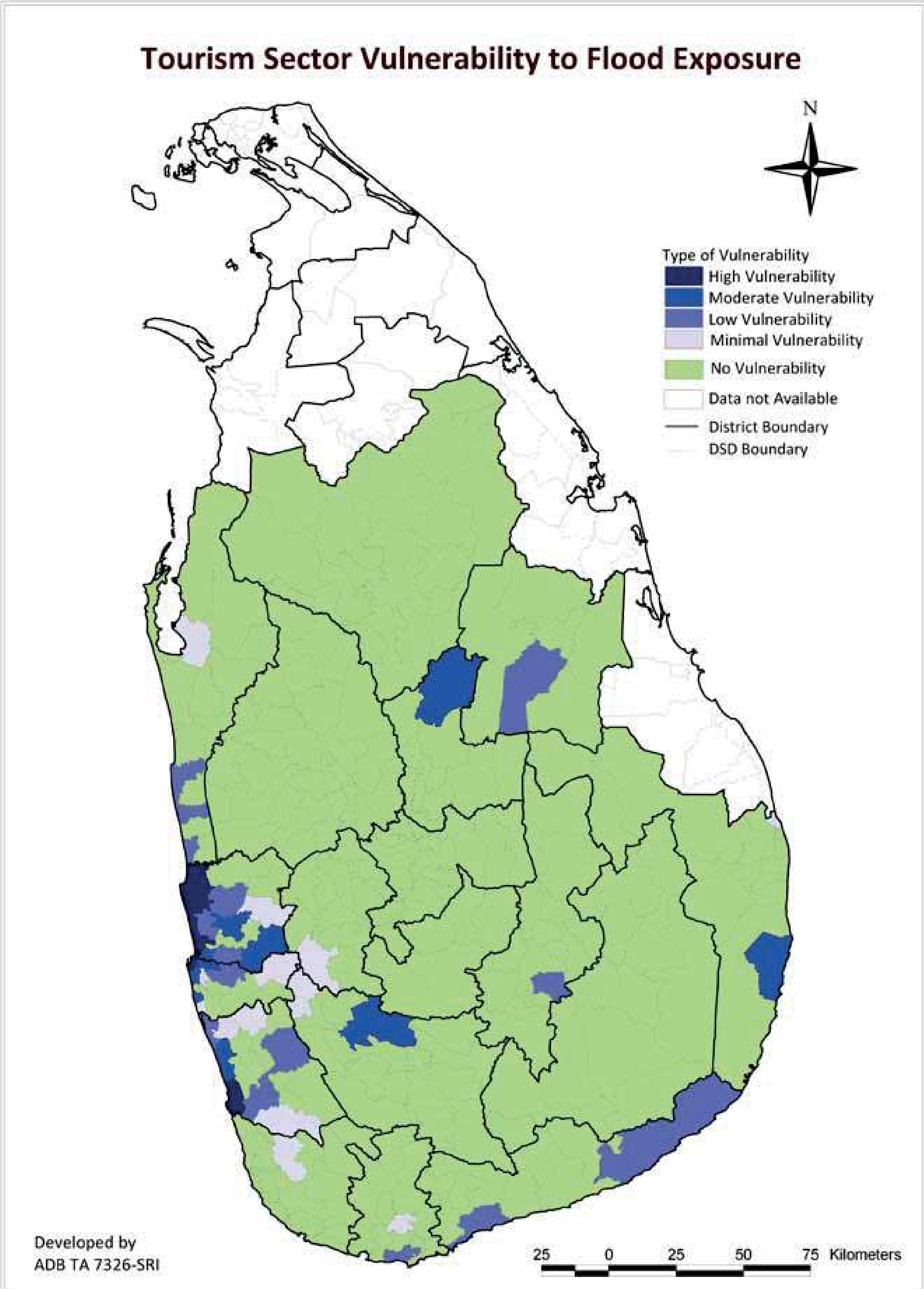
Vulnerability of the Tourism Sector to Flood Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • Percentage of livelihoods dependent on tourism • Total number of guestrooms in hotels/guesthouses	A composite of data (at DSD level) on: • percentage of people employed in sectors other than tourism • percentage of people who have completed secondary education • Number of hotels/guesthouses with over 15 room capacity
Data sources: 2001 National Census and SLTDA	

Some key findings include:

- Vulnerability of the tourism sector to the expected increase of floods due to climate change is generally focused in the Western region of the country, although pockets of moderate vulnerability can be found in several other areas.
- 5 DSDs are highly vulnerable. These 5 DSDs have:
    - 4,466 hotel rooms and 713 guest house rooms (30.5% and 12.6% of capacity in each category respectively).
    - 386,449 livelihoods of which 14,876 are directly dependent on tourism.
- Colombo DSD (Colombo District) is the most vulnerable, followed by Beruwala DSD (Kalutara District).
- 10 DSDs emerge as moderately vulnerable to flood exposure. These DSDs have:
    - 2,652 hotel rooms and 853 guest rooms (18.2% and 15.1% of total capacity in each category).
    - 13,699 jobs directly dependent on tourism.


Tourism Sector Vulnerability to Flood Exposure
N
Type of Vulnerability
High Vulnerability
Moderate Vulnerability
Low Vulnerability
Minimal Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Tourism Sector Vulnerability to Flood Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Colombo	Colombo	17.8538	380946	21337	70735	380946	0	0	12.10	32.53
2	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20
3	Gampaha	Katana	124.9577	222683	1782	50765	73318	149365	0	7.70	41.14
4	Gampaha	Negombo	46.1424	144274	3127	31915	121413	22861	0	7.10	30.04
5	Gampaha	Wattala	57.6911	160127	2776	36368	28740	131387	0	6.10	40.21
6	Matale	Dambulla	455.1342	60976	134	15285	0	60959	17	19.90	23.88
7	Colombo	Thimbirigasyaya	22.3754	266154	11895	52397	266154	0	0	4.40	49.35
8	Rathnapura	Rathnapura	326.7894	115223	353	26549	45623	53219	16381	21.90	30.01
9	Gampaha	Kelaniya	21.9313	134364	6127	30272	29820	104544	0	6.90	41.85
10	Kalutara	Kaluthara	77.6779	141829	1826	31857	37451	104378	0	12.50	38.35
11	Ampara	Pothuvil	271.8310	28480	105	6693	0	28480	0		13.45
12	Colombo	Kolonnawa	26.0388	161247	6193	35803	56396	104851	0	8.20	35.95
13	Colombo	Rathmalana	13.1472	108716	8269	25013	108716	0	0	4.20	47.88
14	Gampaha	Dompe	182.1586	130021	714	31962	0	130021	0	21.10	31.48
15	Gampaha	Gampaha	90.6959	171040	1886	41357	9284	161756	0	9.90	43.27
16	Gampaha	Biyagama	60.2668	161300	2676	36655	0	161300	0	11.30	41.68
17	Kalutara	Panadura	45.0310	163492	3631	37245	33514	129978	0	7.40	40.07
18	Gampaha	Ja-Ela	61.4202	184666	3007	42975	30791	153875	0	7.80	44.60
19	Puttalam	Wennappuwa	40.9400	70817	1730	18180	0	70487	330	14.88	25.79
20	Kalutara	Bulathsinhala	209.4387	59787	285	15611	0	53331	6456	27.40	22.09
21	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
22	Hambantota	Tissamaharama	783.8008	60982	78	14829	0	60486	496	32.20	22.31
23	Polonnaruwa	Thamankaduwa	465.7376	74224	159	17920	0	73956	268	14.15	28.23
24	Badulla	Ella	109.3657	42894	392	10775	0	29156	13738	28.04	21.90
25	Kalutara	Mathugama	134.3624	73269	545	17604	0	66781	6488	29.40	28.65
26	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
27	Puttalam	Mahawewa	75.3055	48861	649	12600	0	48405	456	14.78	26.88
28	Colombo	Kaduwela	87.7537	209251	2385	48849	0	209251	0	6.00	48.78
29	Matara	Matara	56.1514	108238	1928	23705	42663	65575	0	16.90	42.45
30	Gampaha	Minuwangoda	133.2225	151661	1138	37683	7567	144084	10	12.50	38.36
31	Gampaha	Attanagalla	154.3057	154967	1004	36838	0	154821	146	15.40	39.55
32	Colombo	Hanwella	145.8825	94001	644	22689	21601	66446	5954	14.20	34.61
33	Kalutara	Bandaragama	57.4085	86886	1513	20579	0	86886	0	8.20	37.31
34	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
35	Matara	Kaburupitiya	59.7187	37347	625	9079	0	37347	0	24.90	31.28
36	Ampara	Kalmunai	19.6568	70465	3585	15821	70465	0	0		28.44
37	Rathnapura	Eheliyagoda	141.9292	63870	450	15566	0	61593	2277	26.90	26.60
38	Galle	Elpitiya	151.2593	60292	399	15049	0	58153	2139	22.70	26.49
39	Kegalle	Dehiovita	193.2396	73991	383	18460	0	62883	11108	29.30	24.21
40	Kalutara	Walallawita	213.2047	50676	238	12793	0	47579	3097	31.40	25.28
41	Colombo	Moratuwa	19.2051	177563	9246	41282	177563	0	0	10.30	40.58
42	Kalutara	Horana	112.7795	90690	804	22048	9127	80042	1521	8.40	42.98
43	Colombo	Sri Jayawardanapura Kotte	16.5150	116366	7046	25822	116366	0	0	2.70	55.07

Land Use			Sector Specific Data					DSD Name	Rank
Agriculture Land Area (Acres)[d]	Forest Land (Acres)[d]	Other Land Uses (Acres)[a]	Livelihoods Dependent on Tourism[b]	% of Livelihoods Dependent on Tourism[a]	No. of Hotel Rooms in DS[f and a]	No. Guest House Rooms [f and a]	Total Rooms[a]		
0	0	4411.760	6480	4.71	1969	120	2089	Colombo	1
6334	377	11001.073	2651	6.44	1095	209	1304	Beruwala	2
6612	81	24184.605	1992	1.92	471	67	538	Katana	3
889	17	10495.985	2151	4.59	665	253	918	Negombo	4
1498	140	12617.728	1602	2.80	266	64	330	Wattala	5
22407	2218	87840.666	1161	4.41	560	88	648	Dambulla	6
0	0	5529.063	4157	3.87	1082	195	1277	Thimbirigasyaya	7
13687	1504	65560.086	732	1.62	53	25	78	Rathnapura	8
472	17	4930.320	1334	2.57	40	116	156	Kelaniya	9
5288	235	13671.544	1607	3.63	613	70	683	Kaluthara	10
3781	51	63338.632	146	2.48	23	25	48	Pothuvil	11
770	32	5632.309	1250	2.19	0	10	10	Kolonnawa	12
0	0	3248.735	1694	3.69	260	215	475	Rathmalana	13
20538	421	24053.187	485	1.12	21	20	41	Dompe	14
8491	77	13843.352	1133	1.89	0	89	89	Gampaha	15
4743	143	10006.193	1007	1.60	153	25	178	Biyagama	16
2001	68	9058.369	1456	2.64	304	133	437	Panadura	17
2368	43	12766.210	1356	2.02	0	56	56	Ja-Ela	18
2494	39	7583.446	547	2.27	240	52	292	Wennappuwa	19
16292	1202	34259.229	264	1.16	64	17	81	Bulathsinhala	20
15465	1846	20372.810	401	2.04	79	64	143	Tangalle	21
17224	1145	175311.632	490	2.53	64	64	128	Tissamaharama	22
18061	831	96193.798	515	2.00	162	56	218	Thamankaduwa	23
3924	524	22576.736	227	1.42	40	25	65	Ella	24
8883	619	23699.538	664	2.89	0	10	10	Mathugama	25
7252	316	15561.806	390	2.02	15	0	15	Chilaw	26
5354	56	13198.323	384	2.37	191	31	222	Mahawewa	27
3569	116	17999.317	1398	1.80	10	16	26	Kaduwela	28
3948	133	9794.253	624	2.01	56	71	127	Matara	29
16148	192	16579.853	845	1.55	57	33	90	Minuwangoda	30
15028	362	22739.604	1000	1.97	12	35	47	Attanagalla	31
8158	544	27346.217	826	2.37	14	57	71	Hanwella	32
4220	150	9815.890	381	1.33	0	9	9	Bandaragama	33
5189	965	37930.636	338	1.85	0	10	10	Puttalam	34
8089	223	6444.750	98	0.96	57	23	80	Kaburupitiya	35
0	0	4857.293	274	1.75	0	15	15	Kalmunai	36
10422	639	24010.328	343	1.51	0	22	22	Eheliyagoda	37
18602	1040	17734.834	298	1.44	0	19	19	Elpitiya	38
10718	947	36085.352	360	1.38	10	0	10	Dehiovita	39
18416	1700	32567.808	248	1.48	0	4	4	Walallawita	40
0	26	4719.672	1306	1.94	45	64	109	Moratuwa	41
10552	227	17089.315	452	1.38	0	36	36	Horana	42
0	0	4080.936	1066	2.44	0	20	20	Sri Jayawardanapura Kotte	43

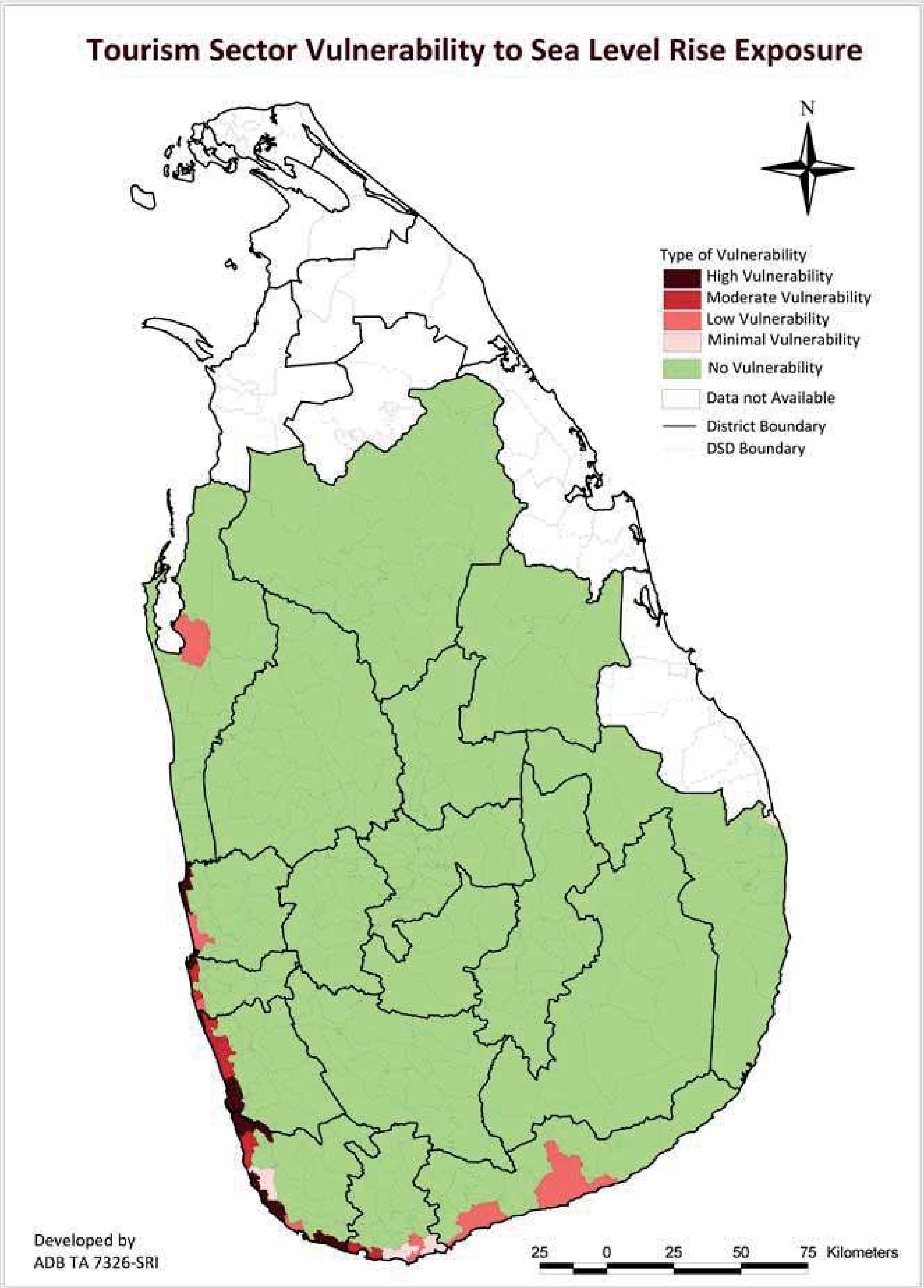
Vulnerability of the Tourism Sector to Sea Level Rise Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • Percentage of livelihoods dependent on tourism • Total number of guestrooms in hotels/guesthouses	A composite of data (at DSD level) on: • percentage of people employed in sectors other than tourism • percentage of people who have completed secondary education • Number of hotels/guesthouses with over 15 room capacity
Data sources: 2001 National Census and SLTDA	

Some key findings include:

- The tourism sector's vulnerability is concentrated along the Western and South-western coastline of Colombo, reflecting the concentration of tourism activities in these areas.
- 5 DSDs emerge as being highly vulnerable to potential sea level rise exposure. These 5 DSDs
    - o 4,960 hotel rooms and 895 guest rooms (34% and 15.8% of national capacity in each category.
    - o have 13,810 jobs directly dependent on tourism.
- A further 6 DSDs emerge as moderately vulnerable. These DSDs have:
    - o 2,928 hotel rooms and 808 guest rooms (20% and 14.3% of the total capacity in each category respectively).
    - o 9,715 livelihoods directly dependent on tourism.
- Complete and comparable data was not available for the North and East.
- The distribution of hotel rooms is likely to change substantially with planned new tourism developments in Kalpitiya (Puttalam District) and along the Eastern coastline. A planning scenario simulating 1,500 hotel rooms in Kalpitiya raised it to be one of the DSDs with its tourism sector most vulnerable to sea level rise exposure.

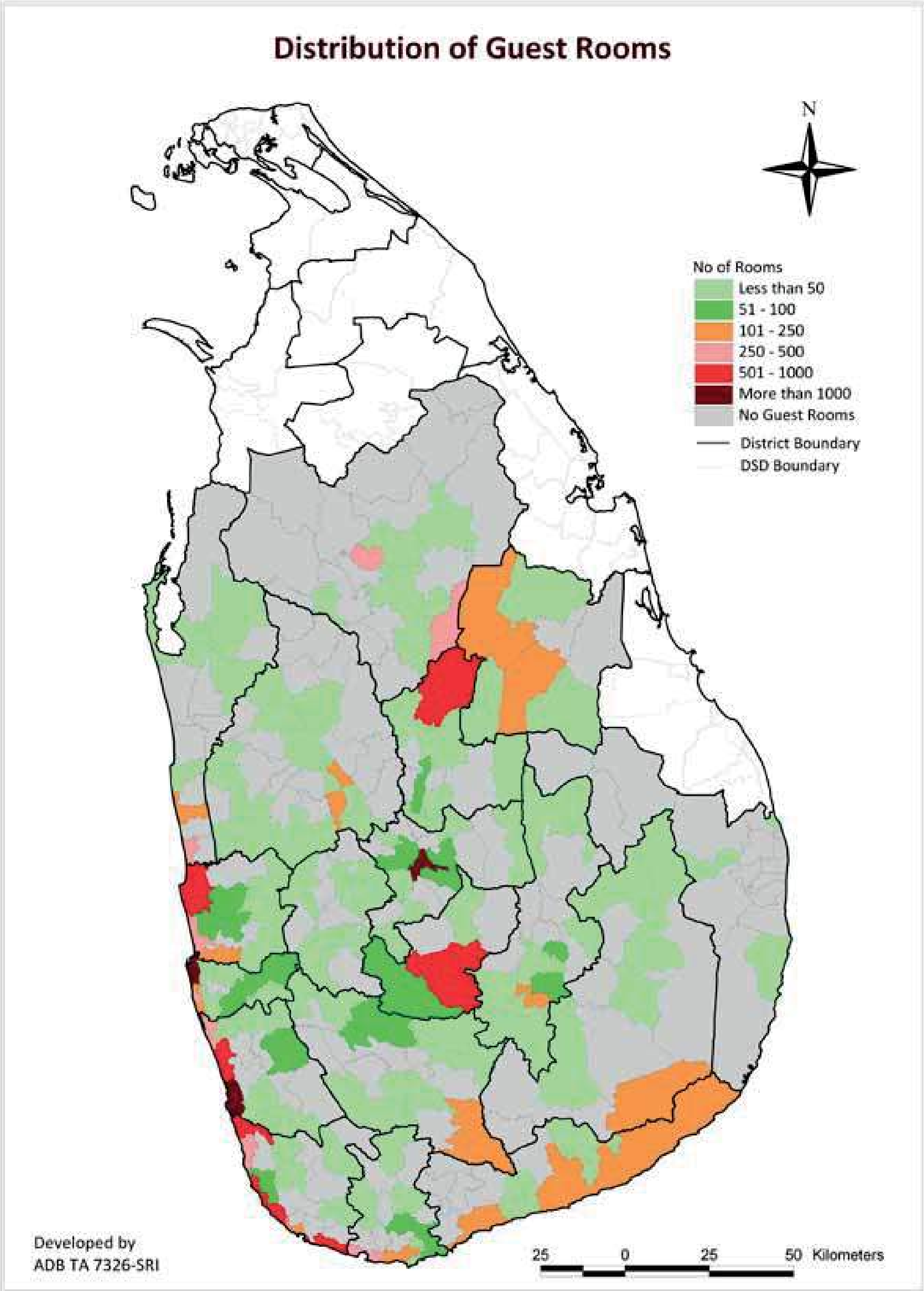

Tourism Sector Vulnerability to Sea Level Rise Exposure
N
Type of Vulnerability
High Vulnerability
Moderate Vulnerability
Low Vulnerability
Minimal Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Tourism Sector Vulnerability to Sea Level Rise Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Galle	Bentota	72.3358	46442	642	11015	0	46442	0	22.30	31.14
2	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20
3	Galle	Habaraduwa	49.5183	59041	1192	13567	0	59041	0	28.70	29.53
4	Gampaha	Negombo	46.1424	144274	3127	31915	121413	22861	0	7.10	30.04
5	Colombo	Colombo	17.8538	380946	21337	70735	380946	0	0	12.10	32.53
6	Galle	Hikkaduwa	66.0971	98589	1492	22820	0	98539	50	24.90	33.61
7	Colombo	Thimbirigasyaya	22.3754	266154	11895	52397	266154	0	0	4.40	49.35
8	Matara	Weligama	43.1469	66459	1540	14825	21698	44761	0	21.50	30.48
9	Colombo	Rathmalana	13.1472	108716	8269	25013	108716	0	0	4.20	47.88
10	Kalutara	Kaluthara	77.6779	141829	1826	31857	37451	104378	0	12.50	38.35
11	Galle	Balapitiya	54.5727	65346	1197	15054	0	65346	0	22.00	27.89
12	Kalutara	Panadura	45.0310	163492	3631	37245	33514	129978	0	7.40	40.07
13	Galle	Galle Four Gravets	23.7565	103246	4346	19425	90270	12976	0	19.30	39.96
14	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
15	Gampaha	Wattala	57.6911	160127	2776	36368	28740	131387	0	6.10	40.21
16	Colombo	Moratuwa	19.2051	177563	9246	41282	177563	0	0	10.30	40.58
17	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
18	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
19	Matara	Devinuwara	37.6183	44199	1175	9988	0	44199	0	20.90	26.80
20	Galle	Ambalangoda	70.2467	71047	1011	17122	39302	51396	0	20.30	32.73
21	Matara	Matara	56.1514	108238	1928	23705	42663	65575	0	16.90	42.45
22	Ampara	Kalmunai	19.6568	70465	3585	15821	70465	0	0		28.44
23	Matara	Dickwella	50.9687	51314	1007	11592	0	51314	0	22.70	31.87

Land Use			Sector Specific Data					DSD Name	Rank
Agriculture Land Area (Acres)[d]	Forest Land (Acres)[d]	Other Land Uses (Acres)[a]	Livelihoods Dependent on Tourism[b]	% of Livelihoods Dependent on Tourism[a]	No. of Hotel Rooms in DS[f and a]	No. Guest House Rooms[f and a]	Total Rooms[a]		
8597	240	9037.489	1601	12.00	766	90	856	Bentota	1
6334	377	11001.073	2651	6.44	1095	209	1304	Beruwala	2
6562	209	5465.181	927	5.08	465	223	688	Habaraduwa	3
889	17	10495.985	2151	4.59	665	253	918	Negombo	4
0	0	4411.760	6480	4.71	1969	120	2089	Colombo	5
6512	300	9520.874	1051	3.92	625	148	773	Hikkaduwa	6
0	0	5529.063	4157	3.87	1082	195	1277	Thimbirigasyaya	7
4315	111	6235.785	413	2.33	120	153	273	Weligama	8
0	0	3248.735	1694	3.69	260	215	475	Rathmalana	9
5288	235	13671.544	1607	3.63	613	70	683	Kaluthara	10
7227	93	6165.164	793	4.48	228	27	255	Balapitiya	11
2001	68	9058.369	1456	2.64	304	133	437	Panadura	12
1564	71	4235.335	847	2.86	78	45	123	Galle Four Gravets	13
9087	1059	73618.859	353	2.35	161	7	168	Hambantota	14
1498	140	12617.728	1602	2.80	266	64	330	Wattala	15
0	26	4719.672	1306	1.94	45	64	109	Moratuwa	16
15465	1846	20372.810	401	2.04	79	64	143	Tangalle	17
5189	965	37930.636	338	1.85	0	10	10	Puttalam	18
3860	153	5282.647	157	1.35	32	0	32	Devinuwara	19
10933	128	6297.275	405	1.97	24	27	51	Ambalangoda	20
3948	133	9794.253	624	2.01	56	71	127	Matara	21
0	0	4857.293	274	1.75	0	15	15	Kalmunai	22
6411	260	5923.599	242	1.83	71	0	71	Dickwella	23


Distribution of Guest Rooms
N
No of Rooms
Less than 50
51 - 100
101 - 250
250 - 500
501 - 1000
More than 1000
No Guest Rooms
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 Kilometers

Water for Domestic Needs and Irrigation

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.

Sri Lanka is frequently subjected to several natural hazards, mainly floods, landslides, and droughts. The frequency and intensity of these hazards are expected to increase with climate change. Sea level rise, coastal flooding, coastal erosions, changes in rainfall regimes and the rise in ambient temperature are also expected. These concerns will be exacerbated by various anthropogenic factors that already threaten freshwater resources in the island and have resulted in many socio-economic and environmental problems.

Drinking Water

Sri Lanka depends 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. 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, which is bound to increase the pressure to meet the national targets for drinking water.

Currently, 35.5% of the entire population in the island have access to pipe-borne water, but rural populations continue to rely considerably on wells for their drinking, culinary needs, washing, bathing and laundering requirements, while others use water from tanks and reservoirs for these needs. Although around 84.8% of the population has access to safe drinking water, 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.

The analysis of climate data for Sri Lanka clearly indicates changes in rainfall and temperature throughout the country. 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.

Drinking water availability in terms of quantity and quality, in the country is already under threat due to anthropogenic stresses. These, with the added implications of climate change will bring about further risk to resource availability. For example, sea level rise is expected to cause saline intrusion which can seriously affect freshwater availability. Salt water intrusion can affect coastal aquifers upon which people are heavily dependent, especially with the country's population concentrated on the coastal belt. More frequent and prolonged drought conditions will seriously affect the availability of freshwater resources further inland, which will impede meeting the targets for providing drinking water for all. Freshwater availability problems are expected to worsen especially in the Dry Zone.

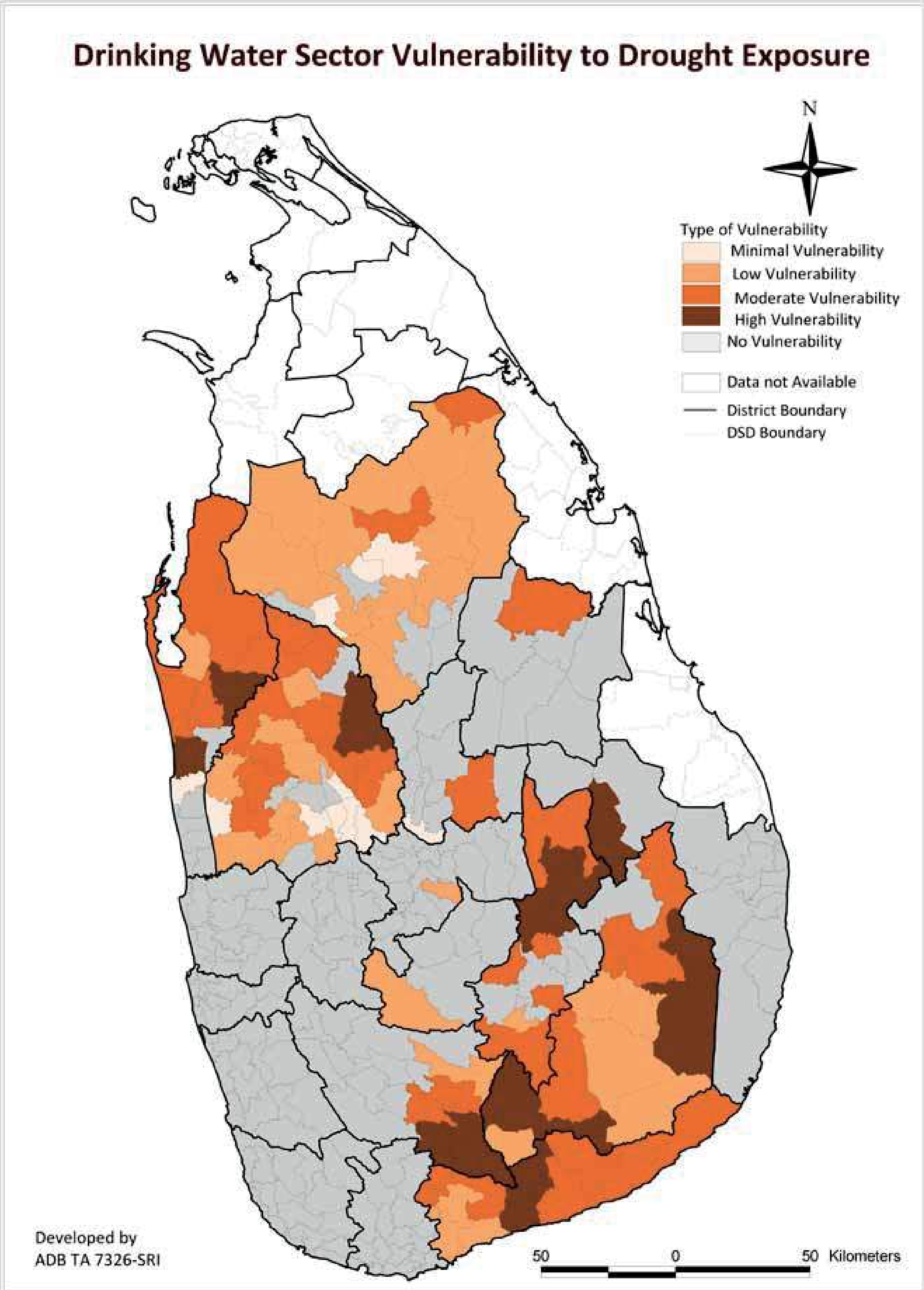
Drinking Water Sector Vulnerability to Drought Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
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	

Some of the key findings include:

- 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:
    - o a population of 575,287.
    - o 143,036 housing units.
    - o 194,950 people below the poverty line.
- In the highly vulnerable DSDs
    - o 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).
    - o 18.1% of the population have access to pipe-borne water.
    - o 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.
    - o In the Embilipitiya DSD, 54% of the housing units used groundwater as their primary source of drinking water.
    - o In the Rideemaliyadda DSD, 89.3% of the 10,681 households use groundwater as their primary source of water.
    - o In the Siyambalanduwa DSD, 90.9% of the households used groundwater as the primary water source.
    - o All three of these DSDs have very high levels of poverty and low education levels (especially Rideemaliyadda and Siyambalanduwa DSDs).
    - o 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:
    - o 15.2% of households with access to pipe-borne water.
    - o 75.1% of households that use groundwater as their primary source of water.
    - o 8.3% of households that use water from rivers, streams and other sources only 32.3% of households with their primary source of water within their own premises.


Drinking Water Sector Vulnerability to Drought Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
50
0
50 Kilometers

Drinking Water Sector Vulnerability to Drought Exposure

High Vulnerability · Moderate Vulnerability · Low Vulnerability · Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households [b]	Urban Population [b]	Rural Population [b]	Estate Population [b]	% in Poverty [c]	% Completed Secondary Education[a]
1	Rathnapura	Embilipitiya	383.4799	119563	312	29126	0	119490	73	31.60	21.16
2	Badulla	Rideemaliyadda	438.2808	45759	104	10681	0	45582	177	51.15	14.89
3	Moneragala	Siyambalanduwa	1065.6754	47438	45	10808	0	47438	0	51.80	13.52
4	Puttalam	Anamaduwa	259.0095	33302	129	9039	0	33302	0	16.77	22.53
5	Badulla	Kandaketiya	152.6207	22494	147	5425	0	21428	1066	46.10	14.56
6	Ampara	Padiyathalawa	386.8510	15971	41	3642	0	15971	0		11.66
7	Badulla	Meegahakivula	108.7195	18650	172	4558	0	16316	2334	46.50	12.52
8	Moneragala	Thanamalwila	661.4470	23172	35	5893	0	23172	0	35.80	14.18
9	Hambantota	Suriyawewa	189.7447	35529	187	9031	0	35529	0	34.80	17.37
10	Kurunegala	Polpithigama	417.5552	67263	161	18926	0	67263	0	30.00	18.13
11	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
12	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
13	Rathnapura	Kolonna	183.0319	43693	239	10661	0	38930	4763	37.70	14.65
14	Badulla	Uva Paranagama	137.2816	76524	557	19213	0	65809	10715	33.35	19.52
15	Kurunegala	Kuliyapitiya West	163.9366	71483	436	18666	6290	65102	91	16.62	32.77
16	Rathnapura	Godakawela	155.7512	69123	444	16962	0	57669	11454	38.20	20.31
17	Rathnapura	Weligepola	203.5279	29099	143	7690	0	28720	379	39.20	19.60
18	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
19	Anuradhapura	Padaviya	242.5157	21146	87	5452	0	21146	0	34.33	14.43
20	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
21	Hambantota	Lunugamvehera	300.3473	25226	84	6922	0	25226	0	33.50	17.85
22	Hambantota	Angunukolapeles	174.0781	42426	244	10394	0	42426	0	33.00	16.83
23	Moneragala	Madulla	722.5206	28358	39	6678	0	28358	0	40.70	19.44
24	Badulla	Soranathota	80.8879	22760	281	5667	0	18160	4600	34.24	17.35
25	Badulla	Mahiyanganaya	598.4674	67301	112	16499	0	67301	0	38.57	20.02
26	Puttalam	Karuwalagaswewa	503.9380	20225	40	5550	0	20225	0	23.77	14.80
27	Puttalam	Vanathavilluwa	736.5317	16460	22	4024	0	16410	50	40.31	12.25
28	Kurunegala	Ganewatta	147.1195	36812	250	9830	0	36770	42	23.20	22.57
29	Badulla	Haldummulla	414.9996	38223	92	9855	0	23207	15016	31.65	18.09
30	Hambantota	Katuwana	103.7065	41392	399	10025	0	62344	0	34.30	17.11
31	Puttalam	Mahakumbuk kadawala	175.8432	16905	96	4686	0	16905	0	28.65	15.18
32	Moneragala	Wellawaya	585.9537	50768	87	12698	0	50768	0	24.90	17.79
33	Kurunegala	Galgamuwa	273.2962	47844	175	12759	0	47844	0	25.70	22.00
34	Badulla	Ella	109.3657	42894	392	10775	0	29156	13738	28.04	21.90
35	Kurunegala	Panduwasnuwara	216.0387	69888	323	18130	0	69888	0	18.90	28.69
36	Anuradhapura	Rambewa	303.6555	31604	104	8230	0	31592	12	20.57	19.54
37	Kurunegala	Kobeigane	130.8780	32230	246	8581	0	32230	0	19.10	24.70
38	Kurunegala	Kotawehera	182.1192	19273	106	5323	0	19273	0	21.70	26.07
39	Matale	Laggala-Pallegama	373.8370	12399	33	3305	0	12055	344	34.60	19.05
40	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
41	Polonnaruwa	Medirigiriya	570.3679	57899	102	15189	0	57899	0	13.37	14.73
42	Moneragala	Medagama	241.1373	32467	135	7664	0	32467	0	30.20	14.89
43	Kurunegala	Ibbagamuwa	219.4878	76344	348	19589	0	75913	431	24.30	26.50
44	Puttalam	Nawagattegama	171.9949	12956	75	3519	0	12956	0	26.44	13.19
45	Hambantota	Tissamaharama	783.8008	60982	78	14829	0	60486	496	32.20	22.31
46	Kurunegala	Mahawa	260.6953	50576	194	13674	0	50576	0	20.90	21.83
47	Kurunegala	Giribawa	207.1489	28093	136	7831	0	28093	0	24.00	19.56
48	Kurunegala	Rasnayakapura	125.8909	18814	149	5071	0	18678	136	23.00	20.46
49	Anuradhapura	Horowpothana	845.8179	29642	35	7578	0	29642	0	24.95	14.78
50	Kurunegala	Nikaweratiya	152.4124	36370	239	9549	0	36370	0	19.40	24.93
51	Anuradhapura	Medawachchiya	492.1070	40469	82	10338	0	40469	0	21.34	24.09
52	Anuradhapura	Kebithigollewa	611.9821	19457	32	4903	0	19457	0	27.74	18.03
53	Moneragala	Moneragala	292.5414	42457	145	10071	0	39112	3345	29.30	23.23

Primary Water Source						DSD Name	Rank
Wells[b]	Tubewells[b]	Tap[b]	Other[b]	Wells and Taps within Premises[b]	Wells and Taps outside Premises[b]		
13235	2528	10436	2627	10577	9994	Embilipitiya	1
8838	697	262	772	2876	3748	Rideemaliyadda	2
9098	723	41	875	2126	2952	Siyambalanduwa	3
7072	1386	410	75	1958	5177	Anamaduwa	4
2284	462	1258	1342	903	2110	Kandaketiya	5
2588	601	36	399	540	791	Padiyathalawa	6
1749	262	1893	602	1330	1964	Meegahakivula	7
2775	1279	1103	673	1284	1514	Thanamalwila	8
5948	406	1448	1111	1848	3625	Suriyawewa	9
16971	982	266	487	5644	8251	Polpithigama	10
8054	1028	5810	354	5968	6238	Ambalantota	11
7358	987	758	700	3545	4458	Arachchikattuwa	12
4860	278	2183	3208	1702	3275	Kolonna	13
10964	804	3167	3671	2962	7741	Uva Paranagama	14
17236	224	887	95	10419	5370	Kuliyapitiya West	15
6858	247	4124	5519	3836	5313	Godakawela	16
5146	151	841	1457	1476	3147	Weligepola	17
10213	1222	223	1575	4952	4778	Mundalama	18
4252	520	414	216	1292	1337	Padaviya	19
13889	1747	1103	818	8347	5920	Kalpitiya	20
851	103	5760	108	1488	5021	Lunugamvehera	21
7997	1221	1065	31	2148	4790	Angunukolapeles	22
5338	361	325	592	2620	2308	Madulla	23
1870	114	2280	1320	1179	2398	Soranathota	24
13240	747	1531	734	6613	5728	Mahiyanganaya	25
3978	1350	31	122	624	2689	Karuwalagaswewa	26
1850	804	606	678	681	1293	Vanathavilluwa	27
9344	153	107	143	4427	4223	Ganewatta	28
1133	151	6158	2267	3285	3606	Haldummulla	29
8504	1557	2612	2316	3491	2757	Katuwana	30
3534	975	86	79	793	2393	Mahakumbuk kadawala	31
5768	1111	2043	3597	2716	2878	Wellawaya	32
10145	1802	577	60	3036	5741	Galgamuwa	33
3162	259	5252	1887	2722	4725	Ella	34
17364	317	276	57	9614	7353	Panduwasnuwara	35
6951	1007	27	173	2190	3883	Rambewa	36
8072	210	159	56	3975	3980	Kobeigane	37
4489	747	16	8	1173	3130	Kotawehera	38
1525	436	386	939	592	954	Laggala-Pallegama	39
3016	78	7370	378	5482	4664	Hambantota	40
12514	1300	889	319	2420	4231	Medirigiriya	41
5985	311	378	880	1720	2745	Medagama	42
18167	288	641	289	9059	8134	Ibbagamuwa	43
2243	1098	118	15	540	1499	Nawagattegama	44
6098	1071	7108	394	6400	6309	Tissamaharama	45
12782	594	176	49	5503	6218	Mahawa	46
6274	1332	47	140	1391	3296	Giribawa	47
4623	296	26	45	1330	3025	Rasnayakapura	48
6132	1079	117	158	1962	3400	Horowpothana	49
8047	969	415	67	3041	4915	Nikaweratiya	50
7988	1654	409	68	3167	3843	Medawachchiya	51
3863	560	226	151	1071	1932	Kebithigollewa	52
5721	818	2087	1341	3139	2903	Moneragala	53

Rank	District Name	DSD Name	Physical Characteristics: Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Demographics: Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
54	Hambantota	Weeraketiya	115.4094	37401	324	9208	0	55459	0	32.50	21.20
55	Kurunegala	Bingiriya	195.2943	55763	286	15223	0	55613	150	16.80	24.53
56	Rathnapura	Balangoda	274.1594	77303	282	18720	11402	58032	7869	27.30	27.22
57	Anuradhapura	Maha Vilachchiya	624.8276	18557	30	4630	0	18557	0	31.16	17.85
58	Hambantota	Okewela	41.9560	18247	435	4266	0	18247	0	34.10	25.51
59	Moneragala	Sewanagala	191.9569	36820	192	9221	0	35739	1081	19.30	20.35
60	Moneragala	Badalkumbura	235.9900	36784	156	9030	0	32733	4051	27.90	23.53
61	Anuradhapura	Nuwaragam Palatha Central	389.4952	53665	138	13055	11598	42067	0	20.14	20.32
62	Kurunegala	Wariyapola	201.7589	56880	282	15207	0	56832	48	18.90	29.42
63	Kurunegala	Rideegama	222.5431	80473	362	21118	0	78808	1665	32.76	26.28
64	Nuwara Eliya	Ambagamuwa	487.9105	203717	418	47145	14204	47474	142039	22.90	16.74
65	Anuradhapura	Kahatagasdigiliya	366.6055	33572	92	8619	0	33572	0	19.63	20.03
66	Kurunegala	Ambanpola	142.5265	19964	140	5488	0	19964	0	23.10	23.46
67	Moneragala	Buttala	735.5660	47324	64	11843	0	47324	0	21.20	22.01
68	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
69	Anuradhapura	Thalawa	220.5999	50919	231	13375	0	50919	0	19.44	22.25
70	Moneragala	Katharagama	536.3836	16297	30	3875	0	16297	0	19.80	19.56
71	Badulla	Haputhale	70.3267	50735	721	11565	3235	29372	18128	24.42	29.37
72	Anuradhapura	Galenbidunuwawe	288.1528	40888	142	10454	0	40888	0	18.56	21.42
73	Kurunegala	Polgahawela	97.3861	58762	603	14506	0	57940	822	22.91	35.64
74	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
75	Anuradhapura	Thirappane	278.9562	23378	84	6143	0	23378	0	18.59	23.27
76	Anuradhapura	Nochchiyagama	843.5736	41601	49	11239	0	41601	0	16.98	19.61
77	Anuradhapura	Palagala	226.9676	29837	131	8196	0	29837	0	23.83	21.98
78	Anuradhapura	Galnewa	140.2283	30344	216	8165	0	30344	0	18.46	20.55
79	Kandy	Pathahewaheta	83.5016	53843	645	13229	0	51531	2312	26.60	30.92
80	Hambantota	Beliatta	102.5034	52283	510	12630	0	52283	0	28.30	36.26
81	Kurunegala	Kuliyapitiya East	113.2748	46966	415	11728	0	46839	127	20.32	27.57
82	Kurunegala	Pannala	284.9191	114438	402	29467	0	113726	712	17.80	31.16
83	Anuradhapura	Ipalogama	142.4270	32933	231	8730	0	31992	941	17.41	25.86
84	Kurunegala	Narammala	108.3197	51244	473	13092	0	51244	0	21.40	33.36
85	Anuradhapura	Thambuttegama	111.4855	36524	328	9448	0	36524	0	19.05	22.52
86	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
87	Kurunegala	Mawathagama	109.6233	56820	518	14191	0	55013	1807	24.92	33.95
88	Matale	Ukuwela	77.9074	61568	790	14856	977	54983	5608	21.40	29.55
89	Anuradhapura	Mihintale	234.9169	26786	114	6657	1523	25263	0	18.97	29.03
90	Kurunegala	Udubaddawa	117.5985	48800	415	12669	0	48742	58	17.70	29.43
91	Kurunegala	Mallawapitiya	79.9307	46575	583	11574	0	46240	335	19.50	33.19
92	Kurunegala	Weerambugedara	91.3110	30311	332	8085	0	30311	0	20.11	39.05
93	Kurunegala	Kurunegala	111.0680	88944	801	20292	28401	60369	174	14.70	44.87
94	Anuradhapura	Nuwaragam Palatha East	90.6614	65671	724	14504	40030	25641	0	11.97	44.47

Primary Water Source						DSD Name	Rank
Wells[b]	Tubewells[b]	Tap[b]	Other[b]	Wells and Taps within Premises[b]	Wells and Taps outside Premises[b]		
10838	1533	782	275	3559	4399	Weeraketiya	54
14361	526	170	70	7704	5936	Bingiriya	55
8372	91	6801	3188	5736	7168	Balangoda	56
3084	1303	55	101	1064	1687	Maha Vilachchiya	57
3985	161	55	49	1404	1727	Okewela	58
5852	558	503	2178	1074	3235	Sewanagala	59
4904	581	1070	2385	1566	2996	Badalkumbura	60
7755	2528	2280	254	4230	4949	Nuwaragam Palatha Central	61
14379	300	331	86	7346	6553	Wariyapola	62
15626	546	2887	1845	7217	9121	Rideegama	63
4996	1679	28970	9840	14791	17703	Ambagamuwa	64
7019	814	638	61	2621	4359	Kahatagasdigiliya	65
4275	834	259	82	1416	2696	Ambanpola	66
7043	1216	1877	1636	3838	3525	Buttala	67
8081	1443	5207	681	5780	7182	Puttalam	68
11715	979	170	383	3328	5925	Thalawa	69
331	49	3235	191	1991	1546	Katharagama	70
2526	187	6548	1951	3917	4396	Haputhale	71
8811	1162	152	186	2467	4968	Galenbidunuwawe	72
13132	280	916	46	7049	5067	Polgahawela	73
5415	455	8699	326	6255	7096	Tangalle	74
4717	1227	21	115	1073	3193	Thirappane	75
8841	1343	729	189	2742	5465	Nochchiyagama	76
6070	1362	199	435	1726	3345	Palagala	77
6658	1259	95	110	1574	3628	Galnewa	78
5861	1863	4363	1000	2064	6751	Pathahewaheta	79
10122	312	1995		5075	5703	Beliatta	80
11310	77	172	65	5754	4188	Kuliyapitiya East	81
27873	243	837	183	14896	4928	Pannala	82
7006	1222	379	87	1815	4005	Ipalogama	83
12458	220	267	48	6286	3561	Narammala	84
7543	764	892	130	2368	4533	Thambuttegama	85
7886	774	5331	357	7252	5801	Chilaw	86
12283	399	854	520	6403	5482	Mawathagama	87
5776	848	6644	1349	4856	6691	Ukuwela	88
3851	1763	862	32	2278	2102	Mihintale	89
12003	332	168	70	7019	2997	Udubaddawa	90
10063	380	590	403	5778	3838	Mallawapitiya	91
7785	85	83	42	4400	2281	Weerambugedara	92
16326	562	2943	54	11674	6855	Kurunegala	93
3495	1275	9274	140	9352	3025	Nuwaragam Palatha East	94

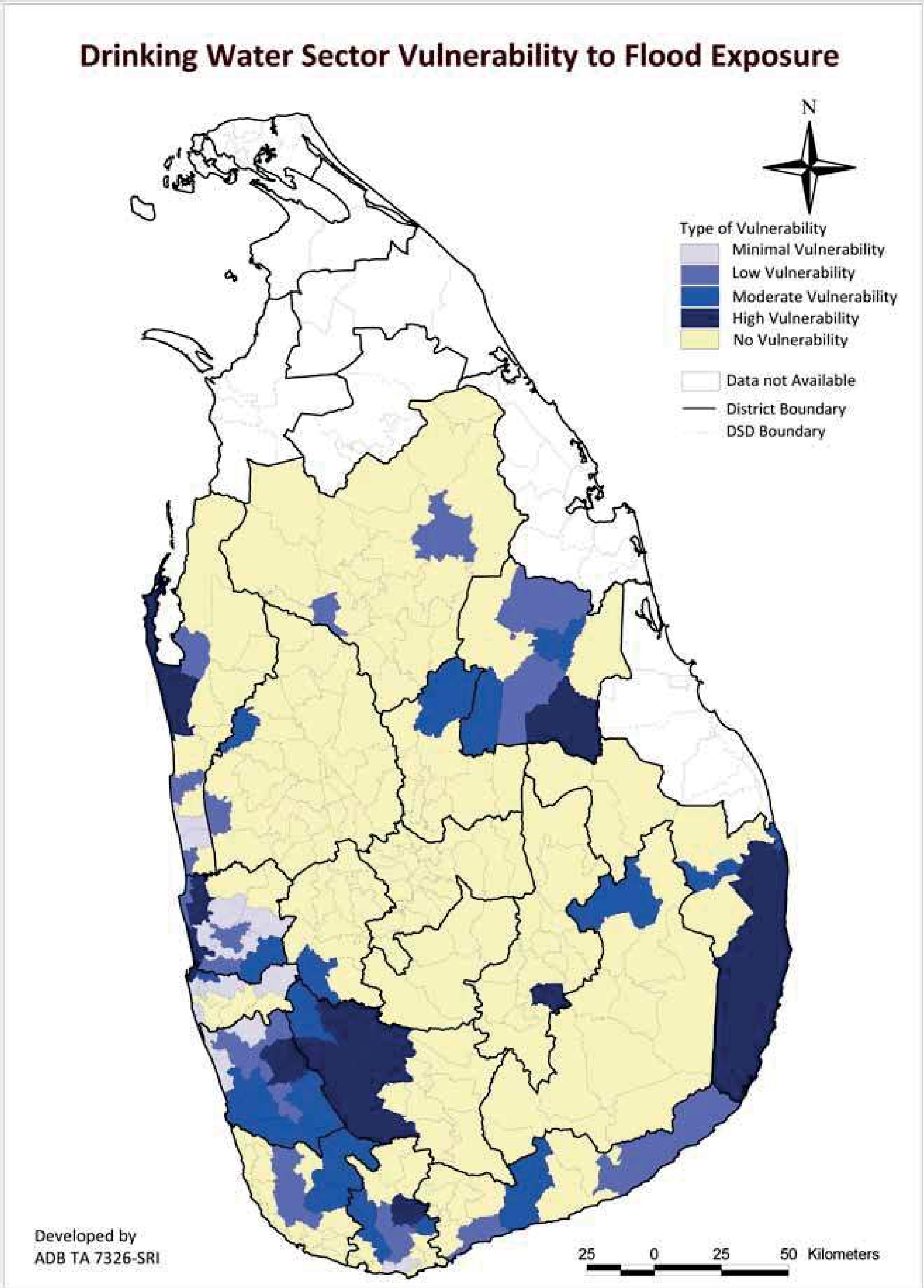
Drinking Water Sector Vulnerability to Flood Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
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	

Some of the key findings include:

- 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 33% 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 42.8% of households have their primary source of water within their own premises.
- Elapaatha (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.


Drinking Water Sector Vulnerability to Flood Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25
0
25
50
Kilometers

Drinking Water Sector Vulnerability to Flood Exposure

High Vulnerability   Moderate Vulnerability   Low Vulnerability   Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Rathnapura	Elapatha	86.8547	36322	418	8828	0	34219	2103	40.10	22.39
2	Ampara	Addalachchenai	56.9586	36020	632	7640	0	36020	0		17.64
3	Ampara	Pothuvil	271.8310	28480	105	6693	0	28480	0		13.45
4	Colombo	Colombo	17.8538	380946	21337	70735	380946	0	0	12.10	32.53
5	Rathnapura	Rathnapura	326.7894	115223	353	26549	45623	53219	16381	21.90	30.01
6	Rathnapura	Ayagama	157.6893	28637	182	7357	0	25160	3477	33.70	21.37
7	Gampaha	Katana	124.9577	222683	1782	50765	73318	149365	0	7.70	41.14
8	Ampara	Sainthamarathu	3.0272	24114	7966	5144	24114	0	0		21.81
9	Ampara	Alayadiwembu	82.5912	22627	274	4956	0	22627	0		22.67
10	Ampara	Lahugala	923.3049	7623	8	1888	0	7623	0		15.57
11	Rathnapura	Kalawana	384.7488	48669	126	11905	0	44632	4037	36.40	23.93
12	Ampara	Akkaraipattu	60.4089	34939	578	7649	0	34939	0		26.00
13	Ampara	Eragama	66.6480	11344	170	2632	0	11344	0		13.35
14	Ampara	Thirukkovil	187.0859	23700	127	5427	0	23700	0		20.88
15	Polonnaruwa	Dimbulagala	552.3964	63349	115	16757	0	63339	10	22.59	18.60
16	Rathnapura	Nivithigala	157.9051	59092	374	13989	0	47942	11150	32.80	17.57
17	Ampara	Samanthurai	123.0101	51510	419	11729	0	51510	0		20.13
18	Rathnapura	Kuruwita	174.6734	85882	492	20460	0	80326	5556	28.90	23.57
19	Ampara	Ninthavur	36.3016	24625	678	6235	0	24625	0		22.78
20	Matara	Mulatiyana	119.4139	46066	386	11169	0	45501	565	30.90	21.41
21	Rathnapura	Pelmadulla	144.8430	84966	587	19906	560	73480	10926	30.20	26.35
22	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
23	Badulla	Ella	109.3657	42894	392	10775	0	29156	13738	28.04	21.90
24	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
25	Gampaha	Wattala	57.6911	160127	2776	36368	28740	131387	0	6.10	40.21
26	Kalutara	Bulathsinhala	209.4387	59787	285	15611	0	53331	6456	27.40	22.09
27	Gampaha	Dompe	182.1586	130021	714	31962	0	130021	0	21.10	31.48
28	Kalutara	Palindanuwara	283.2330	45911	162	11597	0	40298	5613	30.70	22.88
29	Rathnapura	Kiriella	79.5653	30881	388	7666	0	29748	1133	25.60	26.58
30	Moneragala	Bibila	483.5204	35490	73	8817	0	34818	672	26.00	17.05
31	Matara	Hakmana	49.6219	30201	609	7190	0	30201	0	32.00	29.15
32	Ampara	Karativu	8.9392	16365	1831	3641	0	16365	0		28.99
33	Galle	Neluwa	152.2868	27501	181	6445	0	27251	250	33.40	16.54
34	Ampara	Ampara	139.2692	38166	274	8713	17957	20209	0		30.45
35	Galle	Thawalama	174.1470	31803	183	7710	0	30789	1014	29.50	19.99
36	Kalutara	Walallawita	213.2047	50676	238	12793	0	47579	3097	31.40	25.28
37	Rathnapura	Eheliyagoda	141.9292	63870	450	15566	0	61593	2277	26.90	26.60
38	Hambantota	Suriyawewa	189.7447	35529	187	9031	0	35529	0	34.80	17.37
39	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
40	Ampara	Kalmunai	19.6568	70465	3585	15821	70465	0	0		28.44
41	Kalutara	Mathugama	134.3624	73269	545	17604	0	66781	6488	29.40	28.65
42	Kurunegala	Rasnayakapura	125.8909	18814	149	5071	0	18678	136	23.00	20.46
43	Kalutara	Dodangoda	112.8241	55052	488	13646	0	47970	7082	21.20	27.42
44	Galle	Nagoda	174.6178	52414	300	13028	0	46707	5707	28.70	23.04
45	Matara	Malimbada	47.9781	31524	657	7577	0	31384	140	24.30	31.38
46	Polonnaruwa	Lankapura	200.7756	33676	168	8611	0	33676	0	14.54	19.42
47	Kegalle	Dehiovita	193.2396	73991	383	18460	0	62883	11108	29.30	24.21
48	Matara	Akuressa	148.6167	49806	335	11825	0	48508	1298	21.90	24.28
49	Polonnaruwa	Elahera	353.1772	39908	113	10446	0	39908	0	18.45	17.46
50	Colombo	Kolonnawa	26.0388	161247	6193	35803	56396	104851	0	8.20	35.95
51	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20
52	Matale	Dambulla	455.1342	60976	134	15285	0	60959	17	19.90	23.88
53	Matara	Athuraliya	65.9339	30179	458	7039	0	29380	799	27.80	26.77
54	Kalutara	Millaniya	82.0638	44476	542	11035	0	43110	1366	16.90	30.71

Primary Water Source						DSD Name	Rank
Wells[b]	Tubewells[b]	Tap[b]	Other[b]	Wells and Taps within Premises[b]	Wells and Taps outside Premises[b]		
4766	38	1083	2812	1902	2958	Elapatha	1
7021	7	32	409	6033	831	Addalachchenai	2
6295	103	26	92	3507	2555	Pothuvil	3
3149	866	63741	327	34959	31841	Colombo	4
7822	105	9603	8461	7219	8969	Rathnapura	5
1247	4	2456	3470	1212	1920	Ayagama	6
30278	10703	8072	233	27170	9747	Katana	7
5057	11	15	14	4607	444	Sainthamarathu	8
4746	12	19	36	3521	1161	Alayadiwembu	9
1687	107	18	65	608	1004	Lahugala	10
2616	27	2388	6539	2098	1874	Kalawana	11
7202	1	20	278	6483	646	Akkaraipattu	12
2055	36	34	447	914	985	Eragama	13
5156	2	24	60	3736	1277	Thirukkovil	14
13521	700	1138	1158	1919	7279	Dimbulagala	15
3918	45	3106	6769	1851	3261	Nivithigala	16
6607	313	4016	403	5768	4222	Samanthurai	17
12477	75	2281	5388	5870	6363	Kuruwita	18
5725	25	289	40	5640	330	Ninthavur	19
8897	250	567	1361	4048	2869	Mulatiyana	20
8230	131	9247	1933	5942	9334	Pelmadulla	21
10213	1222	223	1575	4952	4778	Mundalama	22
3162	259	5252	1887	2722	4725	Ella	23
13889	1747	1103	818	8347	5920	Kalpitiya	24
12026	3132	20038	204	20928	10959	Wattala	25
12205	591	1328	1215	4863	5284	Bulathsinhala	26
29479	207	1866	169	20042	7667	Dompe	27
8042	60	794	2497	2611	2654	Palindanuwara	28
4318	13	3031	215	3350	3300	Kiriella	29
6388	479	810	1054	2200	2916	Bibila	30
6091	146	876	34	3050	2980	Hakmana	31
3319	7	226	57	2887	634	Karativu	32
3025	28	936	2381	1414	1508	Neluwa	33
4240	61	3957	293	4340	2945	Ampara	34
3393	77	2078	2060	2167	2103	Thawalama	35
10777	142	724	902	4725	3093	Walallawita	36
9896	79	2299	3214	4585	5449	Eheliyagoda	37
5948	406	1448	1111	1848	3625	Suriyawewa	38
8054	1028	5810	354	5968	6238	Ambalantota	39
12931	120	2179	249	12489	2422	Kalmunai	40
15310	207	1530	253	7787	6293	Mathugama	41
4623	296	26	45	1330	3025	Rasnayakapura	42
12419	110	766	216	5409	5503	Dodangoda	43
9850	1034	1089	868	4168	3410	Nagoda	44
6349	120	974	70	4708	1912	Malimbada	45
7164	813	236	290	1629	2696	Lankapura	46
9456	77	3849	4796	4954	6220	Dehiovita	47
8333	107	1461	1743	4516	3001	Akuressa	48
6805	2739	470	304	1455	2720	Elahera	49
5570	330	29216	128	24703	9891	Kolonnawa	50
16223	424	12226	205	14874	10492	Beruwala	51
9777	4429	685	230	3639	4065	Dambulla	52
5979	48	549	440	3312	1906	Athuraliya	53
10469	122	267	50	4693	4602	Millaniya	54

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
55	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
56	Matara	Kaburupitiya	59.7187	37347	625	9079	0	37347	0	24.90	31.28
57	Kurunegala	Udubaddawa	117.5985	48800	415	12669	0	48742	58	17.70	29.43
58	Matara	Thihagoda	50.9425	30909	607	7529	0	30909	0	27.20	30.07
59	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
60	Anuradhapura	Kahatagasdigiliya	366.6055	33572	92	8619	0	33572	0	19.63	20.03
61	Gampaha	Negombo	46.1424	144274	3127	31915	121413	22861	0	7.10	30.04
62	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
63	Kalutara	Agalawatta	89.7814	33962	378	8423	0	32768	1194	26.40	33.03
64	Hambantota	Tissamaharama	783.8008	60982	78	14829	0	60486	496	32.20	22.31
65	Kalutara	Madurawala	62.9158	29750	473	7552	0	27129	2621	18.60	34.30
66	Polonnaruwa	Medirigiriya	570.3679	57899	102	15189	0	57899	0	13.37	14.73
67	Anuradhapura	Thambuttegama	111.4855	36524	328	9448	0	36524	0	19.05	22.52
68	Galle	Welivitiya-Divithura	54.9823	26599	484	6622	0	25059	1540	25.50	23.29
69	Gampaha	Kelaniya	21.9313	134364	6127	30272	29820	104544	0	6.90	41.85
70	Kalutara	Ingiriya	94.0498	45726	486	11314	0	43590	2136	17.40	26.56
71	Galle	Baddegama	114.4507	68634	600	16761	0	66249	2385	21.70	30.17
72	Gampaha	Biyagama	60.2668	161300	2676	36655	0	161300	0	11.30	41.68
73	Galle	Elpitiya	151.2593	60292	399	15049	0	58153	2139	22.70	26.49
74	Kalutara	Bandaragama	57.4085	86886	1513	20579	0	86886	0	8.20	37.31
75	Polonnaruwa	Thamankaduwa	465.7376	74224	159	17920	0	73956	268	14.15	28.23
76	Gampaha	Gampaha	90.6959	171040	1886	41357	9284	161756	0	9.90	43.27
77	Puttalam	Wennappuwa	40.9400	70817	1730	18180	0	70487	330	14.88	25.79
78	Gampaha	Attanagalla	154.3057	154967	1004	36838	0	154821	146	15.40	39.55
79	Gampaha	Ja-Ela	61.4202	184666	3007	42975	30791	153875	0	7.80	44.60
80	Colombo	Hanwella	145.8825	94001	644	22689	21601	66446	5954	14.20	34.61
81	Puttalam	Mahawewa	75.3055	48861	649	12600	0	48405	456	14.78	26.88
82	Kalutara	Kaluthara	77.6779	141829	1826	31857	37451	104378	0	12.50	38.35
83	Gampaha	Minuwangoda	133.2225	151661	1138	37683	7567	144084	10	12.50	38.36
84	Puttalam	Nattandiya	75.3430	57686	766	14528	0	57535	151	15.54	28.96
85	Matara	Matara	56.1514	108238	1928	23705	42663	65575	0	16.90	42.45
86	Colombo	Moratuwa	19.2051	177563	9246	41282	177563	0	0	10.30	40.58
87	Colombo	Kaduwela	87.7537	209251	2385	48849	0	209251	0	6.00	48.78
88	Kalutara	Panadura	45.0310	163492	3631	37245	33514	129978	0	7.40	40.07
89	Gampaha	Mahara	94.2988	176870	1876	41639	0	176870	0	12.10	37.86
90	Colombo	Thimbirigasyaya	22.3754	266154	11895	52397	266154	0	0	4.40	49.35
91	Kalutara	Horana	112.7795	90690	804	22048	9127	80042	1521	8.40	42.98
92	Colombo	Rathmalana	13.1472	108716	8269	25013	108716	0	0	4.20	47.88
93	Colombo	Sri Jayawardanapura Kotte	16.5150	116366	7046	25822	116366	0	0	2.70	55.07

Primary Water Source						DSD Name	Rank
Wells[b]	Tubewells[b]	Tap[b]	Other[b]	Wells and Taps within Premises[b]	Wells and Taps outside Premises[b]		
7886	774	5331	357	7252	5801	Chilaw	55
7589	141	1143	145	5278	2278	Kaburupitiya	56
12003	332	168	70	7019	2997	Udubaddawa	57
6934	110	379	35	4471	2045	Thihagoda	58
5415	455	8699	326	6255	7096	Tangalle	59
7019	814	638	61	2621	4359	Kahatagasdigiliya	60
6093	3984	20986	325	16316	10694	Negombo	61
8081	1443	5207	681	5780	7182	Puttalam	62
7080	104	495	636	2879	2820	Agalawatta	63
6098	1071	7108	394	6400	6309	Tissamaharama	64
6898	66	367	148	3520	2882	Madurawala	65
12514	1300	889	319	2420	4231	Medirigiriya	66
7543	764	892	130	2368	4533	Thambuttegama	67
5618	634	216	108	2606	1689	Welivitiya-Divithura	68
7662	448	21468	66	19776	9125	Kelaniya	69
8991	242	1488	477	4730	4408	Ingiriya	70
14421	1082	901	192	7821	4933	Baddegama	71
26312	554	8795	95	24415	9589	Biyagama	72
13247	428	890	337	6450	4282	Elpitiya	73
18890	206	1119	81	13324	5588	Bandaragama	74
10813	1569	4895	338	7534	5013	Thamankaduwa	75
37241	511	3182	107	30472	7811	Gampaha	76
10883	4615	2255	128	9146	3400	Wennappuwa	77
32115	169	3946	160	24539	8332	Attanagalla	78
31686	4141	5452	289	27693	8737	Ja-Ela	79
17734	110	3520	1134	11216	7891	Hanwella	80
8605	2169	1511	148	6219	3670	Mahawewa	81
19067	2519	9515	259	17472	9734	Kaluthara	82
33791	685	2561	161	26684	6228	Minuwangoda	83
10640	2757	841	138	8124	2741	Nattandiya	84
7067	112	16139	157	17355	5176	Matara	85
1858	775	37862	88	29404	10214	Moratuwa	86
30566	345	16916	101	33113	13140	Kaduwela	87
21028	2021	13401	153	23432	10382	Panadura	88
31335	291	9266	163	29439	9005	Mahara	89
1184	616	48175	246	29446	19860	Thimbirigasyaya	90
18724	458	2475	131	13333	6113	Horana	91
1440	50	22901	80	20045	4265	Rathmalana	92
1799	71	23286	76	20698	4296	Sri Jayawardanapura Kotte	93

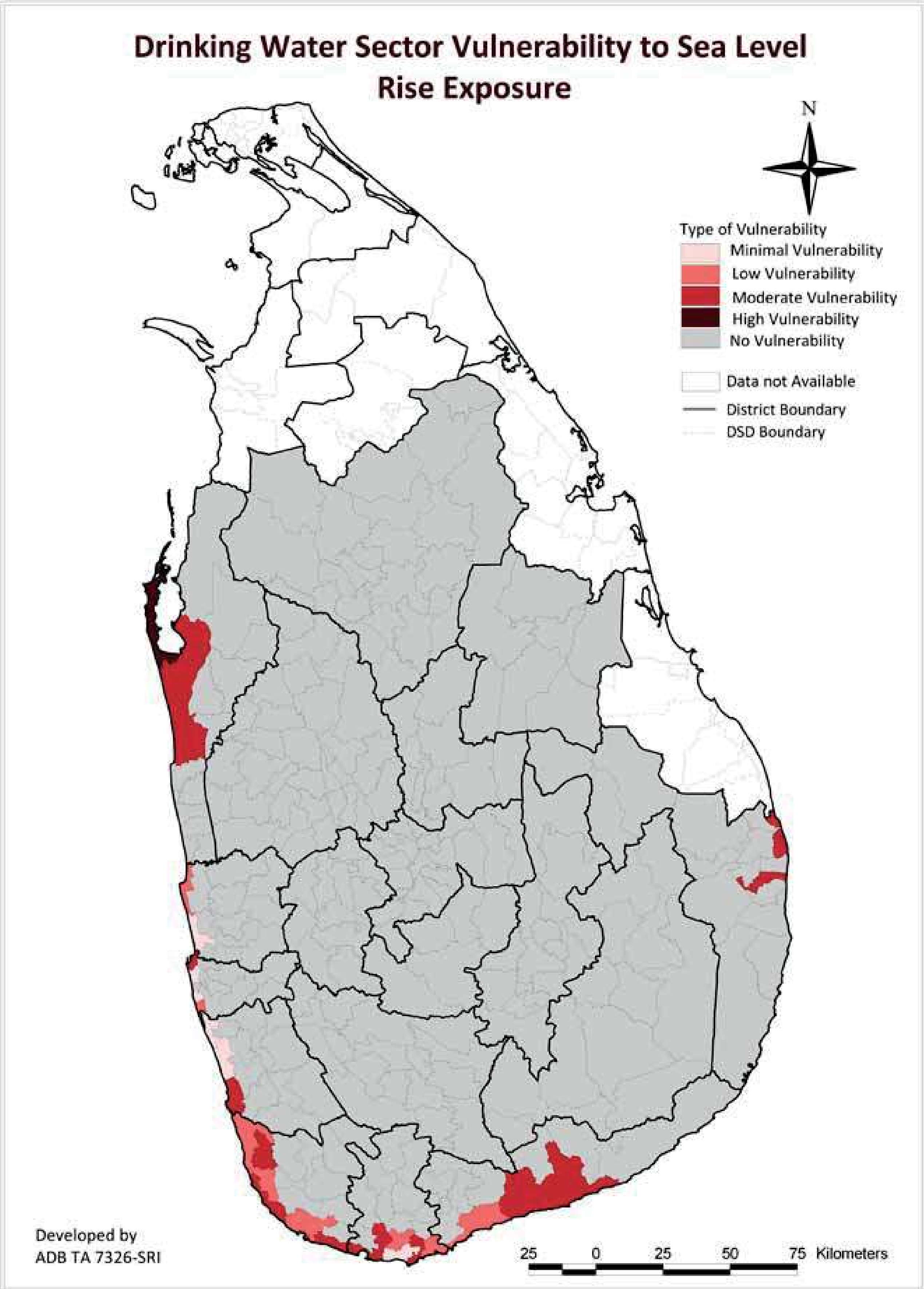
Drinking Water Sector Vulnerability to Sea Level Rise Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

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	

Some of the key findings include:

- 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 44.3% 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.


Drinking Water Sector Vulnerability to 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
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Drinking Water Sector Vulnerability to Sea Level Rise Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics: Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Demographics: Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
2	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
3	Ampara	Akkaraipattu	60.4089	34939	578	7649	0	34939	0		26.00
4	Colombo	Colombo	17.8538	380946	21337	70735	380946	0	0	12.10	32.53
5	Ampara	Karativu	8.9392	16365	1831	3641	0	16365	0		28.99
6	Galle	Habaraduwa	49.5183	59041	1192	13567	0	59041	0	28.70	29.53
7	Ampara	Kalmunai	19.6568	70465	3585	15821	70465	0	0		28.44
8	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
9	Matara	Weligama	43.1469	66459	1540	14825	21698	44761	0	21.50	30.48
10	Ampara	Ninthavur	36.3016	24625	678	6235	0	24625	0		22.78
11	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
12	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
13	Matara	Malimbada	47.9781	31524	657	7577	0	31384	140	24.30	31.38
14	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20
15	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
16	Galle	Hikkaduwa	66.0971	98589	1492	22820	0	98539	50	24.90	33.61
17	Galle	Karandeniya	88.0055	56128	638	14913	0	56128	0	21.90	20.63
18	Matara	Devinuwara	37.6183	44199	1175	9988	0	44199	0	20.90	26.80
19	Matara	Thihagoda	50.9425	30909	607	7529	0	30909	0	27.20	30.07
20	Galle	Galle Four Gravets	23.7565	103246	4346	19425	90270	12976	0	19.30	39.96
21	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
22	Galle	Akmeemana	65.4509	63881	976	15110	0	63239	642	22.00	32.21
23	Galle	Balapitiya	54.5727	65346	1197	15054	0	65346	0	22.00	27.89
24	Gampaha	Negombo	46.1424	144274	3127	31915	121413	22861	0	7.10	30.04
25	Galle	Bentota	72.3358	46442	642	11015	0	46442	0	22.30	31.14
26	Galle	Ambalangoda	70.2467	71047	1011	17122	39302	51396	0	20.30	32.73
27	Matara	Dickwella	50.9687	51314	1007	11592	0	51314	0	22.70	31.87
28	Colombo	Moratuwa	19.2051	177563	9246	41282	177563	0	0	10.30	40.58
29	Galle	Bope-Poddala	29.1730	41612	1426	9732	0	41461	151	18.10	42.27
30	Kalutara	Kaluthara	77.6779	141829	1826	31857	37451	104378	0	12.50	38.35
31	Matara	Matara	56.1514	108238	1928	23705	42663	65575	0	16.90	42.45
32	Kalutara	Panadura	45.0310	163492	3631	37245	33514	129978	0	7.40	40.07
33	Colombo	Thimbirigasyaya	22.3754	266154	11895	52397	266154	0	0	4.40	49.35
34	Gampaha	Wattala	57.6911	160127	2776	36368	28740	131387	0	6.10	40.21
35	Colombo	Rathmalana	13.1472	108716	8269	25013	108716	0	0	4.20	47.88

Primary Water Source						DSD Name	Rank
Wells[b]	Tubewells[b]	Tap[b]	Other[b]	Wells and Taps within Premises[b]	Wells and Taps outside Premises[b]		
13889	1747	1103	818	8347	5920	Kalpitiya	1
10213	1222	223	1575	4952	4778	Mundalama	2
7202	1	20	278	6483	646	Akkaraipattu	3
3149	866	63741	327	34959	31841	Colombo	4
3319	7	226	57	2887	634	Karativu	5
12052	80	1133	170	5054	7065	Habaraduwa	6
12931	120	2179	249	12489	2422	Kalmunai	7
3016	78	7370	378	5482	4664	Hambantota	8
8555	73	5912	113	8209	5179	Weligama	9
5725	25	289	40	5640	330	Ninthavur	10
8054	1028	5810	354	5968	6238	Ambalantota	11
8081	1443	5207	681	5780	7182	Puttalam	12
6349	120	974	70	4708	1912	Malimbada	13
16223	424	12226	205	14874	10492	Beruwala	14
7358	987	758	700	3545	4458	Arachchikattuwa	15
14516	443	7334	146	9808	10947	Hikkaduwa	16
13931	220	453	173	7386	3509	Karandeniya	17
4590	42	5131	134	6975	2210	Devinuwara	18
6934	110	379	35	4471	2045	Thihagoda	19
4532	137	14326	70	12932	5653	Galle Four Gravets	20
5415	455	8699	326	6255	7096	Tangalle	21
13500	184	1123	156	7642	4956	Akmeemana	22
9913	111	4646	102	8013	5601	Balapitiya	23
6093	3984	20986	325	16316	10694	Negombo	24
9020	105	1781	27	5173	3944	Bentota	25
12497	260	4158	56	9707	5340	Ambalangoda	26
4910	54	6442	85	7502	3365	Dickwella	27
1858	775	37862	88	29404	10214	Moratuwa	28
7482	283	1872	19	5212	3449	Bope-Poddala	29
19067	2519	9515	259	17472	9734	Kaluthara	30
7067	112	16139	157	17355	5176	Matara	31
21028	2021	13401	153	23432	10382	Panadura	32
1184	616	48175	246	29446	19860	Thimbirigasyaya	33
12026	3132	20038	204	20928	10959	Wattala	34
1440	50	22901	80	20045	4265	Rathmalana	35

Irrigation Water

Sri Lanka's inland waters are the most important supply of water for agriculture where irrigation waters are vital for enhancing productivity of the sector. Agriculture and food production contributes about 16% to the national economy. Agriculture in the Wet Zone is mainly rain-fed, due to the considerable reliability and intensity of rainfall regimes in this region and conversely, in the Dry and Intermediate Zones where rainfall is limited, water collected in numerous surface reservoirs is the vital source of water, which supplements water received from the north-east monsoon and inter-monsoonal rains.

The implications of changes in rainfall patterns are numerous, including possible shifts in the demarcation between the Dry and Wet Zones with a reduction in the latter. High intensity rainfall often leads to significant erosion and runoff reducing retention and re-charge as well as creating higher probability of landslides especially in the hills. Unusual flash floods can also damage headworks of irrigation schemes and canal structures which can hinder a reliable water supply.

Reduced rainfall on the other hand can affect seasonal flows of the rivers that originate and flow entirely in the Dry Zone. Prolonged droughts will exacerbate already existing water deficiency issues in these areas. This will, in turn, affect food production significantly as 70% of paddy grown in the country is in the Dry Zone, relying on irrigation. Lowered water levels during low rainfall periods will also have implications on power production as well as water availability for multiple uses in both the Wet and the Dry Zones. The main issue associated with sea level rise is saline intrusion into freshwater bodies especially along the Southern and Eastern coasts of the country. Reduction of river water flows can increase the risk of saltwater intrusion.

The impacts of temperature increase on water availability include increased rates of evaporation and evapo-transpiration. Thus, during drought periods water availability for irrigation will be affected due to high evaporation rates – this is especially true for the Dry Zone tanks and rivers. Increased evaporation and transpiration can also reduce soil moisture, stream flow and groundwater re-charge, thus reducing water available for food production, and increasing the irrigation requirement. Salinization of soil is another potential risk where intensified evaporation coupled with less rain leads to increased salt accumulation in the soil.

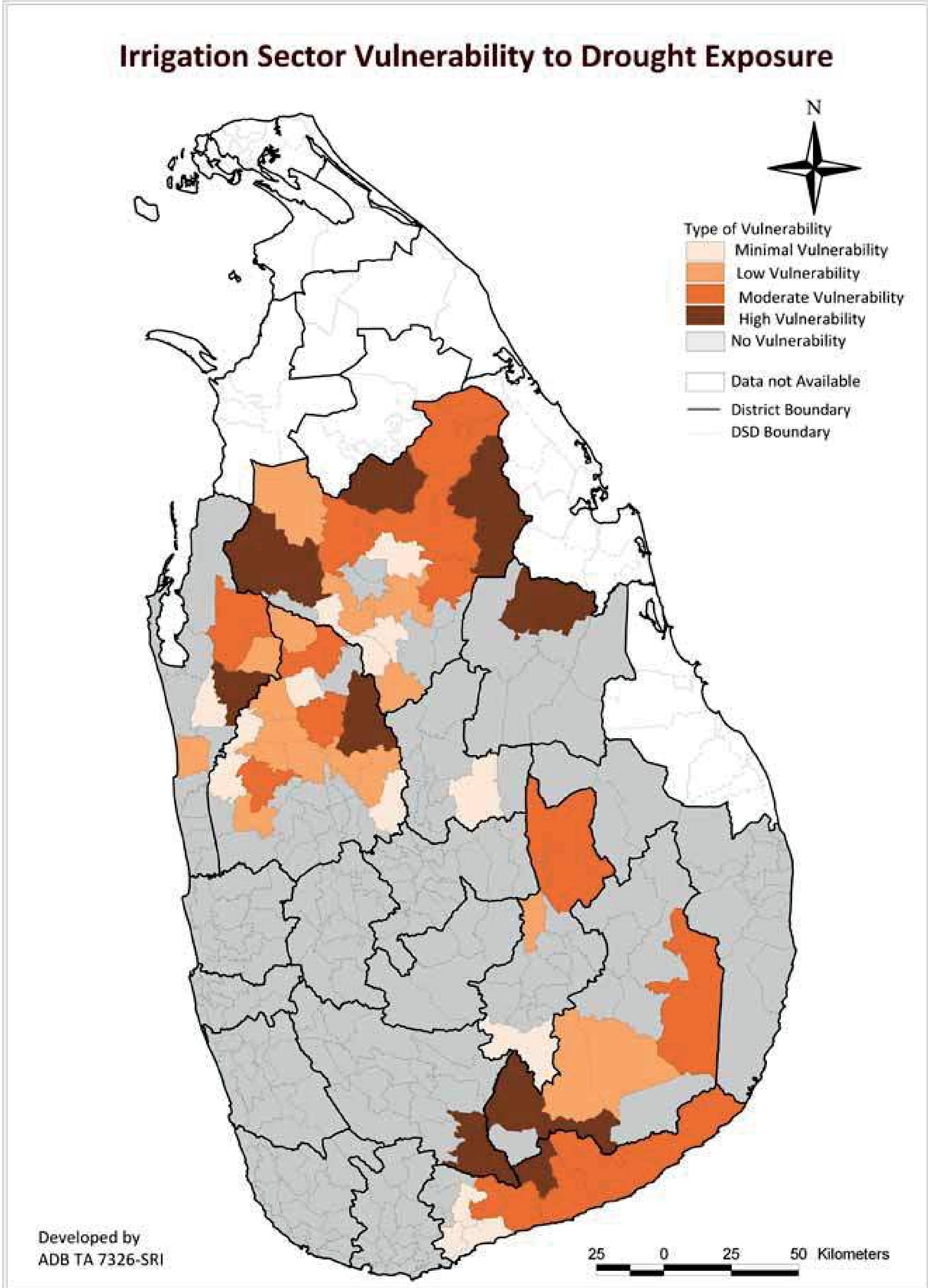
Irrigation Sector Vulnerability to Drought Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
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
Sources of raw data: Survey Department 1:50,000 topographic maps, Population and Housing Census, 2001	

Some of the key findings include:

- 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 27.6 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.


Irrigation Sector Vulnerability to Drought Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 Kilometers

Irrigation Sector Vulnerability to Drought Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Moneragala	Thanamalwila	661.4470	23172	35	5893	0	23172	0	35.80	14.18
2	Puttalam	Anamaduwa	259.0095	33302	129	9039	0	33302	0	16.77	22.53
3	Anuradhapura	Horowpothana	845.8179	29642	35	7578	0	29642	0	24.95	14.78
4	Anuradhapura	Nochchiyagama	843.5736	41601	49	11239	0	41601	0	16.98	19.61
5	Kurunegala	Polpithigama	417.5552	67263	161	18926	0	67263	0	30.00	18.13
6	Polonnaruwa	Medirigiriya	570.3679	57899	102	15189	0	57899	0	13.37	14.73
7	Hambantota	Suriyawewa	189.7447	35529	187	9031	0	35529	0	34.80	17.37
8	Rathnapura	Embilipitiya	383.4799	119563	312	29126	0	119490	73	31.60	21.16
9	Anuradhapura	Medawachchiya	492.1070	40469	82	10338	0	40469	0	21.34	24.09
10	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
11	Anuradhapura	Kahatagasdigiliya	366.6055	33572	92	8619	0	33572	0	19.63	20.03
12	Kurunegala	Panduwasnuwara	216.0387	69888	323	18130	0	69888	0	18.90	28.69
13	Moneragala	Siyambalanduwa	1065.6754	47438	45	10808	0	47438	0	51.80	13.52
14	Hambantota	Tissamaharama	783.8008	60982	78	14829	0	60486	496	32.20	22.31
15	Anuradhapura	Rambewa	303.6555	31604	104	8230	0	31592	12	20.57	19.54
16	Anuradhapura	Padaviya	242.5157	21146	87	5452	0	21146	0	34.33	14.43
17	Kurunegala	Mahawa	260.6953	50576	194	13674	0	50576	0	20.90	21.83
18	Badulla	Rideemaliyadda	438.2808	45759	104	10681	0	45582	177	51.15	14.89
19	Puttalam	Karuwalagaswewa	503.9380	20225	40	5550	0	20225	0	23.77	14.80
20	Hambantota	Angunukolapeles	174.0781	42426	244	10394	0	42426	0	33.00	16.83
21	Anuradhapura	Galenbidunuwawe	288.1528	40888	142	10454	0	40888	0	18.56	21.42
22	Kurunegala	Galgamuwa	273.2962	47844	175	12759	0	47844	0	25.70	22.00
23	Hambantota	Lunugamvehera	300.3473	25226	84	6922	0	25226	0	33.50	17.85
24	Anuradhapura	Kebithigollewa	611.9821	19457	32	4903	0	19457	0	27.74	18.03
25	Anuradhapura	Nuwaragam Palatha Central	389.4952	53665	138	13055	11598	42067	0	20.14	20.32
26	Badulla	Mahiyanganaya	598.4674	67301	112	16499	0	67301	0	38.57	20.02
27	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
28	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
29	Kurunegala	Kuliyapitiya West	163.9366	71483	436	18666	6290	65102	91	16.62	32.77
30	Kurunegala	Giribawa	207.1489	28093	136	7831	0	28093	0	24.00	19.56
31	Moneragala	Wellawaya	585.9537	50768	87	12698	0	50768	0	24.90	17.79
32	Kurunegala	Kotawehera	182.1192	19273	106	5323	0	19273	0	21.70	26.07
33	Anuradhapura	Thalawa	220.5999	50919	231	13375	0	50919	0	19.44	22.25
34	Anuradhapura	Maha Vilachchiya	624.8276	18557	30	4630	0	18557	0	31.16	17.85
35	Kurunegala	Wariyapola	201.7589	56880	282	15207	0	56832	48	18.90	29.42
36	Anuradhapura	Palagala	226.9676	29837	131	8196	0	29837	0	23.83	21.98
37	Badulla	Kandaketiya	152.6207	22494	147	5425	0	21428	1066	46.10	14.56
38	Kurunegala	Kobeigane	130.8780	32230	246	8581	0	32230	0	19.10	24.70
39	Moneragala	Buttala	735.5660	47324	64	11843	0	47324	0	21.20	22.01
40	Kurunegala	Ibbagamuwa	219.4878	76344	348	19589	0	75913	431	24.30	26.50
41	Kurunegala	Ganewatta	147.1195	36812	250	9830	0	36770	42	23.20	22.57
42	Kurunegala	Nikaweratiya	152.4124	36370	239	9549	0	36370	0	19.40	24.93
43	Anuradhapura	Thirappane	278.9562	23378	84	6143	0	23378	0	18.59	23.27
44	Puttalam	Nawagattegama	171.9949	12956	75	3519	0	12956	0	26.44	13.19
45	Puttalam	Mahakumbukkadawala	175.8432	16905	96	4686	0	16905	0	28.65	15.18
46	Kurunegala	Bingiriya	195.2943	55763	286	15223	0	55613	150	16.80	24.53
47	Kurunegala	Ambanpola	142.5265	19964	140	5488	0	19964	0	23.10	23.46
48	Anuradhapura	Galnewa	140.2283	30344	216	8165	0	30344	0	18.46	20.55
49	Badulla	Haldummulla	414.9996	38223	92	9855	0	23207	15016	31.65	18.09
50	Matale	Laggala-Pallegama	373.8370	12399	33	3305	0	12055	344	34.60	19.05
51	Kurunegala	Rasnayakapura	125.8909	18814	149	5071	0	18678	136	23.00	20.46
52	Anuradhapura	Mihintale	234.9169	26786	114	6657	1523	25263	0	18.97	29.03

Sector Specific Data							DSD Name	Rank
Area of Tanks (Sq. km)[a]	No of Tanks[a]	Irrigation Paddy Area (Acres)[g]	Rainfed Paddy Area (Acres)[g]	Agriculture Employment[b]	% Agri. Employment[a]	HH with Agri. as Primary Source of Income[d and a]		
27.61	464	5085	146	6399	71.65	90.47	Thanamalwila	1
16.62	303	8414	180	5029	42.23	53.90	Anamaduwa	2
49.61	383	14587	3452	7078	67.17	66.38	Horowpothana	3
50.26	401	13470	0	11806	65.34	61.10	Nochchiyagama	4
12.57	316	12276	4804	16728	63.17	64.82	Polpithigama	5
33.41	70	22062	1947	15957	63.87	65.74	Medirigiriya	6
6.39	95	7875	47	9155	66.46	91.26	Suriyawewa	7
5.95	18	3163	119	18476	44.61	59.45	Embilipitiya	8
37.35	325	13929	722	6942	45.31	56.96	Medawachchiya	9
11.43	49	9719	0	8618	42.08	65.72	Ambalantota	10
36.93	263	13344	1433	7335	61.07	65.34	Kahatagasdigiliya	11
11.83	457	8560	1139	8305	34.17	49.50	Panduwasnuwara	12
13.11	80	5533	4438	12160	71.93	72.51	Siyambalanduwa	13
30.41	139	11893	79	7508	38.82	75.66	Tissamaharama	14
25.84	189	13843	946	5825	54.27	60.45	Rambewa	15
31.71	45	8189	578	3504	52.30	72.81	Padaviya	16
14.13	476	8476	3210	9748	48.32	45.30	Mahawa	17
6.27	37	8604	3306	14647	75.27	73.06	Rideemaliyadda	18
20.01	170	7075	86	4418	53.91	57.82	Karuwalagaswewa	19
4.00	99	14498	40	8646	62.15	65.13	Angunukolapeles	20
30.76	175	14527	744	12235	71.60	67.98	Galenbidunuwawe	21
25.02	180	8943	1038	7860	48.13	61.39	Galgamuwa	22
10.35	118	11278	20	4659	56.17	72.23	Lunugamvehera	23
26.75	277	10672	383	4377	56.58	70.38	Kebithigollewa	24
32.23	196	10808	40	6161	30.23	50.32	Nuwaragam Palatha Central	25
16.88	57	17698	3230	15925	60.46	73.06	Mahiyanganaya	26
13.27	115	18184	0	3949	26.25	65.72	Hambantota	27
9.68	41	2916	801	2954	23.69	36.39	Arachchikattuwa	28
2.36	76	2676	2696	5408	22.19	39.13	Kuliyapitiya West	29
17.17	122	9098	111	7598	67.89	82.07	Giribawa	30
13.64	129	4085	20	11478	59.13	69.07	Wellawaya	31
11.15	270	5671	1124	5077	64.23	51.27	Kotawehera	32
18.73	106	12533	35	12371	61.56	68.55	Thalawa	33
23.60	129	5303	47	4617	61.54	63.99	Maha Vilachchiya	34
8.21	352	5678	2580	7233	35.08	42.13	Wariyapola	35
14.97	90	10719	633	8831	72.81	75.20	Palagala	36
0.19	6	3558	84	6095	72.27	88.42	Kandaketiya	37
5.94	221	3324	722	4575	40.87	51.98	Kobeigane	38
17.88	182	7996	516	9228	55.00	70.86	Buttala	39
7.38	111	6395	3333	11965	41.49	48.68	Ibbagamuwa	40
2.81	130	4742	1273	5631	42.10	49.57	Ganewatta	41
11.00	200	7683	620	5508	41.48	51.05	Nikaweratiya	42
24.32	167	6818	544	5981	60.77	60.37	Thirappane	43
6.11	93	5036	25	3347	66.19	76.12	Nawagattegama	44
11.67	95	4166	351	1846	34.49	48.68	Mahakumbukkadawala	45
5.79	164	3269	2493	5029	27.37	38.13	Bingiriya	46
8.54	200	5063	591	3979	52.47	59.67	Ambanpola	47
7.64	56	12756	10	7530	61.92	61.35	Galnewa	48
1.33	28	2073	0	8982	61.86	56.56	Haldummulla	49
0.20	5	2916	171	3708	66.71	64.89	Laggala-Pallegama	50
5.52	112	3684	840	3416	53.49	53.26	Rasnayakapura	51
28.40	151	4910	213	3483	38.67	52.67	Mihintale	52

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households [b]	Urban Population [b]	Rural Population [b]	Estate Population [b]	% in Poverty [c]	% Completed Secondary Education[a]
53	Hambantota	Weeraketiya	115.4094	37401	324	9208	0	55459	0	32.50	21.20
54	Anuradhapura	Ipalogama	142.4270	32933	231	8730	0	31992	941	17.41	25.86
55	Anuradhapura	Thambuttegama	111.4855	36524	328	9448	0	36524	0	19.05	22.52
56	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
57	Kurunegala	Rideegama	222.5431	80473	362	21118	0	78808	1665	32.76	26.28
58	Hambantota	Beliatta	102.5034	52283	510	12630	0	52283	0	28.30	36.26

Sector Specific Data							DSD Name	Rank
Area of Tanks (Sq. km)[a]	No of Tanks[a]	Irrigation Paddy Area (Acres)[g]	Rainfed Paddy Area (Acres)[g]	Agriculture Employment[b]	% Agri. Employment[a]	HH with Agri. as Primary Source of Income[d and a]		
3.75	63	4001	82	4818	42.74	61.13	Weeraketiya	53
9.37	69	8584	215	6284	52.10	56.24	Ipalogama	54
5.54	41	7687	0	9073	58.46	75.39	Thambuttegama	55
2.92	90	4547	7	4235	21.52	45.96	Tangalle	56
0.48	23	2844	4386	8311	31.92	46.08	Rideegama	57
0.75	33	2409	1117	2703	19.03	50.75	Beliatta	58

Agriculture and Fisheries

Agriculture and livestock are important sectors for the national development of Sri Lanka. The government developmental policies envisage an agricultural renaissance, with special attention on the paddy farmer. The aim is to achieve self sufficiency in food crops and milk for the people, and also to generate agricultural crops and livestock for the export market. The fishery sector on the other hand, earns valuable foreign exchange through the export of marine and aquaculture products, and provides direct employment to 208,731 people island wide, while sustaining over 2.5 million people. The fishery sector is important as a livelihood source as well as a source of protein for the people of Sri Lanka.

Paddy

The gross total extent of paddy land cultivation in 2009 was approximately 980,000 ha for the whole country during both Yala and Maha seasons. Sri Lanka's paddy fields are both rainfed and irrigated where paddies in the Dry Zone are rain-fed from the North-East monsoon during the Maha season and irrigated in the Yala season. Paddy fields in the Wet Zone are mostly rainfed. The national paddy production is currently adequate to satisfy the country's domestic requirements. However, a reduction in the production in of rice (by 5.8%) was observed in 2009 compared to the highest ever production of 3.87 million MT in 2008. This was mainly due to insufficient water for cultivation during the Yala season due to delayed monsoon rains. There is already recognition that the country needs to adapt or prepare itself for the implications of future climate change. Very high genetic variation among indigenous rice varieties is an indicator of excellent potential for varietal improvement for adaptation. The need for development of different age groups of paddy (short term and long term varieties) to suit unpredictable rainfall regimes is also recognized by the Department of Agriculture. Already several New Improved Varieties with varying yield times have been developed. Overall, the extent of paddy lands has increased since the establishment of peace, due to the re-use of a large extent of abandoned paddy lands in the Northern and Eastern Provinces.

Saline intrusion due to sea level rise and storm surges are bound to exacerbate with lowered river flows during drought which are expected to increase with climate change. In coastal areas, surface and groundwater will be affected, restricting freshwater availability for farming communities and agricultural activities leading to reduced agricultural productivity. Salt water intrusion may be felt up to considerable distances inland along rivers discharging to the sea, and could degrade arable coastal land, particularly paddy fields, causing them to be abandoned. Paddy lands in Kalutara, Batticaloa and the northern peninsula are expected to be most at risk.

The higher variability of rainfall due to climate change will adversely affect some agro-ecological regions, and hence affect rice production – especially rainfed paddy comprising over 30% of all rice paddies in the country. The Dry Zone, where nearly 70% of the paddy is cultivated in Sri Lanka, is already showing an increasing number of consecutive dry days due to rainfall variability. Further incidences of drought and variability in rainfall is bound to adversely affect paddy yields. This may cause serious socio-economic impacts and imperil the future food security of the country. Similarly, high intensity rainfall and prolonged floods can also cause destruction to paddy.

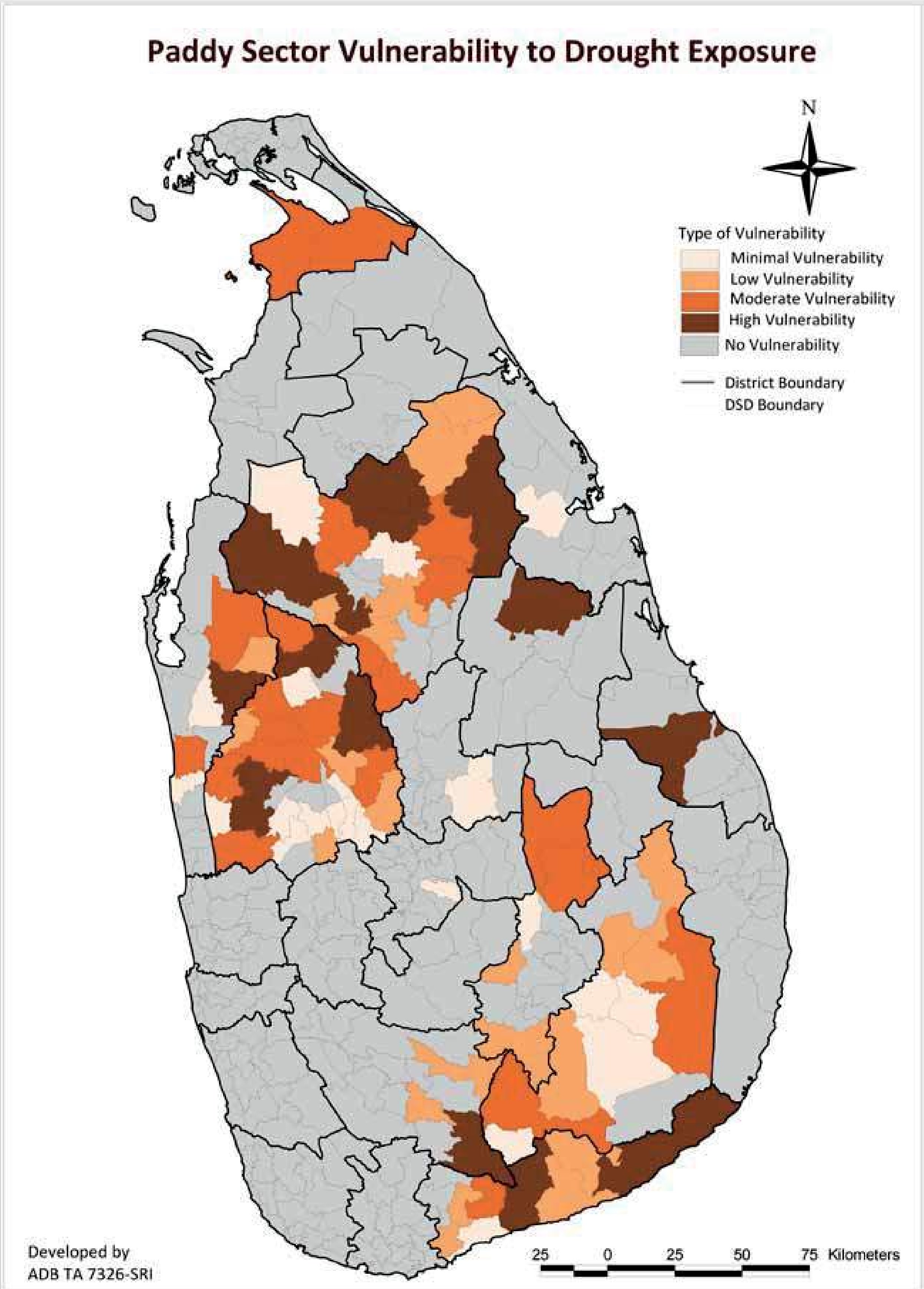
Paddy Sector Vulnerability to Drought Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
Data (at DSD level) on: • Area of paddy cultivation (Asveddumized paddy)	A composite of data (at DSD level) on: • Percentage of people employed in agriculture with education below O/L • Percentage of landless paddy farmers • Percentage agriculture share in income (among those employed in agriculture) • Percentage of paddy land not fed by major irrigation
Raw data sources: Census of Agriculture 2002, Department of Census and Statistics	

Some of the key findings include:

- Vulnerability to the increase in droughts expected due to climate change is widespread throughout the country and is concentrated in the Dry and Intermediate Zones.
- 16 DSDs emerge as highly vulnerable to drought exposure. These DSDs have:
  - o 100,317 households with agriculture as primary source of income.
  - o 400,973 ac of agricultural lands of which 176,852 ac (44.1%) are cultivated with paddy.
  - o 3153 tanks covering a total area of 88,395 ac.
- Anamaduwa (Puttalam District), Ambalantota (Hambantota District), and Polpithigama (Kurunegala District) emerge as the DSDs most vulnerable.
  - o In these DSDs farmers, on average, earn 63% of their income from agriculture.
- A further 23 DSDs emerge as moderately vulnerable to drought exposure. These DSDs have:
  - o 195,573 agricultural operators.
  - o 174,839 ac of paddy lands.
  - o 3,901 tanks covering a total area of 80,675 ac.


Paddy Sector Vulnerability to Drought Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Paddy Sector Vulnerability to Drought Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households [b]	Urban Population [b]	Rural Population [b]	Estate Population [b]	% in Poverty [c]	% Completed Secondary Education[a]
1	Puttalam	Anamaduwa	259.0095	33302	129	9039	0	33302	0	16.77	22.53
2	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
3	Kurunegala	Polpithigama	417.5552	67263	161	18926	0	67263	0	30.00	18.13
4	Rathnapura	Embilipitiya	383.4799	119563	312	29126	0	119490	73	31.60	21.16
5	Polonnaruwa	Medirigiriya	570.3679	57899	102	15189	0	57899	0	13.37	14.73
6	Kurunegala	Kuliyapitiya West	163.9366	71483	436	18666	6290	65102	91	16.62	32.77
7	Anuradhapura	Thalawa	220.5999	50919	231	13375	0	50919	0	19.44	22.25
8	Batticaloa	Eravur Pattu	612.3070								
9	Hambantota	Suriyawewa	189.7447	35529	187	9031	0	35529	0	34.80	17.37
10	Kurunegala	Panduwasnuwara	216.0387	69888	323	18130	0	69888	0	18.90	28.69
11	Anuradhapura	Nochchiyagama	843.5736	41601	49	11239	0	41601	0	16.98	19.61
12	Anuradhapura	Horowpothana	845.8179	29642	35	7578	0	29642	0	24.95	14.78
13	Hambantota	Tissamaharama	783.8008	60982	78	14829	0	60486	496	32.20	22.31
14	Anuradhapura	Medawachchiya	492.1070	40469	82	10338	0	40469	0	21.34	24.09
15	Kurunegala	Galgamuwa	273.2962	47844	175	12759	0	47844	0	25.70	22.00
16	Anuradhapura	Rambewa	303.6555	31604	104	8230	0	31592	12	20.57	19.54
17	Badulla	Mahiyanganaya	598.4674	67301	112	16499	0	67301	0	38.57	20.02
18	Hambantota	Angunukolapeles	174.0781	42426	244	10394	0	42426	0	33.00	16.83
19	Moneragala	Siyambalanduwa	1065.6754	47438	45	10808	0	47438	0	51.80	13.52
20	Anuradhapura	Galenbidunuwawe	288.1528	40888	142	10454	0	40888	0	18.56	21.42
21	Anuradhapura	Kahatagasdigiliya	366.6055	33572	92	8619	0	33572	0	19.63	20.03
22	Kurunegala	Wariyapola	201.7589	56880	282	15207	0	56832	48	18.90	29.42
23	Anuradhapura	Galnewa	140.2283	30344	216	8165	0	30344	0	18.46	20.55
24	Kurunegala	Ibbagamuwa	219.4878	76344	348	19589	0	75913	431	24.30	26.50
25	Kurunegala	Mahawa	260.6953	50576	194	13674	0	50576	0	20.90	21.83
26	Kurunegala	Nikaweratiya	152.4124	36370	239	9549	0	36370	0	19.40	24.93
27	Kurunegala	Kobeigane	130.8780	32230	246	8581	0	32230	0	19.10	24.70
28	Anuradhapura	Palagala	226.9676	29837	131	8196	0	29837	0	23.83	21.98
29	Kurunegala	Giribawa	207.1489	28093	136	7831	0	28093	0	24.00	19.56
30	Badulla	Rideemaliyadda	438.2808	45759	104	10681	0	45582	177	51.15	14.89
31	Kurunegala	Bingiriya	195.2943	55763	286	15223	0	55613	150	16.80	24.53
32	Kurunegala	Kotawehera	182.1192	19273	106	5323	0	19273	0	21.70	26.07
33	Kilinochchi	Poonakary	558.4683								
34	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
35	Puttalam	Karuwalagaswewa	503.9380	20225	40	5550	0	20225	0	23.77	14.80
36	Kilinochchi	Karachchi	621.6203								
37	Anuradhapura	Nuwaragam Palatha Central	389.4952	53665	138	13055	11598	42067	0	20.14	20.32
38	Kurunegala	Pannala	284.9191	114438	402	29467	0	113726	712	17.80	31.16
39	Moneragala	Thanamalwila	661.4470	23172	35	5893	0	23172	0	35.80	14.18
40	Hambantota	Lunugamvehera	300.3473	25226	84	6922	0	25226	0	33.50	17.85
41	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
42	Kurunegala	Ganewatta	147.1195	36812	250	9830	0	36770	42	23.20	22.57
43	Anuradhapura	Kebithigollewa	611.9821	19457	32	4903	0	19457	0	27.74	18.03
44	Moneragala	Madulla	722.5206	28358	39	6678	0	28358	0	40.70	19.44
45	Rathnapura	Godakawela	155.7512	69123	444	16962	0	57669	11454	38.20	20.31
46	Kurunegala	Rideegama	222.5431	80473	362	21118	0	78808	1665	32.76	26.28
47	Anuradhapura	Padaviya	242.5157	21146	87	5452	0	21146	0	34.33	14.43
48	Badulla	Haldummulla	414.9996	38223	92	9855	0	23207	15016	31.65	18.09
49	Moneragala	Wellawaya	585.9537	50768	87	12698	0	50768	0	24.90	17.79
50	Anuradhapura	Thambuttegama	111.4855	36524	328	9448	0	36524	0	19.05	22.52
51	Hambantota	Weeraketiya	115.4094	37401	324	9208	0	55459	0	32.50	21.20
52	Kurunegala	Rasnayakapura	125.8909	18814	149	5071	0	18678	136	23.00	20.46

Land Utilization within Agricultural Holdings						Sector Specific Data						DSD Name	Rank
Total Extent of Holdings (Acres)[d]	Aswed-dumized Paddy (Acres)[d]	Temp. Crops other than Aswed-dumized Paddy (Acres)[d]	Perm. Crops (Acres)[d]	Forest Land (Acres)[d]	Other Land (Acres)[d]	Rainfed Paddy (Acres)[g]	Irrigated Paddy (Acres)[g]	Non Paddy Temp. Crops (Acres)[d]	Total Population of Agri. hh (5 ac - le than 10 Acres)[d]	Total Agri. Operators [d]	HH with Agri. as Primary Source of Income[d]		
19439	7347	2231	6221	2310	1330	180	8414	2231	3001	7445	3993	Anamaduwa	1
21017	12198	2162	4872	487	1298	0	9719	2162	3126	8966	5898	Ambalantota	2
39693	14325	5177	15404	2423	2364	4804	12276	5177	5520	16447	10625	Polpithigama	3
41930	8551	7968	18816	3544	3051	119	3163	7968	5028	20930	12435	Embilipitiya	4
29714	17124	1313	6803	1544	2930	1947	22062	1313	531	13352	6945	Medirigiriya	5
19648	3955	327	13803	306	1257	2696	2676	327	2346	11354	4442	Kuliyapitiya West	6
25927	16434	1518	5055	1134	1786	35	4030	1518	3091	11281	7668	Thalawa	7
18955	14352	2420	1190	192	801	21735	12484	2420	4444	3580	2894	Eravur Pattu	8
19629	5970	8671	2541	1105	1342	47	2137	8671	3738	7383	6587	Suriyawewa	9
28170	7642	299	18435	175	1619	1139	8560	299	3465	12558	6308	Panduwasnuwara	10
23135	12180	4081	3603	1230	2041	0	4569	4081	3041	9310	5763	Nochchiyagama	11
22207	14557	2079	2848	1345	1378	3452	14587	2079	4971	7054	4673	Horowpothana	12
19398	9526	4094	3604	1145	1029	79	11893	4094	3214	8302	6359	Tissamaharama	13
23828	10674	4492	4543	1650	2469	722	13929	4492	4187	9215	5252	Medawachchiya	14
27216	10496	4503	5420	5274	1523	1038	8943	4503	4564	10553	6499	Galgamuwa	15
21067	11521	2556	3285	1869	1836	946	13843	2556	4850	6575	3976	Rambewa	16
30387	17054	4433	5967	1501	1432	3230	17698	4433	2231	12698	9390	Mahiyanganaya	17
20551	10185	2450	5781	1164	971	40	5478	2450	3292	8740	5662	Angunukolapeles	18
38422	8283	15734	8557	3505	2343	4438	5533	15734	11625	10293	7417	Siyambalanduwa	19
25773	13205	4173	4899	1163	2333	744	14527	4173	4082	9726	6569	Galenbidunuwawe	20
19794	9691	3697	3420	1198	1788	1433	13344	3697	3115	8240	5370	Kahatagasdigiliya	21
24713	6362	721	15298	1175	1157	2580	5678	721	3234	11060	4687	Wariyapola	22
14837	8887	1166	2664	630	1490	10	2083	1166	1334	6943	4289	Galnewa	23
23214	8071	435	12640	516	1552	3333	6395	435	2067	12336	6030	Ibbagamuwa	24
30696	8370	4699	12250	2950	2427	3210	8476	4699	4805	11949	5423	Mahawa	25
20070	7036	2228	6215	3141	1450	620	7683	2228	3032	7759	3917	Nikaweratiya	26
15533	3322	754	9834	641	982	722	3324	754	2021	6736	3498	Kobeigane	27
15762	8706	1883	3423	675	1075	633	5192	1883	1599	6993	5251	Palagala	28
16632	7581	2002	3714	2147	1188	111	9098	2002	2704	6404	5121	Giribawa	29
30443	10010	7997	8344	2486	1606	3306	8604	7997	6119	10178	7405	Rideemaliyadda	30
22151	4228	254	15339	756	1574	2493	3269	254	2102	11983	4556	Bingiriya	31
17991	5523	2511	3784	5523	650	1124	5671	2511	3806	5031	2556	Kotawehera	32
8795	4729	1805	1780	254	227	10065	1359	1805	2475	2388	2013	Poonakary	33
13234	2651	395	7448	1361	1379	801	2916	395	1802	5904	2146	Arachchikattuwa	34
12040	5002	960	3103	1735	1240	86	7075	960	1942	4143	2404	Karuwalagaswewa	35
19741	9284	3413	5023	419	1602	3635	17755	3413	5102	7544	5707	Karachchi	36
19849	6771	4027	4281	1341	3429	40	10808	4027	2589	8773	4393	Nuwaragam Palatha Central	37
28284	5721	334	19461	493	2275	6736	1527	334	3183	14161	6066	Pannala	38
17167	4167	6306	4227	989	1478	146	5085	6306	2598	5591	5097	Thanamalwila	39
17071	9384	3363	1401	2391	532	20	11278	3363	1715	6199	4289	Lunugamvehera	40
11482	5179	2757	1151	1059	1336	0	7337	2757	2073	4728	3070	Hambantota	41
15663	4921	789	7694	622	1637	1273	4742	789	2127	6875	3368	Ganewatta	42
12461	8231	333	2678	693	526	383	10672	333	2102	4412	3118	Kebithigollewa	43
24796	3021	6804	9961	3466	1544	2308	1065	6804	7763	6232	5041	Madulla	44
13977	1648	175	10209	1116	829	578	1727	175	1360	8053	4561	Godakawela	45
26197	5572	256	17773	860	1736	4386	2844	256	2865	13473	6174	Rideegama	46
13577	7117	1286	2630	1529	1015	578	8189	1286	4677	4355	3186	Padaviya	47
11094	1834	808	5175	2144	1133	0	2073	808	1245	4867	2734	Haldummulla	48
26611	3143	11708	7443	1473	2844	20	4085	11708	3943	10885	7636	Wellawaya	49
14783	11040	79	2725	240	699	0	0	79	1059	6592	5025	Thambuttegama	50
17631	3603	1226	11507	567	728	937	1918	1226	2346	7868	4664	Weeraketiya	51
12430	3066	1524	5133	2099	608	840	3684	1524	2420	4400	2309	Rasnayakapura	52

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
53	Badulla	Uva Paranagama	137.2816	76524	557	19213	0	65809	10715	33.35	19.52
54	Moneragala	Medagama	241.1373	32467	135	7664	0	32467	0	30.20	14.89
55	Kurunegala	Polgahawela	97.3861	58762	603	14506	0	57940	822	22.91	35.64
56	Anuradhapura	Thirappane	278.9562	23378	84	6143	0	23378	0	18.59	23.27
57	Hambantota	Beliatta	102.5034	52283	510	12630	0	52283	0	28.30	36.26
58	Puttalam	Nawagattegama	171.9949	12956	75	3519	0	12956	0	26.44	13.19
59	Rathnapura	Balangoda	274.1594	77303	282	18720	11402	58032	7869	27.30	27.22
60	Anuradhapura	Ipalogama	142.4270	32933	231	8730	0	31992	941	17.41	25.86
61	Anuradhapura	Mihintale	234.9169	26786	114	6657	1523	25263	0	18.97	29.03
62	Kurunegala	Kurunegala	111.0680	88944	801	20292	28401	60369	174	14.70	44.87
63	Anuradhapura	Maha Vilachchiya	624.8276	18557	30	4630	0	18557	0	31.16	17.85
64	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
65	Moneragala	Buttala	735.5660	47324	64	11843	0	47324	0	21.20	22.01
66	Badulla	Kandaketiya	152.6207	22494	147	5425	0	21428	1066	46.10	14.56
67	Matale	Laggala-Pallegama	373.8370	12399	33	3305	0	12055	344	34.60	19.05
68	Kurunegala	Ambanpola	142.5265	19964	140	5488	0	19964	0	23.10	23.46
69	Puttalam	Mahakumbukkadawala	175.8432	16905	96	4686	0	16905	0	28.65	15.18
70	Kurunegala	Kuliyapitiya East	113.2748	46966	415	11728	0	46839	127	20.32	27.57
71	Kurunegala	Narammala	108.3197	51244	473	13092	0	51244	0	21.40	33.36
72	Moneragala	Badalkumbura	235.9900	36784	156	9030	0	32733	4051	27.90	23.53
73	Moneragala	Sewanagala	191.9569	36820	192	9221	0	35739	1081	19.30	20.35
74	Kandy	Pathahewaheta	83.5016	53843	645	13229	0	51531	2312	26.60	30.92
75	Kurunegala	Mawathagama	109.6233	56820	518	14191	0	55013	1807	24.92	33.95
76	Moneragala	Moneragala	292.5414	42457	145	10071	0	39112	3345	29.30	23.23
77	Kurunegala	Weerambugedara	91.3110	30311	332	8085	0	30311	0	20.11	39.05
78	Trincomalee	Thampalakamam	267.0782								
79	Kurunegala	Mallawapitiya	79.9307	46575	583	11574	0	46240	335	19.50	33.19
80	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
81	Kurunegala	Udubaddawa	117.5985	48800	415	12669	0	48742	58	17.70	29.43

Land Utilization within Agricultural Holdings						Sector Specific Data						DSD Name	Rank
Total Extent of Holdings (Acres)[d]	Aswed-dumized Paddy (Acres)[d]	Temp. Crops other than Aswed-dumized Paddy (Acres)[d]	Perm. Crops (Acres)[d]	Forest Land (Acres)[d]	Other Land (Acres)[d]	Rainfed Paddy (Acres)[g]	Irrigated Paddy (Acres)[g]	Non Paddy Temp. crops (Acres)[d]	Total Population of Agri. hh (5 ac - le than 10 Acres)[d]	Total Agri. Operators [d]	HH with Agri. as Primary Source of Income[d]		
14085	3627	6531	2852	322	753	156	3805	6531	845	11379	8683	Uva Paranagama	53
16651	3619	1459	9107	1518	948	2748	1789	1459	1916	7157	4789	Medagama	54
12562	3901	87	7784	208	582	4801	413	87	1532	7042	3080	Polgahawela	55
14577	5747	3599	2562	1942	727	544	6818	3599	2292	5472	3315	Thirappane	56
17204	3048	237	12539	433	947	1117	2409	237	2691	7353	3713	Beliatta	57
8997	4601	759	1577	1581	479	25	5036	759	1042	3200	2435	Nawagattegama	58
16543	3312	1441	8455	1569	1766	670	3655	1441	1284	9813	6643	Balangoda	59
13323	6996	986	3160	1182	999	215	8584	986	1692	6007	3350	Ipalogama	60
12435	4175	2539	2966	1177	1578	213	4910	2539	2304	4877	2517	Mihintale	61
11182	3746	93	6361	184	798	3450	1500	93	1342	5415	1845	Kurunegala	62
13869	4070	5595	2532	329	1343	47	5303	5595	3246	4385	2813	Maha Vilachchiya	63
19264	3547	3667	8251	1846	1953	7	4547	3667	2945	8228	3786	Tangalle	64
24273	4498	4518	10146	1947	3164	516	7996	4518	6500	8719	6013	Buttala	65
8204	3749	578	2430	981	466	84	3558	578	627	3983	3544	Kandaketiya	66
7179	2825	349	2049	1263	693	171	2916	349	667	2868	1861	Laggala-Pallegama	67
12224	3757	2344	3003	2551	569	591	5063	2344	2047	4421	2645	Ambanpola	68
15837	2774	1157	6127	4285	1494	351	4166	1157	3297	4195	2025	Mahakumbukkadawala	69
13572	4006	73	8712	124	657	3435	1745	73	1639	6453	2805	Kuliyapitiya East	70
13216	3426	94	8399	216	1081	3899	561	94	1400	7445	2196	Narammala	71
17567	1615	1987	10035	2223	1707	297	1774	1987	2100	7637	5098	Badalkumbura	72
20748	3883	3578	8687	2974	1626	20	1265	3578	2	7566	6223	Sewanagala	73
8610	1732	1745	3843	543	747	42	2217	1745	635	5769	3262	Pathahewaheta	74
11687	2878	103	7484	376	846	3823	413	103	1258	6280	2003	Mawathagama	75
18742	1693	5256	7137	1332	3324	1302	969	5256	4172	6972	3873	Moneragala	76
11477	3303	55	7461	143	515	3810	430	55	1484	5273	1891	Weerambugedara	77
4281	3062	148	650	116	305	1552	5540	148	1412	1236	936	Thampalakamam	78
8328	2217	72	5323	157	559	2918	269	72	1055	4986	1431	Mallawapitiya	79
8185	1775	493	4984	316	617	759	1539	493	1019	3731	1524	Chilaw	80
13974	2401	74	10408	173	918	1416	1856	74	1645	7392	2482	Udubaddawa	81

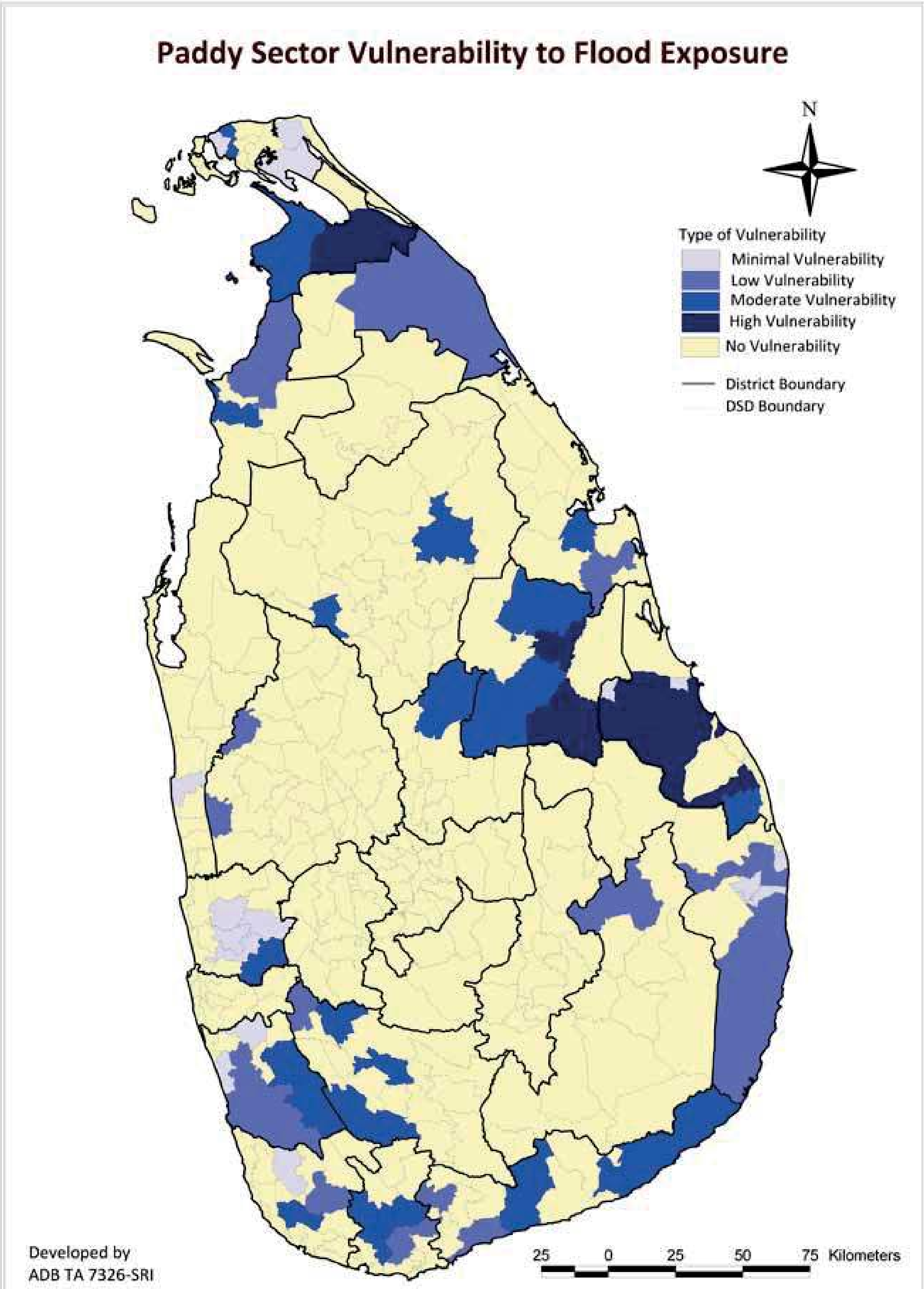
Paddy Sector Vulnerability to Flood Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
Data (at DSD level) on: • Area of paddy cultivation (Asveddumized paddy)	A composite of data (at DSD level) on: • Percentage of people employed in agriculture with education below O/L • Percentage of landless paddy farmers • Percentage agriculture share in income (among those employed in agriculture) • Percentage of paddy land not fed by major irrigation
Raw data sources: Census of Agriculture 2002, Department of Census and Statistics	

Some of the key findings include:

- 6 DSDs emerge as highly vulnerable to the increase in floods expected due to climate change. These DSDs have:
  - o 114,555 ac of agricultural lands of which 81,890 ac (71.5%) are cultivated with paddy.
  - o 27,557 households with agriculture as primary source of income.
  - o 283 tanks covering an area of 16,717 ac.
- A further 25 DSDs emerge as moderately vulnerable to flood exposure. These DSDs have
  - o 156,650 ac of paddy lands, and
  - o 109,052 households with agriculture as primary source of income.


Paddy Sector Vulnerability to Flood Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Paddy Sector Vulnerability to Flood Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics: Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Demographics: Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Polonnaruwa	Dimbulagala	552.3964	63349	115	16757	0	63339	10	22.59	18.60
2	Batticaloa	Eravur Pattu	612.3070								
3	Kilinochchi	Karachchi	621.6203								
4	Batticaloa	Manmunai South - West	150.8018								
5	Batticaloa	Koralai Pattu (Valach.)	593.7964								
6	Polonnaruwa	Lankapura	200.7756	33676	168	8611	0	33676	0	14.54	19.42
7	Matara	Mulatiyana	119.4139	46066	386	11169	0	45501	565	30.90	21.41
8	Matara	Akuressa	148.6167	49806	335	11825	0	48508	1298	21.90	24.28
9	Polonnaruwa	Thamankaduwa	465.7376	74224	159	17920	0	73956	268	14.15	28.23
10	Rathnapura	Pelmadulla	144.8430	84966	587	19906	560	73480	10926	30.20	26.35
11	Polonnaruwa	Medirigiriya	570.3679	57899	102	15189	0	57899	0	13.37	14.73
12	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
13	Gampaha	Dompe	182.1586	130021	714	31962	0	130021	0	21.10	31.48
14	Polonnaruwa	Elahera	353.1772	39908	113	10446	0	39908	0	18.45	17.46
15	Matale	Dambulla	455.1342	60976	134	15285	0	60959	17	19.90	23.88
16	Trincomalee	Kinniya	151.4995								
17	Rathnapura	Kalawana	384.7488	48669	126	11905	0	44632	4037	36.40	23.93
18	Matara	Malimbada	47.9781	31524	657	7577	0	31384	140	24.30	31.38
19	Rathnapura	Kuruwita	174.6734	85882	492	20460	0	80326	5556	28.90	23.57
20	Jaffna	Sandilipay	48.1604								
21	Kalutara	Bulathsinhala	209.4387	59787	285	15611	0	53331	6456	27.40	22.09
22	Hambantota	Tissamaharama	783.8008	60982	78	14829	0	60486	496	32.20	22.31
23	Anuradhapura	Kahatagasdigiliya	366.6055	33572	92	8619	0	33572	0	19.63	20.03
24	Galle	Baddegama	114.4507	68634	600	16761	0	66249	2385	21.70	30.17
25	Kilinochchi	Poonakary	558.4683								
26	Batticaloa	Porativu Pattu	174.9570								
27	Kalutara	Palindanuwara	283.2330	45911	162	11597	0	40298	5613	30.70	22.88
28	Matara	Athuraliya	65.9339	30179	458	7039	0	29380	799	27.80	26.77
29	Hambantota	Suriyawewa	189.7447	35529	187	9031	0	35529	0	34.80	17.37
30	Anuradhapura	Thambuttegama	111.4855	36524	328	9448	0	36524	0	19.05	22.52
31	Mannar	Nanaddan	147.6092								
32	Ampara	Samanthurai	123.0101	51510	419	11729	0	51510	0		20.13
33	Matara	Hakmana	49.6219	30201	609	7190	0	30201	0	32.00	29.15
34	Ampara	Alayadiwembu	82.5912	22627	274	4956	0	22627	0		22.67
35	Mannar	Manthai West	609.4103								
36	Ampara	Pothuvil	271.8310	28480	105	6693	0	28480	0		13.45
37	Kalutara	Walallawita	213.2047	50676	238	12793	0	47579	3097	31.40	25.28
38	Ampara	Thirukkovil	187.0859	23700	127	5427	0	23700	0		20.88
39	Rathnapura	Eheliyagoda	141.9292	63870	450	15566	0	61593	2277	26.90	26.60
40	Matara	Kaburupitiya	59.7187	37347	625	9079	0	37347	0	24.90	31.28
41	Mulattivu	Pudukudiyirippu	1002.7885								
42	Mulattivu	Maritimepattu	756.2531								
43	Kurunegala	Rasnayakapura	125.8909	18814	149	5071	0	18678	136	23.00	20.46
44	Ampara	Lahugala	923.3049	7623	8	1888	0	7623	0		15.57
45	Kalutara	Millaniya	82.0638	44476	542	11035	0	43110	1366	16.90	30.71
46	Moneragala	Bibila	483.5204	35490	73	8817	0	34818	672	26.00	17.05
47	Galle	Nagoda	174.6178	52414	300	13028	0	46707	5707	28.70	23.04
48	Kalutara	Dodangoda	112.8241	55052	488	13646	0	47970	7082	21.20	27.42
49	Ampara	Ampara	139.2692	38166	274	8713	17957	20209	0		30.45
50	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
51	Ampara	Addalachchenai	56.9586	36020	632	7640	0	36020	0		17.64
52	Matara	Thihagoda	50.9425	30909	607	7529	0	30909	0	27.20	30.07
53	Kurunegala	Udubaddawa	117.5985	48800	415	12669	0	48742	58	17.70	29.43

Land Utilization within Agricultural Holdings						Sector Specific Data						DSD Name	Rank
Total Extent of Holdings (Acres)[d]	Aswed-dumized Paddy (Acres)[d]	Temp. Crops other than Aswed-dumized Paddy (Acres)[d]	Perm. Crops (Acres)[d]	Forest Land (Acres)[d]	Other Land (Acres)[d]	Rainfed Paddy (Acres)[g]	Irrigated Paddy (Acres)[g]	Non Paddy Temp. crops (Acres)[d]	Total population of Agri. hh (5 ac - le than 10 Acres)[d]	Total Agri. Operators [d]	HH with Agri. as Primary Source of Income[d]		
39611	29574	923	5147	1737	2230	0	33515	923	356	7230	10198	Dimbulagala	1
18955	14352	2420	1190	192	801	21735	12484	2420	4444	3580	2894	Eravur Pattu	2
19741	9284	3413	5023	419	1602	3635	17755	3413	5102	7544	5707	Karachchi	3
8612	7828	453	227	12	92	8849	6652	453	1874	2314	2178	Manmunai South-West	4
10216	7914	1387	682	36	197	0	57	1387	2020	2394	1892	Koralai Pattu (Valach.)	5
17420	12938	440	2206	449	1387	247	14629	440	579	5537	4688	Lankapura	6
16471	2755	314	11541	774	1087	2004	1043	314	428	8690	4414	Mulatiyana	7
13970	3170	325	8464	593	1418	2674	1451	325	253	8036	5426	Akuressa	8
20085	13660	761	3640	831	1193	138	16781	761	547	6799	4698	Thamankaduwa	9
12035	1886	144	8299	619	1087	803	1804	144	1040	8321	4873	Pelmadulla	10
29714	17124	1313	6803	1544	2930	1947	22062	1313	531	13352	6945	Medirigiriya	11
21017	12198	2162	4872	487	1298	0	9719	2162	3126	8966	5898	Ambalantota	12
22102	3984	1028	15526	421	1143	3899	877	1028	2451	12061	4120	Dompe	13
20168	12708	736	3251	938	2535	460	14559	736	193	10584	5410	Elahera	14
25755	9287	6624	6496	2218	1130	815	10386	6624	3680	10295	6251	Dambulla	15
2502	1750	377	253	26	96	2807	3319	377	463	1254	1011	Kinniya	16
19905	2140	134	13315	2853	1463	1848	1290	134	2705	8389	6556	Kalawana	17
6462	2770	57	2804	135	696	2128	724	57	141	3995	1258	Malimbada	18
12810	1798	403	8557	678	1374	1834	2273	403	1015	7983	4494	Kuruwita	19
2822	1671	325	630	6	190	0	0	325	71	2660	1657	Sandilipay	20
18827	3384	712	12196	1202	1333	4203	346	712	2115	8938	4490	Bulathsinhala	21
19398	9526	4094	3604	1145	1029	79	11893	4094	3214	8302	6359	Tissamaharama	22
19794	9691	3697	3420	1198	1788	1433	13344	3697	3115	8240	5370	Kahatagasdigiliya	23
13506	4143	189	11495	690	1235	4910	0	189	1339	9296	3996	Baddegama	24
8795	4729	1805	1780	254	227	10065	1359	1805	2475	2388	2013	Poonakary	25
10142	8144	1007	661	59	271	8169	14273	1007	1230	3507	2542	Porativu Pattu	26
19411	2755	345	12708	2009	1594	2854	618	345	2136	7951	5738	Palindanuwara	27
7839	2713	104	3890	382	750	1161	1999	104	153	4620	2197	Athuraliya	28
19629	5970	8671	2541	1105	1342	47	2137	8671	3738	7383	6587	Suriyawewa	29
14783	11040	79	2725	240	699	0	0	79	1059	6592	5025	Thambuttegama	30
9131	7654	322	615	64	476	0	11051	322	1797	2078	1724	Nanaddan	31
11331	10933	77	191	2	128	662	21602	77	2221	2250	1685	Samanthurai	32
9322	2360	81	6004	196	681	1485	1203	81	349	4387	1779	Hakmana	33
6310	5947	32	138	78	115	1688	14031	32	825	984	770	Alayadiwembu	34
5343	3660	558	603	168	354	25	6635	558	1094	1488	1357	Manthai West	35
3875	3688	10	83	51	43	7416	8883	10	1121	797	521	Pothuvil	36
21882	4525	254	13637	1700	1766	4226	282	254	2663	9560	4821	Walallawita	37
3260	2706	122	390	4	38	6084	5105	122	545	812	565	Thirukkovil	38
11761	1754	798	7870	639	700	902	1357	798	843	6739	1825	Eheliyagoda	39
9051	2874	30	5185	223	739	1559	2172	30	262	5283	1325	Kaburupitiya	40
12353	3567	3694	4488	132	472	2375	2721	3694	2598	4541	3959	Pudukudiyirippu	41
8473	4421	1157	2248	99	548	3917	5108	1157	1840	2299	1829	Maritimepattu	42
12430	3066	1524	5133	2099	608	840	3684	1524	2420	4400	2309	Rasnayakapura	43
5107	2901	1116	651	234	205	811	3012	1116	1115	1289	870	Lahugala	44
7966	2849	226	4012	226	653	2847	437	226	1035	4034	1512	Millaniya	45
16988	3750	1886	8254	1322	1776	1110	2970	1886	2245	7370	4355	Bibila	46
14097	2915	86	14296	585	1493	3116	284	86	1064	1856	6354	Nagoda	47
6716	2297	201	3384	207	627	2978	141	201	804	3619	758	Dodangoda	48
9208	5294	734	1780	800	600	304	5471	734	1643	3575	2283	Ampara	49
19264	3547	3667	8251	1846	1953	7	4547	3667	2945	8228	3786	Tangalle	50
5081	4445	174	362	30	70	1181	9103	174	1004	1258	894	Addalachchenai	51
7192	3835	68	2705	118	466	1011	4015	68	189	3904	1340	Thihagoda	52
13974	2401	74	10408	173	918	1416	1856	74	1645	7392	2482	Udubaddawa	53

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households [b]	Urban Population [b]	Rural Population [b]	Estate Population [b]	% in Poverty [c]	% Completed Secondary Education[a]
54	Kalutara	Mathugama	134.3624	73269	545	17604	0	66781	6488	29.40	28.65
55	Trincomalee	Seruvila	270.3615								
56	Kalutara	Agalawatta	89.7814	33962	378	8423	0	32768	1194	26.40	33.03
57	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20
58	Hambantota	Walasmulla	109.0750	39010	358	9443				33.40	23.96
59	Gampaha	Minuwangoda	133.2225	151661	1138	37683	7567	144084	10	12.50	38.36
60	Gampaha	Gampaha	90.6959	171040	1886	41357	9284	161756	0	9.90	43.27
61	Ampara	Akkaraipattu	60.4089	34939	578	7649	0	34939	0		26.00
62	Kalutara	Horana	112.7795	90690	804	22048	9127	80042	1521	8.40	42.98
63	Ampara	Ninthavur	36.3016	24625	678	6235	0	24625	0		22.78
64	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
65	Gampaha	Attanagalla	154.3057	154967	1004	36838	0	154821	146	15.40	39.55
66	Kalutara	Kaluthara	77.6779	141829	1826	31857	37451	104378	0	12.50	38.35
67	Ampara	Eragama	66.6480	11344	170	2632	0	11344	0		13.35
68	Jaffna	Chavakachcheri	222.1802								
69	Gampaha	Mahara	94.2988	176870	1876	41639	0	176870	0	12.10	37.86
70	Galle	Elpitiya	151.2593	60292	399	15049	0	58153	2139	22.70	26.49
71	Jaffna	Chankanai	48.0547								
72	Jaffna	Karaveddy	90.6898								
73	Batticaloa	Koralai P.W. (Oddamavadi)	39.1499								

Land Utilization within Agricultural Holdings						Sector Specific Data						DSD Name	Rank
Total Extent of Holdings (Acres)[d]	Aswed-dumized Paddy (Acres)[d]	Temp. Crops other than Aswed-dumized Paddy (Acres)[d]	Perm. Crops (Acres)[d]	Forest Land (Acres)[d]	Other Land (Acres)[d]	Rainfed Paddy (Acres)[g]	Irrigated Paddy (Acres)[g]	Non Paddy Temp. Crops (Acres)[d]	Total population of Agri. hh (5 ac - le than 10 Acres)[d]	Total Agri. Operators [d]	HH with Agri. as Primary Source of Income[d]		
10764	3593	239	5051	619	1262	3291	603	239	1060	6193	1563	Mathugama	54
4652	2990	202	750	370	340	1236	5980	202	693	1667	1368	Seruvila	55
9712	2354	223	5536	716	883	1930	882	223	921	4866	2090	Agalawatta	56
7898	2245	363	3726	377	1187	1569	136	363	777	5611	984	Beruwala	57
16836	2349	333	12497	631	1026	82	4001	333	2216	7513	4666	Walasmulla	58
18244	3096	133	12919	192	1904	3042	892	133	2144	10860	2526	Minuwangoda	59
9476	2737	98	5656	77	908	1107	2165	98	809	7107	1759	Gampaha	60
6461	6170	23	187	9	72	163	11293	23	2281	2117	1162	Akkaraipattu	61
11716	3506	314	6732	227	937	3608	1008	314	997	7063	2027	Horana	62
4693	4376	12	262	1	42	0	0	12	676	915	641	Ninthavur	63
8185	1775	493	4984	316	617	759	1539	493	1019	3731	1524	Chilaw	64
16611	3170	355	11503	362	1221	3267	717	355	1797	9911	2614	Attanagalla	65
6180	2279	234	2775	235	657	1206	37	234	689	3731	703	Kaluthara	66
2958	2585	17	276	2	78	494	5340	17	531	606	361	Eragama	67
10518	4694	1048	3643	452	681	0	0	1048	970	6442	4237	Chavakachcheri	68
11556	2340	301	7330	157	1428	2884	306	301	1406	6534	1718	Mahara	69
15855	4368	317	13917	1040	1354	0	0	317	1413	5418	4544	Elpitiya	70
2540	1858	128	419	2	133	0	0	128	52	1799	894	Chankanai	71
3110	1920	546	402	16	226	0	0	546	104	2372	1291	Karaveddy	72
2056	1979	12	27	2	36	91	3324	12	1543	654	397	Koralai P.W. (Oddamavadi)	73

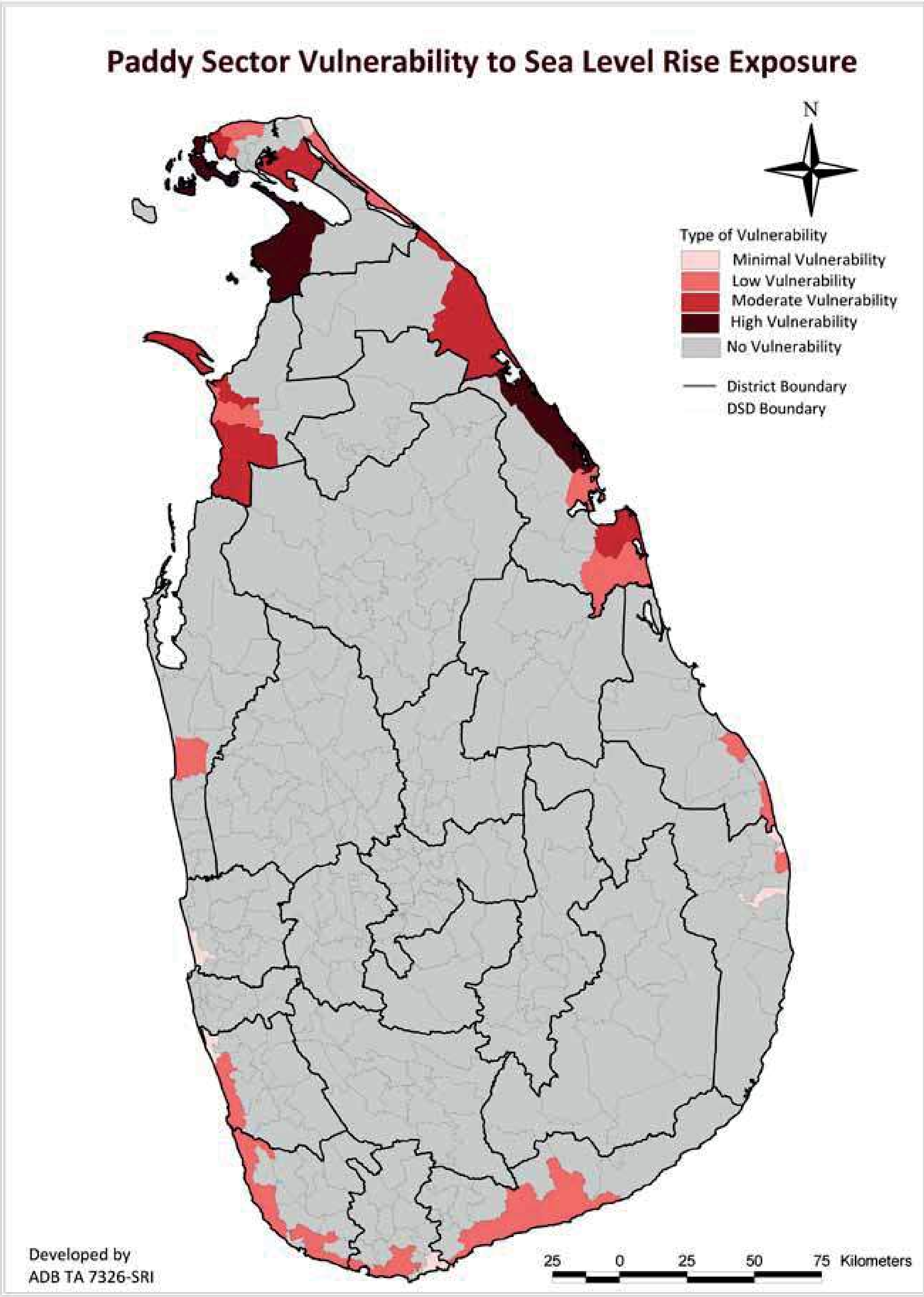
Paddy Sector Vulnerability to Sea Level Rise Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	**The Adaptive Capacity Index**
Data (at DSD level) on: • Area of paddy cultivation (Asveddumized paddy) within 5km from the coast line	A composite of data (at DSD level) on: • Percentage of people employed in agriculture with education below O/L • Percentage of landless paddy farmers • Percentage agriculture share in income (among those employed in agriculture) • Percentage of paddy land not fed by major irrigation
Raw data sources: Census of Agriculture 2002, Department of Census and Statistics	

Some of the key findings include:

- The highest levels of paddy sector vulnerability to sea level rise exposure appear to be concentrated in the North/Northeast of the island.
- 4 DSDs emerge highly vulnerable to sea level rise, all of which are in the Northern part of the country. These 4 DSDs have:
    - o A total paddy cultivation area of 5,898 ac of which 16.4% are located within 5 km from the coastline and below 2m.
- A further 6 DSDs, also in the Northern part of the country, emerge as having moderate vulnerability. These 6 DSDs have:
    - o A total paddy cultivation area of 730 ac of which 1.8% are located within 5 km from the coastline and below 2m.
    - o 4,394 jobs in agriculture.


Paddy Sector Vulnerability to Sea Level Rise Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25
0
25
50
75
Kilometers

Paddy Sector Vulnerability to Sea Level Rise Exposure

High Vulnerability — Moderate Vulnerability — Low Vulnerability — Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics: Area (Sq. km)[a]	Physical Characteristics: Total Population[b]	Physical Characteristics: Population Density (Per Sq. km)[a]	Physical Characteristics: No. of Households[b]	Demographics: Urban Population[b]	Demographics: Rural Population[b]	Demographics: Estate Population[b]	Demographics: % in Poverty[c]	Demographics: % Completed Secondary Education[a]
1	Trincomalee	Kuchaveli	434.4600								
2	Jaffna	Velanai	85.4797								
3	Jaffna	Kayts	55.2340								
4	Kilinochchi	Poonakary	558.4683								
5	Jaffna	Chavakachcheri	222.1802								
6	Mannar	Mannar Town	207.1215								
7	Mulattivu	Maritimepattu	756.2531								
8	Trincomalee	Muttur	194.6406								
9	Jaffna	Chankanai	48.0547								
10	Mannar	Musalai	478.8201								
11	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
12	Batticaloa	Manmunai S. and Eruvilpattu	59.7398								
13	Trincomalee	Eachchilampattai	100.2010								
14	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
15	Matara	Weligama	43.1469	66459	1540	14825	21698	44761	0	21.50	30.48
16	Galle	Hikkaduwa	66.0971	98589	1492	22820	0	98539	50	24.90	33.61
17	Mannar	Nanaddan	147.6092								
18	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
19	Galle	Bentota	72.3358	46442	642	11015	0	46442	0	22.30	31.14
20	Galle	Ambalangoda	70.2467	71047	1011	17122	39302	51396	0	20.30	32.73
21	Galle	Balapitiya	54.5727	65346	1197	15054	0	65346	0	22.00	27.89
22	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20
23	Galle	Akmeemana	65.4509	63881	976	15110	0	63239	642	22.00	32.21
24	Galle	Habaraduwa	49.5183	59041	1192	13567	0	59041	0	28.70	29.53
25	Kalutara	Kaluthara	77.6779	141829	1826	31857	37451	104378	0	12.50	38.35
26	Galle	Bope-Poddala	29.1730	41612	1426	9732	0	41461	151	18.10	42.27
27	Trincomalee	Seruvila	270.3615								
28	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
29	Jaffna	Sandilipay	48.1604								
30	Trincomalee	Town & Gravets	132.1348								
31	Matara	Matara	56.1514	108238	1928	23705	42663	65575	0	16.90	42.45
32	Batticaloa	Manmunai North	66.4719								
33	Jaffna	Tellipallai	61.1745								
34	Matara	Thihagoda	50.9425	30909	607	7529	0	30909	0	27.20	30.07
35	Jaffna	Maruthnkerny	135.0921								
36	Ampara	Ninthavur	36.3016	24625	678	6235	0	24625	0		22.78
37	Matara	Dickwella	50.9687	51314	1007	11592	0	51314	0	22.70	31.87
38	Gampaha	Wattala	57.6911	160127	2776	36368	28740	131387	0	6.10	40.21
39	Jaffna	Point Pedro	36.9669								
40	Kalutara	Panadura	45.0310	163492	3631	37245	33514	129978	0	7.40	40.07
41	Ampara	Kalmunai	19.6568	70465	3585	15821	70465	0	0		28.44
42	Ampara	Akkaraipattu	60.4089	34939	578	7649	0	34939	0		26.00
43	Ampara	Karativu	8.9392	16365	1831	3641	0	16365	0		28.99

Land Utilization within Agricultural Holdings					Sector Specific Data				DSD Name	Rank
Total Extent of Holdings (Acres)[d]	Aswed-dumized Paddy (Acres)[d]	Temp. Crops other than Aswed-dumized Paddy (Acres)[d]	Perm. Crops (Acres)[d]	Forest Land (Acres)[d]	Other Land (Acres)[d]	Paddy Areas Below 2m within 5km from Coast Line (Acres)[a]	Paddy Areas Belonging to 5km from Coast Line (Acres)[a]	Total Paddy Area in DS (Acres)[a]		
1446	702	543	154	6	41	3988	17786	22150	Kuchaveli	1
995	135	309	449	10	92	784	4539	4539	Velanai	2
2320	951	382	844	1	142	317	3438	3438	Kayts	3
8795	4729	1805	1780	254	227	809	10258	13424	Poonakary	4
10518	4694	1048	3643	452	160	114	11060	11761	Chavakachcheri	5
3624	1441	57	1797	162	167	34	4978	8537	Mannar Town	6
8473	4421	1157	2248	99	548	187	7302	16082	Maritimepattu	7
5801	4747	356	459	23	217	12	7899	16846	Muttur	8
2540	1858	128	419	2	133	319	3548	3555	Chankanai	9
421	282	4	72	45	18	64	4703	6430	Musalai	10
21017	12198	2162	4872	487	1298	16	5161	15251	Ambalantota	11
1869	918	261	628	17	45	0	1684	1684	Manmunai S. and Eruvilpattu	12
3051	2348	508	190	1	3	0	2150	2482	Eachchilampattai	13
11482	5179	2757	1151	1059	1336	2	3750	7636	Hambantota	14
4892	1283	99	2933	111	466	180	2011	2011	Weligama	15
5720	1232	109	5171	300	817	51	2415	2415	Hikkaduwa	16
9131	7654	322	615	64	476	36	3970	12421	Nanaddan	17
19264	3547	3667	8251	1846	1953	19	4539	6715	Tangalle	18
6930	1666	72	6859	240	624	192	2806	5881	Bentota	19
8602	1893	98	8942	128	843	323	2308	3722	Ambalangoda	20
5698	862	154	6211	93	671	0	1335	1587	Balapitiya	21
7898	2245	363	3726	377	1187	89	3162	3465	Beruwala	22
8242	2023	84	7669	275	1024	211	1296		Akmeemana	23
5675	1567	75	4920	209	720	60	1649	1649	Habaraduwa	24
6180	2279	234	2775	235	657	32	3767	5462	Kaluthara	25
3558	1453	57	2406	130	402	232	944		Bope-Poddala	26
4652	2990	202	750	370	352	10	2008	7423	Seruvila	27
13234	2651	395	7448	1361	1379	356	3622	6827	Arachchikattuwa	28
2822	1671	325	630	6	190	101	3009	3065	Sandilipay	29
344	98	25	182	18	22	282	2376	2557	Town & Gravets	30
4641	974	57	2917	133	559	124	2881	3099	Matara	31
839	378	15	335	1	110	0	2059	2387	Manmunai North	32
1067	344	381	261		81	61	1544	1556	Tellipallai	33
7192	3835	68	2705	118	464	136	1403		Thihagoda	34
843	404	190	176	15	20	2	2407	2407	Maruthnkerny	35
4693	4376	12	262	1	42	14	6289	6520	Ninthavur	36
7578	1308	61	5042	260	907	122	1113	1136	Dickwella	37
2065	168	81	1249	140	680	0	2510	2957	Wattala	38
1257	358	412	341	6	140	3	1316	1316	Point Pedro	39
2448	446	81	1474	68	379	0	1822	1949	Panadura	40
1157	951	20	144		42	0	979	979	Kalmunai	41
6461	6170	23	187	9	72	0	1351	6813	Akkaraipattu	42
815	736	3	57	2	17	0	1146	1146	Karativu	43

Plantations

The plantation sector in Sri Lanla comprises tea, rubber, coconut and sugarcane, which together with other minor export crops such as coffee, cocoa, spices, cashew and arecanut are important for export earnings. Sri Lanka has around 709,000 ha under tea, rubber and coconut cultivation, 7320 ha under sugarcane, and 119,862 ha under other crops such as coffee, cocoa, spices, cashew, arecanut and betel leaves. About 300,000 small scale growers are involved with the cultivation of export crops. Tea and rubber plantations are concentrated in the Central and Sabragamuwa Provinces whereas coconut plantations are mainly located in the Kurunegala, Puttalam and Gampaha Districts.

Research carried out at the respective Tea, Rubber and Coconut Research Institutions, as well as selection by growers, has resulted in considerable diversification of cash crops from the originally introduced germplasm. This has served to produce high-yielding varieties that are also resistant to pests and disease and adverse climatic conditions. The main concerns to the plantations sector regarding climate change revolve around floods, droughts and landslides which are expected to increase in incidence. These disaster incidences are all linked to changes in anticipated and already felt rainfall patterns in the country.

The higher variability of rainfall due to climate change will adversely affect some agro-ecological regions, and hence affect the crops that they usually support. For example, high intensity rainfall will affect harvesting and soil erosion in tea lands and reduce the days suitable for rubber tapping. Associated severe soil erosion and loss of plant nutrients due to heavy surface run-off in agricultural lands located on steep slopes will affect production levels. Reduced annual rainfall leading to drought conditions could increase evapo-transpiration from the soil and plants, and deplete soil moisture reserves. This will be more apparent in the Dry Zone and the coastal areas. Changes in rainfall regimes could cause changes in the length of growing seasons for particular crops.

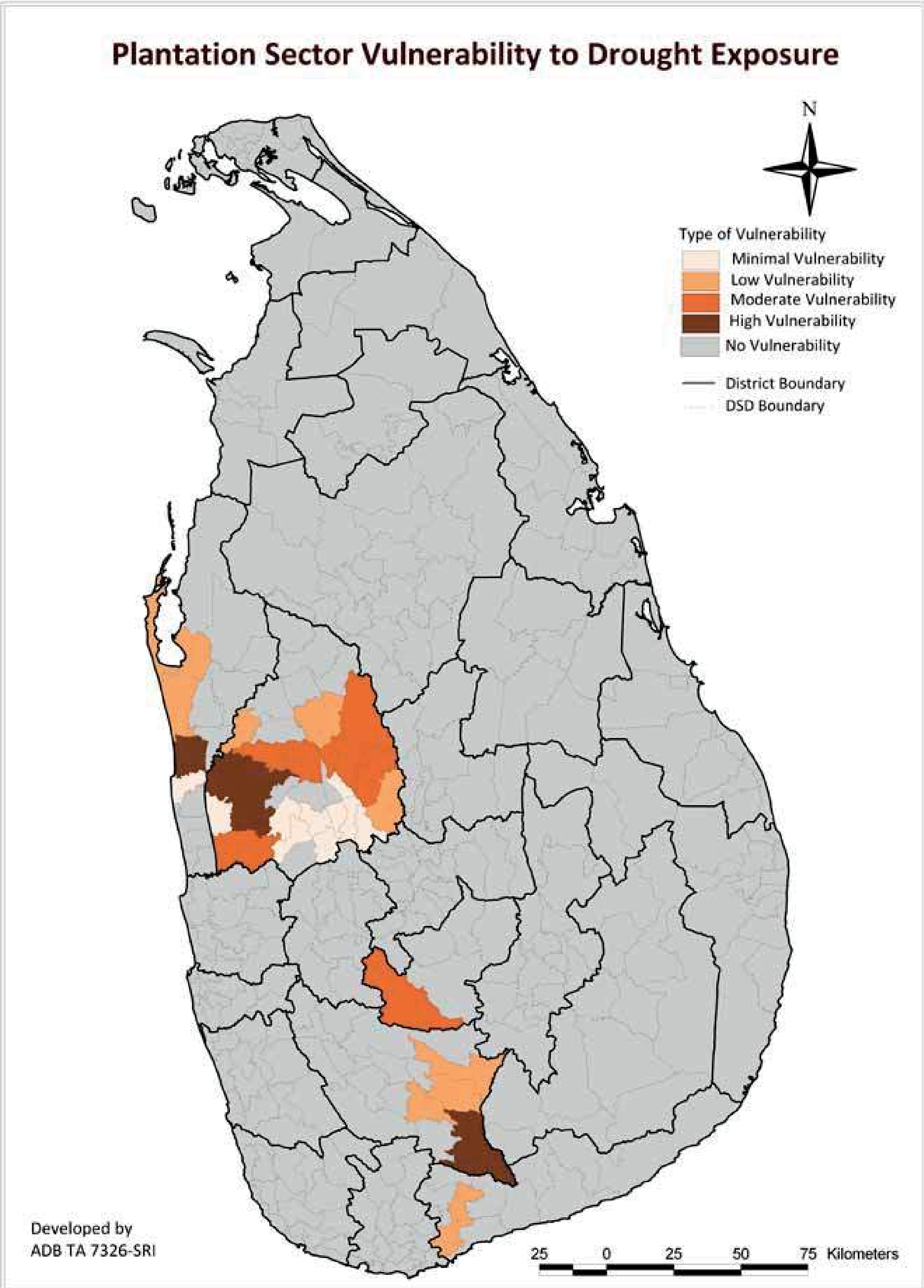
Plantation Sector Vulnerability to Drought Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • area of tea, rubber, and coconut lands • estate population	A composite of data (at DSD level) on: • Percentage of females who have not completed Grade 5 (among those employed in agriculture) • Percentage of population with less than O/L education (among those employed in agriculture) • Percentage agriculture share of income (among those employed in agriculture)
Raw data sources: Census of Agriculture 2002, Department of Census and Statistics	

Some of the key findings include:

- 5 DSDs emerge as highly vulnerable to drought exposure. These DSDs have:
  - o 88,069 ac of coconut cultivations, and negligible amounts of tea and rubber cultivations.
  - o A total population of 354,789 of whom 77,656 are below the poverty line.
  - o 40,172 jobs in agriculture.
- 7 additional DSDs are moderately vulnerable. These DSDs have:
  - o 108,340 ac of coconut, 54,230 ac of tea and very minimal rubber.
  - o A total of 10,522 jobs in agriculture, and an estate population of 143,272 .
- Of the 12 DSDs with high or moderate vulnerability to drought, 9 are in Kurunegala District. Plantations in these DSDs are primarily for coconut cultivation.


Plantation Sector Vulnerability to Drought Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25
0
25
50
75
Kilometers

Plantation Sector Vulnerability to Drought Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Kurunegala	Kuliyapitiya West	163.9366	71483	436	18666	6290	65102	91	16.62	32.77
2	Kurunegala	Panduwasnuwara	216.0387	69888	323	18130	0	69888	0	18.90	28.69
3	Rathnapura	Embilipitiya	383.4799	119563	312	29126	0	119490	73	31.60	21.16
4	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
5	Kurunegala	Bingiriya	195.2943	55763	286	15223	0	55613	150	16.80	24.53
6	Kurunegala	Polpithigama	417.5552	67263	161	18926	0	67263	0	30.00	18.13
7	Nuwara Eliya	Ambagamuwa	487.9105	203717	418	47145	14204	47474	142039	22.90	16.74
8	Kurunegala	Pannala	284.9191	114438	402	29467	0	113726	712	17.80	31.16
9	Kurunegala	Wariyapola	201.7589	56880	282	15207	0	56832	48	18.90	29.42
10	Kurunegala	Ibbagamuwa	219.4878	76344	348	19589	0	75913	431	24.30	26.50
11	Kurunegala	Kobeigane	130.8780	32230	246	8581	0	32230	0	19.10	24.70
12	Kurunegala	Ganewatta	147.1195	36812	250	9830	0	36770	42	23.20	22.57
13	Kurunegala	Rideegama	222.5431	80473	362	21118	0	78808	1665	32.76	26.28
14	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
15	Hambantota	Weeraketiya	115.4094	37401	324	9208	0	55459	0	32.50	21.20
16	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
17	Rathnapura	Weligepola	203.5279	29099	143	7690	0	28720	379	39.20	19.60
18	Hambantota	Beliatta	102.5034	52283	510	12630	0	52283	0	28.30	36.26
19	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
20	Kurunegala	Mahawa	260.6953	50576	194	13674	0	50576	0	20.90	21.83
21	Kurunegala	Rasnayakapura	125.8909	18814	149	5071	0	18678	136	23.00	20.46
22	Rathnapura	Godakawela	155.7512	69123	444	16962	0	57669	11454	38.20	20.31
23	Rathnapura	Balangoda	274.1594	77303	282	18720	11402	58032	7869	27.30	27.22
24	Kurunegala	Kuliyapitiya East	113.2748	46966	415	11728	0	46839	127	20.32	27.57
25	Kurunegala	Udubaddawa	117.5985	48800	415	12669	0	48742	58	17.70	29.43
26	Kurunegala	Polgahawela	97.3861	58762	603	14506	0	57940	822	22.91	35.64
27	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
28	Kurunegala	Kurunegala	111.0680	88944	801	20292	28401	60369	174	14.70	44.87
29	Kurunegala	Narammala	108.3197	51244	473	13092	0	51244	0	21.40	33.36
30	Kurunegala	Weerambugedara	91.3110	30311	332	8085	0	30311	0	20.11	39.05
31	Kurunegala	Mawathagama	109.6233	56820	518	14191	0	55013	1807	24.92	33.95
32	Kurunegala	Mallawapitiya	79.9307	46575	583	11574	0	46240	335	19.50	33.19

Land Utilization within Agricultural Holdings						Sector Specific Data							DSD Name	Rank
Total Extent of Holdings (Acres)[d]	Aswed-dumized Paddy (Acres)[d]	Temp. Crops other than Aswed-dumized Paddy (Acres)[d]	Perm. Crops (Acres)[d]	Forest Land (Acres)[d]	Other Land (Acres)[d]	Tea (Acres)[g]	Rubber (Acres)[g]	Coconut (Acres)[d]	Land Area <= 1/4 Acre Tea (Acres)[d]	Land Area <= 1/4 Acre Rubber (Acres)[d]	Educational Attainment of Agri. Operators % Less than OL[d]	Educational Attainment of Agri. Operators % Female Passed G 5 or below[d]		
19648	3955	327	13803	306	1257			19787	0	0	65.10	7.52	Kuliyapitiya West	1
28170	7642	299	18435	175	1619			22070	0	0	68.50	8.36	Panduwasnuwara	2
41930	8551	7968	18816	3544	3051	28	3	6937	28	3	85.20	7.57	Embilipitiya	3
13234	2651	395	7448	1361	1379			13945	0	0	78.00	10.04	Arachchikattuwa	4
22151	4228	254	15339	756	1574			25330	0	0	72.80	9.46	Bingiriya	5
39693	14325	5177	15404	2423	2364			14507	0	0	81.10	9.08	Polpithigama	6
8420	294	227	6115	785	999	54230	62	557	2727	19	72.40	11.73	Ambagamuwa	7
28284	5721	334	19461	493	2275		301	30157	0	96	65.40	6.50	Pannala	8
24713	6362	721	15298	1175	1157			19466	0	0	73.20	10.37	Wariyapola	9
23214	8071	435	12640	516	1552		218	18559	0	7	71.30	8.72	Ibbagamuwa	10
15533	3322	754	9834	641	982			12488	0	0	75.10	8.98	Kobeigane	11
15663	4921	789	7694	622	1637			12606	0	0	76.70	9.51	Ganewatta	12
26197	5572	256	17773	860	1736	101	1159	18043	77	172	72.10	10.89	Rideegama	13
11838	821	344	8989	1183	501			17879	0	0	81.40	8.68	Mundalama	14
17631	3603	1226	11507	567	728			8565	0	0	80.30	12.52	Weeraketiya	15
6734	242	54	4893	965	580			8970	0	0	79.70	11.35	Puttalam	16
14658	1556	2017	8992	1232	861	1436	252	5803	1170	252	83.60	7.86	Weligepola	17
17204	3048	237	12539	433	947		33	10084	0	28	64.50	10.36	Beliatta	18
9503	11	4018	4451	265	758			8270	0	0	83.00	6.33	Kalpitiya	19
30696	8370	4699	12250	2950	2427			8668	0	0	72.40	8.97	Mahawa	20
12430	3066	1524	5133	2099	608			6008	0	0	81.40	10.48	Rasnayakapura	21
13977	1648	175	10209	1116	829	5946	2516	5194	2855	776	76.50	6.69	Godakawela	22
16543	3312	1441	8455	1569	1766	7981	51	2574	4621	1	74.40	6.26	Balangoda	23
13572	4006	73	8712	124	657			12326	0	0	65.00	6.38	Kuliyapitiya East	24
13974	2401	74	10408	173	918			13190	0	0	62.40	7.55	Udubaddawa	25
12562	3901	87	7784	208	582		278	6903	0	204	55.50	5.68	Polgahawela	26
8185	1775	493	4984	316	617			6454	0	0	69.40	9.76	Chilaw	27
11182	3746	93	6361	184	798		292	9062	0	46	50.90	5.48	Kurunegala	28
13216	3426	94	8399	216	1081		101	9715	0	33	64.60	6.51	Narammala	29
11477	3303	55	7461	143	515		33	10006	0	21	59.00	6.88	Weerambugedara	30
11687	2878	103	7484	376	846		2955	7611	0	678	62.00	6.94	Mawathagama	31
8328	2217	72	5323	157	559		730	7906	0	27	61.20	6.72	Mallawapitiya	32

Plantation Sector Vulnerability to Flood Exposure

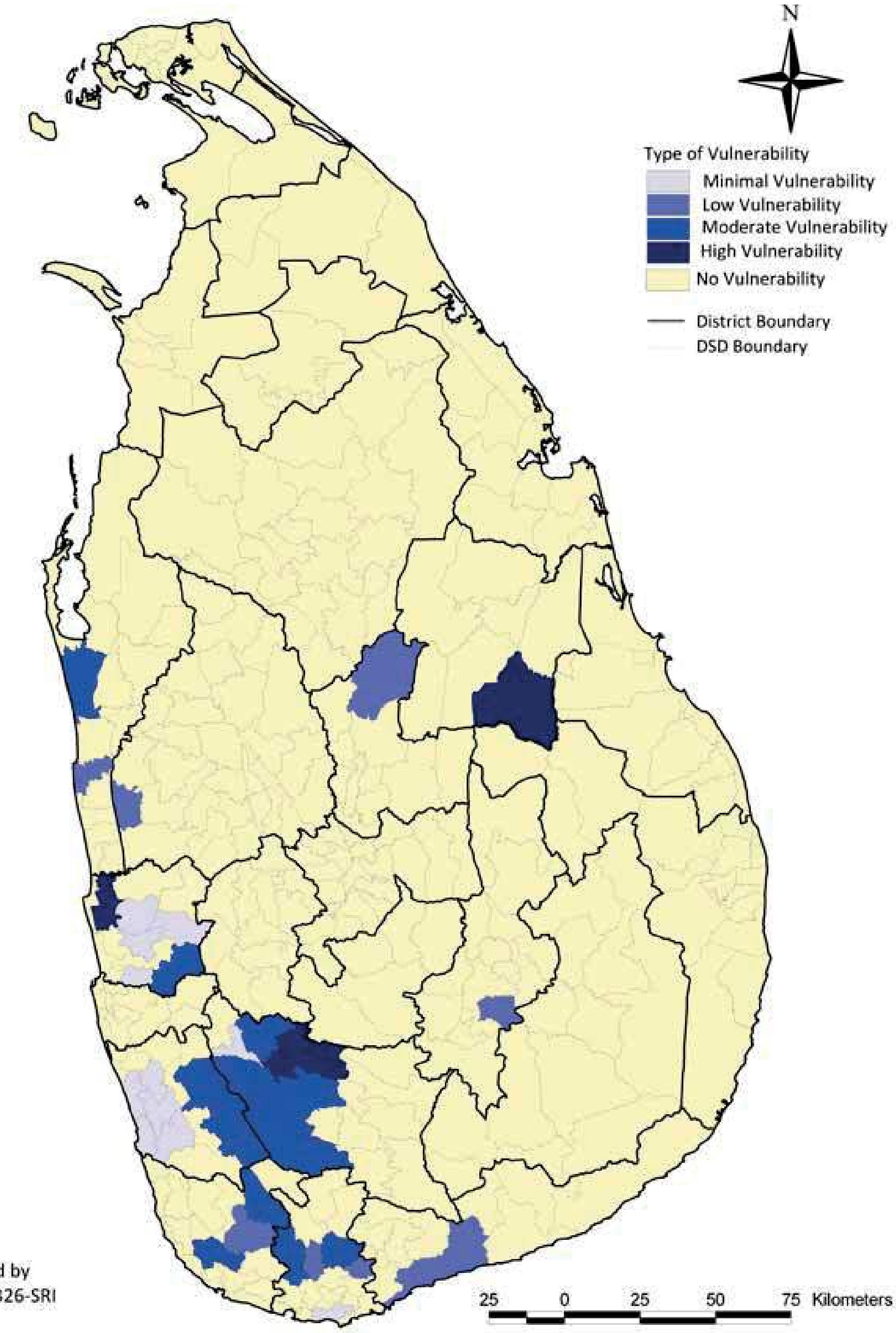
The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • area of tea, rubber, and coconut lands • estate population	A composite of data (at DSD level) on: • Percentage of females who have not completed Grade 5 (among those employed in agriculture) • Percentage of population with less than O/L education (among those employed in agriculture) • Percentage agriculture share of income (among those employed in agriculture)
Raw data sources: Census of Agriculture 2002, Department of Census and Statistics	

Some of the key findings include:

- 3 DSDs emerge as highly vulnerable to flood exposure. These DSDs have:
  - o 13,303 ac of tea cultivation, 2,640 ac of rubber, and 14,170 ac of coconut (36.7%, 6.5%, and 56.9% of total plantation area respectively).
  - o A total population of 401,255 of whom 51,521 are below the poverty line.
  - o 35,875 jobs in agriculture.
  - o An estate population of 16,391.
- 14 additional DSDs are moderately vulnerable. These DSDs have:
  - o 71,547 ac of tea, 64,084 ac of rubber, and 49,339 ac of coconut plantations.
  - o A total of 117,982 jobs in agriculture, and an estate population of 54,580.

Plantation Sector Vulnerability to Flood Exposure



Plantation Sector Vulnerability to Flood Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics: Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Demographics: Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Rathnapura	Rathnapura	326.7894	115223	353	26549	45623	53219	16381	21.90	30.01
2	Gampaha	Katana	124.9577	222683	1782	50765	73318	149365	0	7.70	41.14
3	Polonnaruwa	Dimbulagala	552.3964	63349	115	16757	0	63339	10	22.59	18.60
4	Rathnapura	Kalawana	384.7488	48669	126	11905	0	44632	4037	36.40	23.93
5	Kalutara	Bulathsinhala	209.4387	59787	285	15611	0	53331	6456	27.40	22.09
6	Matara	Mulatiyana	119.4139	46066	386	11169	0	45501	565	30.90	21.41
7	Galle	Thawalama	174.1470	31803	183	7710	0	30789	1014	29.50	19.99
8	Galle	Baddegama	114.4507	68634	600	16761	0	66249	2385	21.70	30.17
9	Kalutara	Palindanuwara	283.2330	45911	162	11597	0	40298	5613	30.70	22.88
10	Rathnapura	Ayagama	157.6893	28637	182	7357	0	25160	3477	33.70	21.37
11	Gampaha	Dompe	182.1586	130021	714	31962	0	130021	0	21.10	31.48
12	Matara	Akuressa	148.6167	49806	335	11825	0	48508	1298	21.90	24.28
13	Rathnapura	Pelmadulla	144.8430	84966	587	19906	560	73480	10926	30.20	26.35
14	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
15	Rathnapura	Nivithigala	157.9051	59092	374	13989	0	47942	11150	32.80	17.57
16	Rathnapura	Kuruwita	174.6734	85882	492	20460	0	80326	5556	28.90	23.57
17	Rathnapura	Elapatha	86.8547	36322	418	8828	0	34219	2103	40.10	22.39
18	Kurunegala	Udubaddawa	117.5985	48800	415	12669	0	48742	58	17.70	29.43
19	Badulla	Ella	109.3657	42894	392	10775	0	29156	13738	28.04	21.90
20	Matale	Dambulla	455.1342	60976	134	15285	0	60959	17	19.90	23.88
21	Matara	Hakmana	49.6219	30201	609	7190	0	30201	0	32.00	29.15
22	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
23	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
24	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
25	Matara	Athuraliya	65.9339	30179	458	7039	0	29380	799	27.80	26.77
26	Galle	Nagoda	174.6178	52414	300	13028	0	46707	5707	28.70	23.04
27	Gampaha	Minuwangoda	133.2225	151661	1138	37683	7567	144084	10	12.50	38.36
28	Rathnapura	Kiriella	79.5653	30881	388	7666	0	29748	1133	25.60	26.58
29	Kalutara	Millaniya	82.0638	44476	542	11035	0	43110	1366	16.90	30.71
30	Gampaha	Attanagalla	154.3057	154967	1004	36838	0	154821	146	15.40	39.55
31	Gampaha	Gampaha	90.6959	171040	1886	41357	9284	161756	0	9.90	43.27
32	Kalutara	Mathugama	134.3624	73269	545	17604	0	66781	6488	29.40	28.65
33	Kalutara	Dodangoda	112.8241	55052	488	13646	0	47970	7082	21.20	27.42
34	Gampaha	Biyagama	60.2668	161300	2676	36655	0	161300	0	11.30	41.68
35	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20
36	Matara	Matara	56.1514	108238	1928	23705	42663	65575	0	16.90	42.45
37	Kalutara	Kaluthara	77.6779	141829	1826	31857	37451	104378	0	12.50	38.35

Land Utilization within Agricultural Holdings						Sector Specific Data							DSD Name	Rank
Total Extent of Holdings (Acres)[d]	Aswed-dumized Paddy (Acres)[d]	Temp. Crops other than Aswed-dumized Paddy (Acres)[d]	Perm. Crops (Acres)[d]	Forest Land (Acres)[d]	Other Land (Acres)[d]	Tea (Acres)[g]	Rubber (Acres)[g]	Coconut (Acres)[d]	Land Area <= 1/4 Acre		Educational Attainment of Agri. Operators			
									Tea (Acres)[d]	Rubber (Acres)[d]	% Less than OL[d]	% Female Passed G 5 or Below[d]		
17045	1180	161	12346	1504	1854	13303	2619	1781	9130	1587	73.00	7.74	Rathnapura	1
7608	893	97	5622	81	915		21	8002	0	21	40.80	3.27	Katana	2
39611	29574	923	5147	1737	2230			4387	0	0	83.10	8.48	Dimbulagala	3
19905	2140	134	13315	2853	1463	11728	1337	1476	9528	1034	74.90	6.34	Kalawana	4
18827	3384	712	12196	1202	1333	3554	14515	2162	2325	7163	76.40	9.52	Bulathsinhala	5
16471	2755	314	11541	774	1087	3403	1423	2147	2878	954	77.00	11.25	Mulatiyana	6
12981	1583	136	14255	1032	1239	8896	331	1251	8393	258	75.10	9.60	Thawalama	7
13506	4143	189	11495	690	1235	6231	1461	2427	4945	214	81.20	14.71	Baddegama	8
19411	2755	345	12708	2009	1594	4878	10173	1398	4590	4960	75.80	8.63	Palindanuwara	9
11403	549	21	8950	1255	628	3861	5542	876	2816	3835	77.00	7.56	Ayagama	10
22102	3984	1028	15526	421	1143		3496	11710	0	3348	56.90	3.81	Dompe	11
13970	3170	325	8464	593	1418	7007	1071	1635	6005	472	76.50	8.31	Akuressa	12
12035	1886	144	8299	619	1087	8294	4973	2228	5868	1344	75.10	5.94	Pelmadulla	13
11838	821	344	8989	1183	501			17879	0	0	81.40	8.68	Mundalama	14
10294	1025	216	7025	855	1173	5828	7518	1531	4919	1484	79.00	6.64	Nivithigala	15
12810	1798	403	8557	678	1374	5566	7772	1702	4225	2985	73.70	5.44	Kuruwita	16
7588	1206	88	5034	529	731	2301	4472	917	1850	2254	72.00	4.55	Elapatha	17
13974	2401	74	10408	173	918			13190	0	0	62.40	7.55	Udubaddawa	18
5015	1100	726	2098	524	567	8063		120	1491	0	73.00	6.42	Ella	19
25755	9287	6624	6496	2218	1130		74	3774	0	6	81.50	5.39	Dambulla	20
9322	2360	81	6004	196	681	27	60	3315	27	59	66.80	10.10	Hakmana	21
19264	3547	3667	8251	1846	1953			5032	0	0	70.30	8.87	Tangalle	22
21017	12198	2162	4872	487	1298			3153	0	0	75.30	6.34	Ambalantota	23
8185	1775	493	4984	316	617			6454	0	0	69.40	9.76	Chilaw	24
7839	2713	104	3890	382	750	2856	1717	1220	2158	406	72.90	8.51	Athuraliya	25
14097	2915	86	14296	585	1493	9726	4329	1804	7911	339	31.10	2.37	Nagoda	26
18244	3096	133	12919	192	1904		405	13816	0	239	48.60	3.23	Minuwangoda	27
8750	1461	248	5763	483	795	1379	4328	959	993	3188	71.80	5.34	Kiriella	28
7966	2849	226	4012	226	653	34	3644	1602	25	2000	61.40	5.23	Millaniya	29
16611	3170	355	11503	362	1221	30	1451	11147	30	1030	50.40	3.70	Attanagalla	30
9476	2737	98	5656	77	908		286	6284	0	238	38.90	2.28	Gampaha	31
10764	3593	239	5051	619	1262	1201	9214	1955	975	2023	64.50	6.41	Mathugama	32
6716	2297	201	3384	207	627	105	8683	1459	83	1641	61.80	5.50	Dodangoda	33
5480	1290	87	3366	143	594		130	3607	0	130	37.80	2.36	Biyagama	34
7898	2245	363	3726	377	1187	10	2613	2991	8	1031	57.40	6.56	Beruwala	35
4641	974	57	2917	133	560		28	3016	0	29	47.10	5.38	Matara	36
6180	2279	234	2775	235	657	14	1125	2879	14	542	43.80	3.81	Kaluthara	37

Plantation Sector Vulnerability to Landslide Exposure

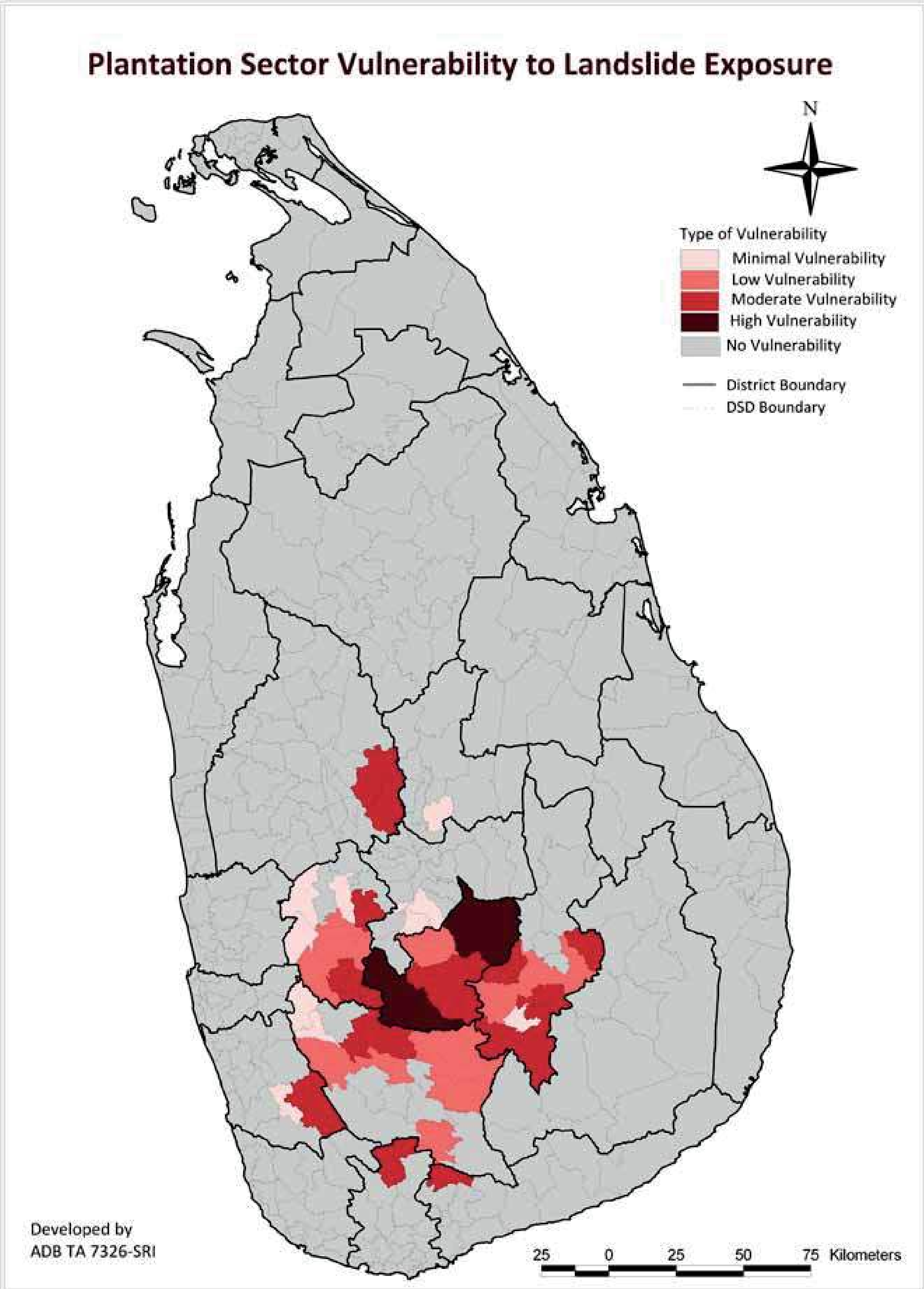
The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • area of tea, rubber, and coconut lands • estate population	A composite of data (at DSD level) on: • Percentage of females who have not completed Grade 5 (among those employed in agriculture) • Percentage of population with less than O/L education (among those employed in agriculture) • Percentage agriculture share of income (among those employed in agriculture)
Raw data sources: Census of Agriculture 2002, Department of Census and Statistics	

Some of the key findings include:

- 3 DSDs, all in the Nuwara Eliya District, emerge as highly vulnerable to landslide exposure. These DSDs have:
    - o 68,296 ac of tea plantations, and 2,383 ac of coconut plantations, while rubber lands are negligible.
    - o A total population of 397,911 of whom 102,470 are below the poverty line.
    - o 100,942 jobs in agriculture.
    - o An estate population of 195,151.

- 14 additional DSDs are moderately vulnerable in this regard. These DSDs have:
    - o 118,936 ac of tea, 51,810 ac of coconut, and 26,226 ac of rubber plantations.
    - o A total population of 993,467 and an estate population of 257,175 (25.9%).
    - o 196,292 jobs in agriculture.


Plantation Sector Vulnerability to Landslide Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25
0
25
50
75
Kilometers

Plantation Sector Vulnerability to Landslide Exposure

High Vulnerability — Moderate Vulnerability — Low Vulnerability — Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Nuwara Eliya	Walapane	321.5229	106434	331	26645	0	66727	39707	26.50	15.66
2	Nuwara Eliya	Ambagamuwa	487.9105	203717	418	47145	14204	47474	142039	22.90	16.74
3	Nuwara Eliya	Hanguranketha	228.6220	87760	384	22524	0	74355	13405	34.60	19.18
4	Rathnapura	Rathnapura	326.7894	115223	353	26549	45623	53219	16381	21.90	30.01
5	Badulla	Bandarawela	70.0596	60269	860	14379	7296	44049	8924	21.61	32.66
6	Nuwara Eliya	Nuwara Eliya	483.5716	208190	431	49385	28869	36922	142399	21.90	18.93
7	Kegalle	Deraniyagala	222.0806	44735	201	11336	0	34377	10358	33.60	19.57
8	Matara	Kotapola	179.3289	64012	357	15073	0	51875	12137	22.60	15.42
9	Badulla	Haldummulla	414.9996	38223	92	9855	0	23207	15016	31.65	18.09
10	Badulla	Lunugala	141.8095	33079	233	8260	0	14585	18494	38.82	13.78
11	Kurunegala	Rideegama	222.5431	80473	362	21118	0	78808	1665	32.76	26.28
12	Kegalle	Aranayaka	124.4190	66198	532	16850	0	64894	1304	36.10	29.31
13	Hambantota	Katuwana	103.7065	41392	399	10025	0	62344	0	34.30	17.11
14	Kalutara	Palindanuwara	283.2330	45911	162	11597	0	40298	5613	30.70	22.88
15	Badulla	Ella	109.3657	42894	392	10775	0	29156	13738	28.04	21.90
16	Badulla	Uva Paranagama	137.2816	76524	557	19213	0	65809	10715	33.35	19.52
17	Kurunegala	Ibbagamuwa	219.4878	76344	348	19589	0	75913	431	24.30	26.50
18	Rathnapura	Weligepola	203.5279	29099	143	7690	0	28720	379	39.20	19.60
19	Nuwara Eliya	Kothmale	223.7228	97509	436	23841	0	58181	39328	22.30	19.01
20	Rathnapura	Elapatha	86.8547	36322	418	8828	0	34219	2103	40.10	22.39
21	Rathnapura	Imbulpe	255.2644	55546	218	14086	660	46388	8498	32.00	24.58
22	Badulla	Welimada	193.9032	94399	487	22838	0	84180	10219	29.19	28.14
23	Rathnapura	Kolonna	183.0319	43693	239	10661	0	38930	4763	37.70	14.65
24	Rathnapura	Pelmadulla	144.8430	84966	587	19906	560	73480	10926	30.20	26.35
25	Rathnapura	Balangoda	274.1594	77303	282	18720	11402	58032	7869	27.30	27.22
26	Rathnapura	Ayagama	157.6893	28637	182	7357	0	25160	3477	33.70	21.37
27	Badulla	Passara	135.9205	49190	362	12245	0	29457	19733	31.88	19.27
28	Badulla	Hali Ela	170.1437	87476	514	21835	0	58715	28761	34.58	24.29
29	Kegalle	Bulathkohupitiya	127.2471	45573	358	11729	0	37396	8177	32.50	22.74
30	Kegalle	Dehiovita	193.2396	73991	383	18460	0	62883	11108	29.30	24.21
31	Kegalle	Yatiyanthota	178.0749	57239	321	14197	0	45071	12168	30.10	23.81
32	Kegalle	Warakapola	195.5200	106038	542	26503	0	103087	2951	26.00	30.93
33	Kegalle	Ruwanwella	138.6165	58892	425	14461	0	54679	4213	28.50	28.11
34	Kegalle	Kegalle	109.0590	87637	804	21327	17139	68733	1765	26.70	37.80
35	Kandy	Doluwa	100.1685	45270	452	11651	0	37392	7878	26.50	21.04
36	Matale	Rattota	105.2255	49382	469	13068	0	40015	9367	23.40	25.32
37	Kalutara	Agalawatta	89.7814	33962	378	8423	0	32768	1194	26.40	33.03
38	Badulla	Haputhale	70.3267	50735	721	11565	3235	29372	18128	24.42	29.37
39	Rathnapura	Eheliyagoda	141.9292	63870	450	15566	0	61593	2277	26.90	26.60
40	Kandy	Udapalatha	90.6003	86145	951	19936	24116	48242	13787	21.40	29.35
41	Rathnapura	Kiriella	79.5653	30881	388	7666	0	29748	1133	25.60	26.58

Land Utilization within Agricultural Holdings						Sector Specific Data							DSD Name	Rank
Total extent of Holdings (Acres)[d]	Aswed-dumized Paddy (Acres)[d]	Temp. Crops other than Aswed-dumized Paddy (Acres)[d]	Perm. Crops (Acres)[d]	Forest Land (Acres)[d]	Other Land (Acres)[d]	Tea (Acres)[g]	Rubber (Acres)[g]	Coconut (Acres)[d]	Land Area <= 1/4 Acre Tea (Acres)[d]	Land Area <= 1/4 Acre Rubber (Acres)[d]	Educational Attainment of Agri. Operators % Less than OL[d]	Educational Attainment of Agri. Operators % Female Passed G 5 or below[d]		
17933	6344	3667	4577	1800	1545	9202		621	633	0	78.20	7.75	Walapane	1
8420	294	227	6115	785	999	54230	62	557	2727	19	72.40	11.73	Ambagamuwa	2
18229	6099	5322	4292	1063	1453	4864		1205	807	0	76.60	6.61	Hanguranketha	3
17045	1180	161	12346	1504	1854	13303	2619	1781	9130	1587	73.00	7.74	Rathnapura	4
4190	1198	732	1467	347	446	5259		28	1285	0	57.50	6.31	Bandarawela	5
3590	22	2919	260	58	331	44013		0	153	0	52.10	4.57	Nuwara Eliya	6
12159	198	135	8735	1172	1919	6047	7370	1686	4076	2261	75.80	9.10	Deraniyagala	7
13240	1826	164	9612	312	1326	15984	68	1482	8849	14	76.70	8.20	Kotapola	8
11094	1834	808	5175	2144	1133	5211	597	543	370	109	75.00	7.93	Haldummulla	9
4622	881	195	2210	609	727	9148	249	251	508	45	76.10	8.93	Lunugala	10
26197	5572	256	17773	860	1736	101	1159	18043	77	172	72.10	10.89	Rideegama	11
13996	2506	247	9962	310	971	1432	3712	2469	892	2799	69.30	7.26	Aranayaka	12
15519	574	489	12272	938	1246	184	61	5241	184	61	86.90	13.80	Katuwana	13
19411	2755	345	12708	2009	1594	4878	10173	1398	4590	4960	75.80	8.63	Palindanuwara	14
5015	1100	726	2098	524	567	8063		120	1491	0	73.00	6.42	Ella	15
14085	3627	6531	2852	322	753	5313		209	1569	0	76.10	7.02	Uva Paranagama	16
23214	8071	435	12640	516	1552		218	18559	0	7	71.30	8.72	Ibbagamuwa	17
14658	1556	2017	8992	1232	861	1436	252	5803	1170	252	83.60	7.86	Weligepola	18
12102	1134	1238	7903	894	933	11899	19	194	5674	57	68.80	8.53	Kothmale	19
7588	1206	88	5034	529	731	2301	4472	917	1850	2254	72.00	4.55	Elapatha	20
13328	2420	485	7618	1663	1142	10244	4	1159	5008	4	75.60	5.91	Imbulpe	21
14422	3562	6708	3070	205	877	7690		33	2596	0	73.90	6.02	Welimada	22
17284	1460	614	11292	2560	1358	4667	44	2184	2753	10	82.80	7.19	Kolonna	23
12035	1886	144	8299	619	1087	8294	4973	2228	5868	1344	75.10	5.94	Pelmadulla	24
16543	3312	1441	8455	1569	1766	7981	51	2574	4621	1	74.40	6.26	Balangoda	25
11403	549	21	8950	1255	628	3861	5542	876	2816	3835	77.00	7.56	Ayagama	26
7264	1208	407	3688	889	1072	7492	1	306	1513	1	67.20	8.21	Passara	27
10387	2542	1222	4514	814	1295	13081		275	2702	0	64.80	6.85	Hali Ela	28
8778	542	260	6730	497	749	3895	5714	1542	1954	2284	67.50	7.22	Bulathkohupitiya	29
12660	572	695	9451	947	995	2790	17388	2333	1561	4929	66.60	8.63	Dehiovita	30
9467	339	434	7184	818	692	3703	8613	1451	2009	1710	73.60	9.21	Yatiyanthota	31
21469	2723	1273	15219	608	1646	72	12439	6779	69	6825	62.10	5.21	Warakapola	32
13863	1074	398	10532	725	1134	201	13711	3170	156	5524	67.20	7.88	Ruwanwella	33
12577	2124	177	8828	321	1127	449	4549	3259	245	2894	59.40	6.81	Kegalle	34
7387	982	240	4574	907	684	6078		443	2451	0	74.20	10.15	Doluwa	35
7434	1449	71	5150	364	400	5115	1498	1310	332	94	68.90	8.35	Rattota	36
9712	2354	223	5536	716	883	934	3882	1089	929	2693	66.40	7.83	Agalawatta	37
2728	596	453	1071	198	410	6222		11	948	0	56.10	5.95	Haputhale	38
11761	1754	798	7870	639	700	1482	9480	1580	1170	4644	70.70	7.02	Eheliyagoda	39
6424	935	218	4332	347	592	6412	9	491	2156	9	65.00	7.98	Udapalatha	40
8750	1461	248	5763	483	795	1379	4328	959	993	3188	71.80	5.34	Kiriella	41

Fisheries

The fishery sector in Sri Lanka consists mainly of coastal fisheries, offshore fisheries, inland capture fisheries, and aquaculture and shrimp farming. This sector earns valuable foreign exchange through the export of marine and aquaculture products, and provides direct employment to 208,731 island wide, while sustaining over 2.5 million people. Fishery constitutes the major economic activity in the coastal region which is home to 25% of the island's population. Fish also provides about 70% of animal protein consumed in the country. Due to its importance as a livelihood of a considerable segment of Sri Lanka's population, and importance as a source of protein for the people of this country, the fishery sector has received much attention in the national development agenda. Since fisheries is heavily dependent on conducive environmental conditions for sustainability and productivity, it is critically important that development of the fishery sector should take into account the ramifications of climate change, including sea level rise, and take steps to strategically adopt appropriate adaptation measures to ensure the continued sustainability of the fishery industry.

There are about 45 major estuaries and 89 lagoons along the island's coastline that are also important components of the coastal fishery. While much of the current fish production is from the coastal sub-sector, the fishery potential in the offshore/deep sea and international waters, and inland fisheries and aquaculture, is increasingly recognized as important for enhancing the total fishery production in the future. Sri Lanka's inland surface waters, including freshwater bodies, perennial reservoirs, seasonal tanks and villus, which cover about 520,000 ha, offer considerable potential for the inland freshwater fishery. Opportunities also exist for brackish water aquaculture in a total extent of around 6,000 ha.

The potential risks of sea level rise on fisheries includes the loss or change of coastal habitats and species distribution. For example, landward migration of coastal wetlands would result in the loss of freshwater and brackish water habitats (such as mangroves and coral reefs) important for the coastal and marine fishery. Loss of beach areas will affect coastal communities such as those dependent on beach seine fishery due to beach accessibility issues. Sea level rise should be taken into account in the construction of new fishery harbours - several anchorages and 14 more fishery harbours are to be constructed according to national development plans, which may be adversely affected by storm surges, flooding and inundation due to sea level rise.

The possible impacts of changes in rainfall regimes and prolonged drought on fisheries can have varied implications affecting mainly inland fisheries. It is expected that in the Dry and Arid Zones, this would lead to increased evaporation which would impact the inland fishery including lowered yields in seasonal tanks. On the other hand, flooding will affect inland aquaculture and capture fishery due to pollution, sedimentation and any adverse changes in water quality parameters of surface water bodies. These would all have serious implications on rural nutrition and incomes for dependent communities.

Increase in temperatures will also have significant implications on coastal, marine and inland fisheries as well as on aquaculture. Coastal habitats, such as coral reefs, seagrass beds and mangroves, which support fisheries will be affected and in turn will affect the distribution and composition of marine and coastal species affecting fish stocks. Inland wetlands important for the food fishery may be adversely affected by temperature anomalies with resultant changes in water quality that for example could cause fish kills. More details on the impacts and already existing anthropogenic factors that can exacerbate the problems associated with climate change can be found in the *SVP on Agriculture and Fisheries.*

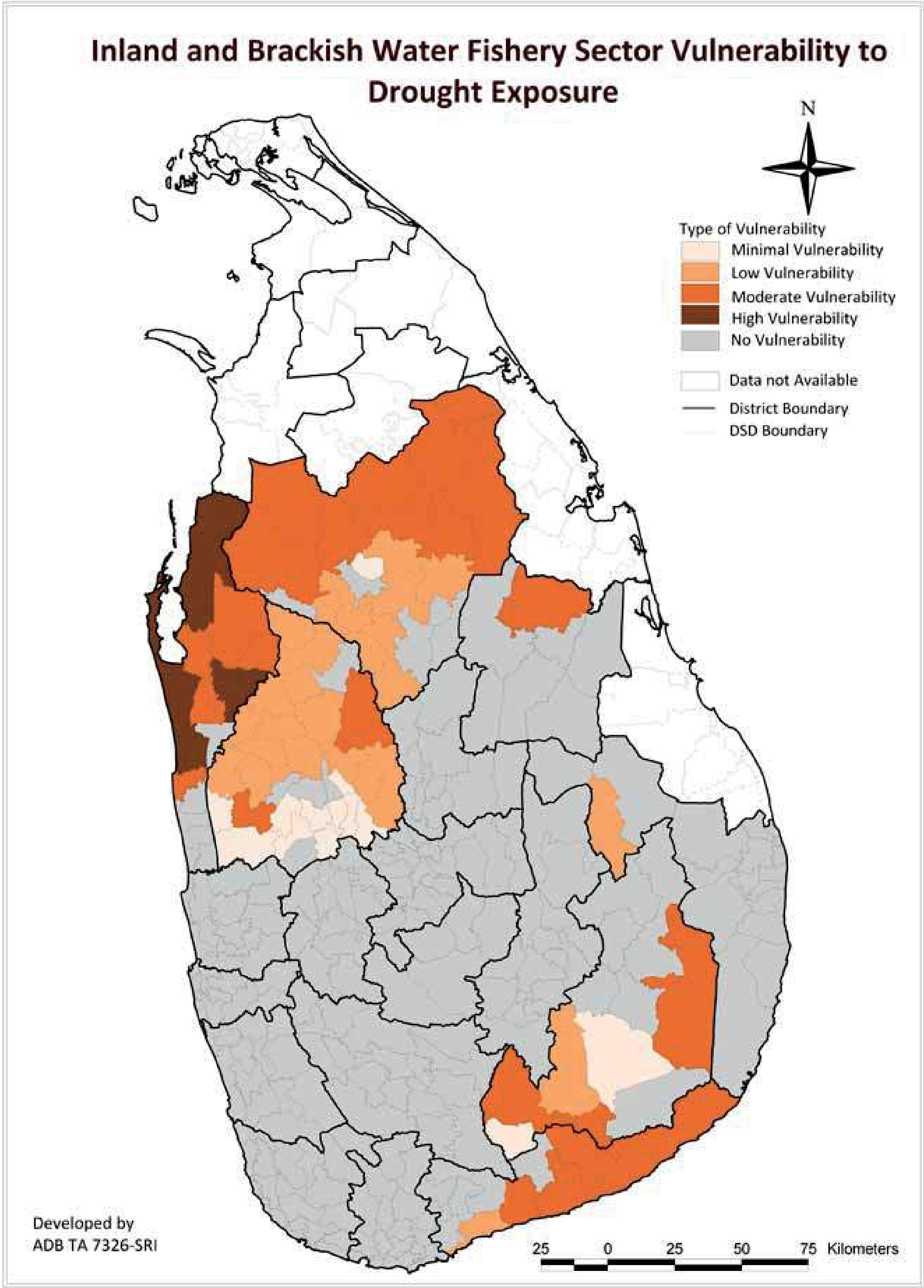
Inland and Brackish Water Fishery Sector Vulnerability to Drought Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • Percentage of employment in fisheries within GN divisions with no coastal frontage • Average inland/brackish water fisheries yield over the last four years • area of water bodies (tanks, lakes, lagoons, mangroves)	A composite of data (at DSD level) on: • percentage of population above the poverty line • percentage of population who have completed secondary education
Raw data sources: Population & Housing Census, 2001; Ministry of Fisheries and Aquatic Resources	

Some of the key findings include:

- Vulnerability to drought exposure in the inland and brackish water fishery sector is widespread, particularly in the Dry and Intermediate zones.
- All 5 DSDs that fall within the highly vulnerable category in this regard are in the Puttalam District. These 5 DSDs have:
  - o 104,162 ac of lagoons and 7,101 ac of tanks.
  - o 9,453 people employed in the inland fishery.
- 23 additional DSDs fall within the moderately vulnerable category. These DSDs have:
  - o 18,142 ac of lagoons and 106,102 ac of tanks.
  - o 6,597 people employed in inland fisheries.
- With 5 DSDs as highly vulnerable, and another 5 DSDs within the moderately vulnerable category, Puttalam is clearly the district most vulnerable to drought exposure with regard to the inland/brackish water fishery.



Inland and Brackish Water Fishery Sector Vulnerability to Drought Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
Data not Available
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Inland and Brackish Water Fishery Sector Vulnerability to Drought Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
2	Puttalam	Vanathavilluwa	736.5317	16460	22	4024	0	16410	50	40.31	12.25
3	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
4	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
5	Puttalam	Anamaduwa	259.0095	33302	129	9039	0	33302	0	16.77	22.53
6	Anuradhapura	Padaviya	242.5157	21146	87	5452	0	21146	0	34.33	14.43
7	Puttalam	Karuwalagaswewa	503.9380	20225	40	5550	0	20225	0	23.77	14.80
8	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
9	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
10	Puttalam	Mahakumbuk kadawala	175.8432	16905	96	4686	0	16905	0	28.65	15.18
11	Moneragala	Siyambalanduwa	1065.6754	47438	45	10808	0	47438	0	51.80	13.52
12	Anuradhapura	Rambewa	303.6555	31604	104	8230	0	31592	12	20.57	19.54
13	Anuradhapura	Horowpothana	845.8179	29642	35	7578	0	29642	0	24.95	14.78
14	Polonnaruwa	Medirigiriya	570.3679	57899	102	15189	0	57899	0	13.37	14.73
15	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
16	Anuradhapura	Nuwaragam Palatha Central	389.4952	53665	138	13055	11598	42067	0	20.14	20.32
17	Anuradhapura	Medawachchiya	492.1070	40469	82	10338	0	40469	0	21.34	24.09
18	Puttalam	Nawagattegama	171.9949	12956	75	3519	0	12956	0	26.44	13.19
19	Kurunegala	Kuliyapitiya West	163.9366	71483	436	18666	6290	65102	91	16.62	32.77
20	Anuradhapura	Maha Vilachchiya	624.8276	18557	30	4630	0	18557	0	31.16	17.85
21	Kurunegala	Polpithigama	417.5552	67263	161	18926	0	67263	0	30.00	18.13
22	Moneragala	Thanamalwila	661.4470	23172	35	5893	0	23172	0	35.80	14.18
23	Hambantota	Tissamaharama	783.8008	60982	78	14829	0	60486	496	32.20	22.31
24	Anuradhapura	Kebithigollewa	611.9821	19457	32	4903	0	19457	0	27.74	18.03
25	Anuradhapura	Kahatagasdigiliya	366.6055	33572	92	8619	0	33572	0	19.63	20.03
26	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
27	Anuradhapura	Nochchiyagama	843.5736	41601	49	11239	0	41601	0	16.98	19.61
28	Hambantota	Lunugamvehera	300.3473	25226	84	6922	0	25226	0	33.50	17.85
29	Anuradhapura	Thalawa	220.5999	50919	231	13375	0	50919	0	19.44	22.25
30	Anuradhapura	Palagala	226.9676	29837	131	8196	0	29837	0	23.83	21.98
31	Anuradhapura	Galenbidunuwawe	288.1528	40888	142	10454	0	40888	0	18.56	21.42
32	Kurunegala	Ganewatta	147.1195	36812	250	9830	0	36770	42	23.20	22.57
33	Kurunegala	Galgamuwa	273.2962	47844	175	12759	0	47844	0	25.70	22.00
34	Kurunegala	Panduwasnuwara	216.0387	69888	323	18130	0	69888	0	18.90	28.69
35	Anuradhapura	Galnewa	140.2283	30344	216	8165	0	30344	0	18.46	20.55
36	Anuradhapura	Thirappane	278.9562	23378	84	6143	0	23378	0	18.59	23.27
37	Kurunegala	Kobeigane	130.8780	32230	246	8581	0	32230	0	19.10	24.70
38	Kurunegala	Ibbagamuwa	219.4878	76344	348	19589	0	75913	431	24.30	26.50
39	Anuradhapura	Ipalogama	142.4270	32933	231	8730	0	31992	941	17.41	25.86
40	Moneragala	Wellawaya	585.9537	50768	87	12698	0	50768	0	24.90	17.79
41	Anuradhapura	Thambuttegama	111.4855	36524	328	9448	0	36524	0	19.05	22.52
42	Anuradhapura	Mihintale	234.9169	26786	114	6657	1523	25263	0	18.97	29.03
43	Kurunegala	Giribawa	207.1489	28093	136	7831	0	28093	0	24.00	19.56
44	Kurunegala	Bingiriya	195.2943	55763	286	15223	0	55613	150	16.80	24.53
45	Kurunegala	Mahawa	260.6953	50576	194	13674	0	50576	0	20.90	21.83
46	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
47	Kurunegala	Nikaweratiya	152.4124	36370	239	9549	0	36370	0	19.40	24.93
48	Ampara	Padiyathalawa	386.8510	15971	41	3642	0	15971	0		11.66
49	Kurunegala	Rideegama	222.5431	80473	362	21118	0	78808	1665	32.76	26.28
50	Kurunegala	Rasnayakapura	125.8909	18814	149	5071	0	18678	136	23.00	20.46
51	Kurunegala	Wariyapola	201.7589	56880	282	15207	0	56832	48	18.90	29.42

Sector Specific Data					DSD Name	Rank
# Employed in Inland Fishing[a]	Inland Fishing as % of Total Jobs[a]	Lagoons (Acres)[a]	Tanks (Acres)[a]	Lakes and Reservoirs (Acres)[a]		
5623	24.40	59800.1	23.4	340.8	Kalpitiya	1
693	13.27	43076.8	443.4	0.0	Vanathavilluwa	2
1436	11.51	48.5	2281.8	61.1	Arachchikattuwa	3
1681	10.57	1237.1	553.6	7447.4	Mundalama	4
20	0.17	0.0	3798.8	0.0	Anamaduwa	5
236	3.52	0.0	7415.9	0.0	Padaviya	6
111	1.35	0.0	3404.1	0.0	Karuwalagaswewa	7
1159	6.36	14914.6	560.4	0.0	Puttalam	8
362	1.77	1876.5	2815.5	0.0	Ambalantota	9
0	0.00	0.0	2941.7	0.0	Mahakumbuk kadawala	10
42	0.25	0.0	3940.8	34.6	Siyambalanduwa	11
0	0.00	0.0	6527.9	0.0	Rambewa	12
60	0.57	0.0	9506.9	0.0	Horowpothana	13
219	0.88	0.0	7293.5	0.0	Medirigiriya	14
2670	13.83	0.0	1523.7	1795.9	Chilaw	15
51	0.25	0.0	7349.5	0.0	Nuwaragam Palatha Central	16
13	0.08	0.0	9013.2	0.0	Medawachchiya	17
35	0.69	0.0	1349.9	660.0	Nawagattegama	18
23	0.09	0.0	575.6	0.0	Kuliyapitiya West	19
79	1.05	0.0	4035.2	0.0	Maha Vilachchiya	20
41	0.15	0.0	3204.3	958.5	Polpithigama	21
52	0.58	0.0	4405.1	5411.9	Thanamalwila	22
619	3.20	474.2	3758.5	57.8	Tissamaharama	23
23	0.30	0.0	5645.4	0.0	Kebithigollewa	24
0	0.00	0.0	8923.7	0.0	Kahatagasdigiliya	25
596	3.96	731.6	2569.5	0.0	Hambantota	26
0	0.00	0.0	7762.0	0.0	Nochchiyagama	27
206	2.48	144.9	1580.1	0.0	Lunugamvehera	28
70	0.35	0.0	4712.6	0.0	Thalawa	29
63	0.52	0.0	3581.2	0.0	Palagala	30
64	0.37	0.0	7553.6	0.0	Galenbidunuwawe	31
0	0.00	0.0	738.9	0.0	Ganewatta	32
152	0.93	0.0	6161.6	1405.0	Galgamuwa	33
0	0.00	0.0	2951.9	0.0	Panduwasnuwara	34
20	0.16	0.0	1869.1	0.0	Galnewa	35
49	0.50	0.0	6188.8	0.0	Thirappane	36
7	0.06	0.0	1484.1	0.0	Kobeigane	37
72	0.25	0.0	1820.3	0.0	Ibbagamuwa	38
102	0.85	0.0	2344.9	0.0	Ipalogama	39
45	0.23	0.0	1353.3	0.0	Wellawaya	40
150	0.97	0.0	1406.8	0.0	Thambuttegama	41
84	0.93	0.0	6914.8	0.0	Mihintale	42
91	0.81	0.0	4217.2	0.0	Giribawa	43
28	0.15	0.0	1453.0	0.0	Bingiriya	44
13	0.06	0.0	3776.4	0.0	Mahawa	45
969	4.92	1017.2	707.5	0.0	Tangalle	46
60	0.45	0.0	2839.4	0.0	Nikaweratiya	47
77	1.31	0.0	136.9	3516.5	Padiyathalawa	48
13	0.05	0.0	119.6	0.0	Rideegama	49
8	0.13	0.0	1536.2	0.0	Rasnayakapura	50
6	0.03	0.0	2054.2	0.0	Wariyapola	51

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
52	Kurunegala	Kotawehera	182.1192	19273	106	5323	0	19273	0	21.70	26.07
53	Kurunegala	Ambanpola	142.5265	19964	140	5488	0	19964	0	23.10	23.46
54	Moneragala	Buttala	735.5660	47324	64	11843	0	47324	0	21.20	22.01
55	Moneragala	Sewanagala	191.9569	36820	192	9221	0	35739	1081	19.30	20.35
56	Kurunegala	Pannala	284.9191	114438	402	29467	0	113726	712	17.80	31.16
57	Kurunegala	Polgahawela	97.3861	58762	603	14506	0	57940	822	22.91	35.64
58	Kurunegala	Kuliyapitiya East	113.2748	46966	415	11728	0	46839	127	20.32	27.57
59	Kurunegala	Narammala	108.3197	51244	473	13092	0	51244	0	21.40	33.36
60	Kurunegala	Mawathagama	109.6233	56820	518	14191	0	55013	1807	24.92	33.95
61	Kurunegala	Udubaddawa	117.5985	48800	415	12669	0	48742	58	17.70	29.43
62	Kurunegala	Mallawapitiya	79.9307	46575	583	11574	0	46240	335	19.50	33.19
63	Anuradhapura	Nuwaragam Palatha East	90.6614	65671	724	14504	40030	25641	0	11.97	44.47
64	Kurunegala	Kurunegala	111.0680	88944	801	20292	28401	60369	174	14.70	44.87
65	Kurunegala	Weerambugedara	91.3110	30311	332	8085	0	30311	0	20.11	39.05

Sector Specific Data					DSD Name	Rank
# Employed in Inland Fishing [a]	Inland Fishing as % of Total Jobs [a]	Lagoons (Acres) [a]	Tanks (Acres) [a]	Lakes and Reservoirs (Acres) [a]		
25	0.32	0.0	2882.1	1137.6	Kotawehera	52
45	0.59	0.0	2193.9	1715.0	Ambanpola	53
3	0.02	0.0	455.8	0.0	Buttala	54
51	0.38	0.0	2112.7	0.0	Sewanagala	55
0	0.00	0.0	224.3	0.0	Pannala	56
7	0.04	0.0	35.8	0.0	Polgahawela	57
3	0.02	0.0	922.9	0.0	Kuliyapitiya East	58
31	0.17	0.0	65.1	0.0	Narammala	59
0	0.00	0.0	86.0	0.0	Mawathagama	60
0	0.00	0.0	93.2	0.0	Udubaddawa	61
0	0.00	0.0	224.2	0.0	Mallawapitiya	62
102	0.41	0.0	3592.1	0.0	Nuwaragam Palatha East	63
18	0.06	0.0	289.9	0.0	Kurunegala	64
0	0.00	0.0	89.8	0.0	Weerambugedara	65

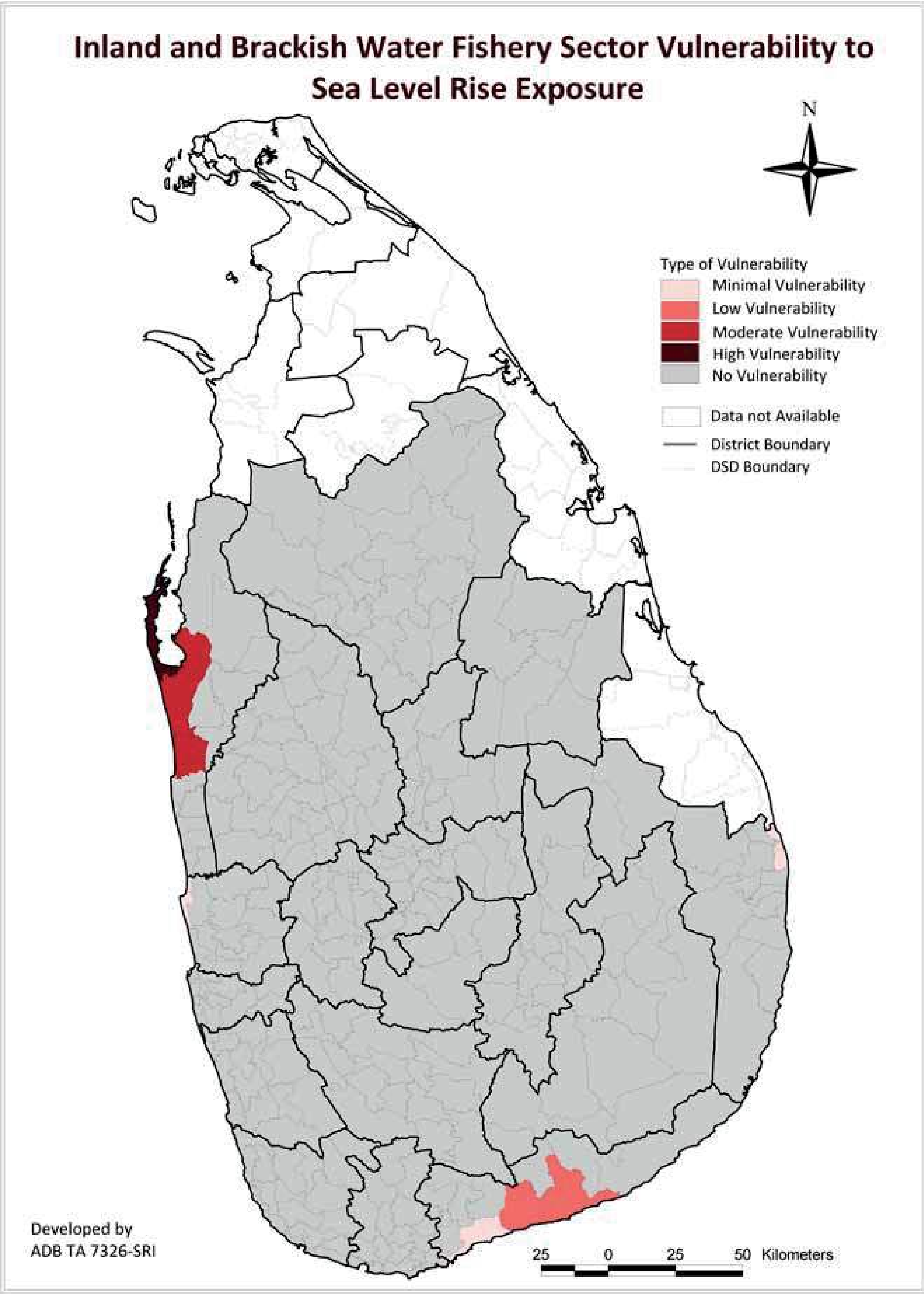
Inland and Brackish Water Fishery Sector Vulnerability to Sea Level Rise Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • Percentage of employment in fisheries within GN divisions with no coastal frontage • Average inland/brackish water fisheries yield over the last four years • area of water bodies (tanks, lakes, lagoons, mangroves)	A composite of data (at DSD level) on: • percentage of population above the poverty line • percentage of population who have completed secondary education
Raw data sources: Population & Housing Census, 2001; Ministry of Fisheries and Aquatic Resources	

Some of the key findings include:

- Vulnerability to sea level rise exposure of the inland and brackish water fishery sector is highest primarily in the Puttalam District, with a pocket of low vulnerably in the Hambantota District.
- All 4 DSDs that are either highly or moderately vulnerable in this regard are in the Puttalam District. These 4 DSDs have:
  - o 76,000 ac of lagoons.
  - o 9,899 people employed in the inland/brackish water fishery sector.


Inland and Brackish Water Fishery Sector Vulnerability to 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
Developed by
ADB TA 7326-SRI
25 0 25 50 Kilometers

Inland and Brackish Water Fishery Sector Vulnerability to Sea Level Rise Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households [b]	Urban Population [b]	Rural Population [b]	Estate Population [b]	% in Poverty [c]	% Completed Secondary Education[a]
1	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
2	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
3	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
4	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
5	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
6	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
7	Ampara	Karativu	8.9392	16365	1831	3641	0	16365	0		28.99
8	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
9	Ampara	Ninthavur	36.3016	24625	678	6235	0	24625	0		22.78
10	Gampaha	Negombo	46.1424	144274	3127	31915	121413	22861	0	7.10	30.04
11	Ampara	Kalmunai	19.6568	70465	3585	15821	70465	0	0		28.44

Sector Specific Data					DSD Name	Rank
# Employed in Inland Fishing[a]	Inland Fishing as % of Total Jobs[a]	Lagoons (Acres)[a]	Tanks (Acres)[a]	Lakes and Reservoirs (Acres)[a]		
5623	24.40	59800.1	23.4	340.8	Kalpitiya	1
1681	10.57	1237.1	553.6	7447.4	Mundalama	2
1159	6.36	14914.6	560.4	0.0	Puttalam	3
1436	11.51	48.5	2281.8	61.1	Arachchikattuwa	4
596	3.96	731.6	2569.5	0.0	Hambantota	5
362	1.77	1876.5	2815.5	0.0	Ambalantota	6
477	11.13	110.8	4.0	0.0	Karativu	7
969	4.92	1017.2	707.5	0.0	Tangalle	8
122	2.15	95.2	0.0	0.0	Ninthavur	9
3252	6.95	4235.2	0.0	0.0	Negombo	10
303	1.94	396.8	975.9	0.0	Kalmunai	11

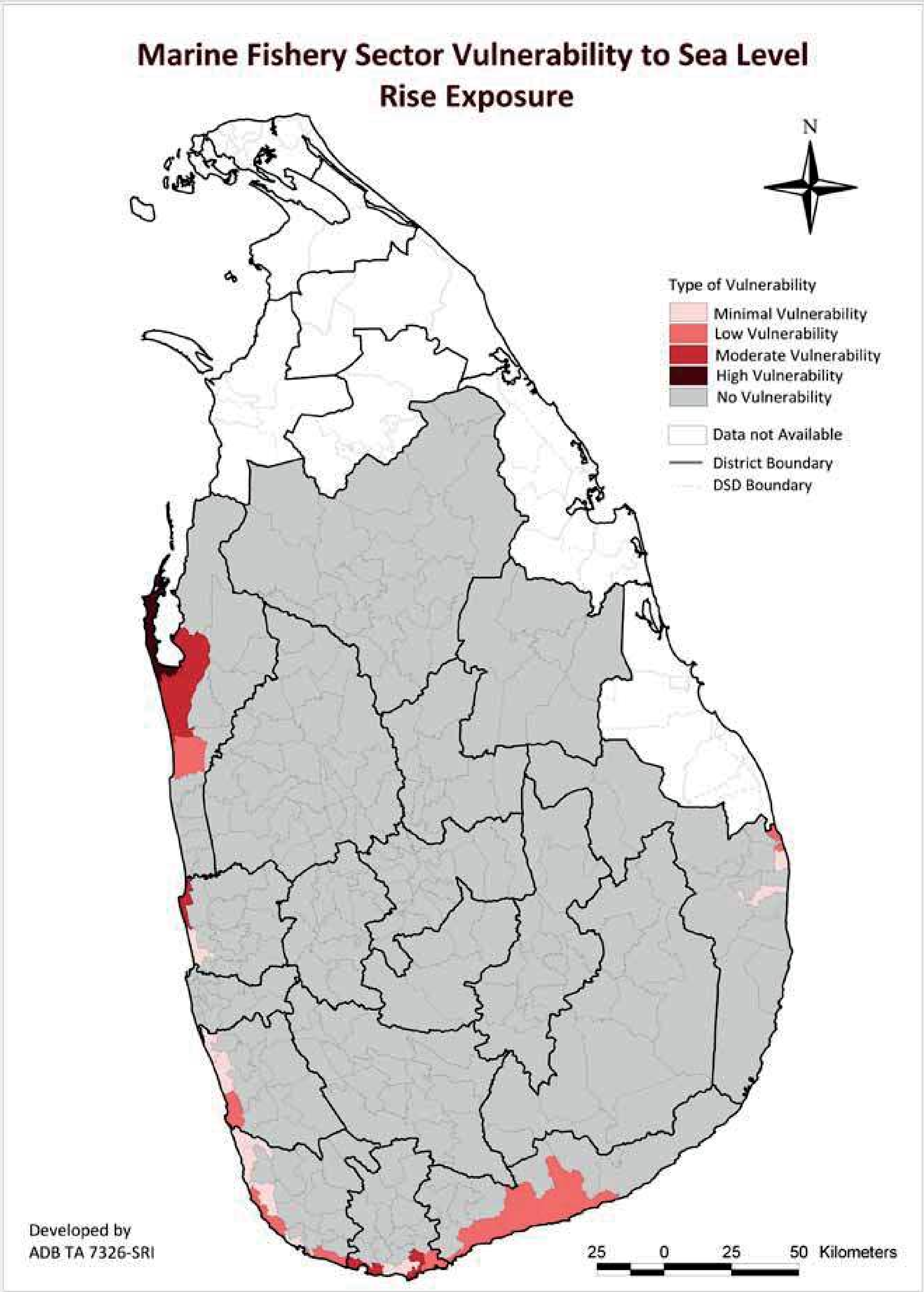
Marine Fishery Sector Vulnerability to Sea Level Rise Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • number of fisheries landing sites • percentage of livelihoods dependent on fisheries • average fishing yield over the last four years	A composite of data (at DSD level) on: • percentage of population above the poverty line • percentage of population who have completed secondary education • percentage employed in sectors other than fisheries
Raw data sources: Population & Housing Census, 2001; Department of Coast Conservation; Ministry of Fisheries and Aquatic Resources	

Some of the key findings include:

- Kalpitiya (Puttalam District) emerges as the DSD that is highly vulnerable to sea level rise exposure in this regard. Kalpitiya has:
    - o 5,938 jobs in the fisheries sector, which is more than 25% of its total employment.
    - o 43 fisheries landing sites.
- An additional 5 DSDs are moderately vulnerable. These DSDs have:
    - o 10,408 jobs in fisheries.
    - o 115 fisheries landing sites.


Marine Fishery Sector Vulnerability to 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
Developed by
ADB TA 7326-SRI
25 0 25 50 Kilometers

Marine Fishery Sector Vulnerability to Sea Level Rise Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
2	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
3	Gampaha	Negombo	46.1424	144274	3127	31915	121413	22861	0	7.10	30.04
4	Matara	Devinuwara	37.6183	44199	1175	9988	0	44199	0	20.90	26.80
5	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
6	Matara	Weligama	43.1469	66459	1540	14825	21698	44761	0	21.50	30.48
7	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
8	Hambantota	Tangalle	152.5016	62800	412	14981	10437	52363	0	27.10	30.04
9	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
10	Matara	Dickwella	50.9687	51314	1007	11592	0	51314	0	22.70	31.87
11	Galle	Habaraduwa	49.5183	59041	1192	13567	0	59041	0	28.70	29.53
12	Galle	Hikkaduwa	66.0971	98589	1492	22820	0	98539	50	24.90	33.61
13	Ampara	Karativu	8.9392	16365	1831	3641	0	16365	0		28.99
14	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20
15	Ampara	Kalmunai	19.6568	70465	3585	15821	70465	0	0		28.44
16	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
17	Galle	Balapitiya	54.5727	65346	1197	15054	0	65346	0	22.00	27.89
18	Galle	Galle Four Gravets	23.7565	103246	4346	19425	90270	12976	0	19.30	39.96
19	Ampara	Ninthavur	36.3016	24625	678	6235	0	24625	0		22.78
20	Galle	Ambalangoda	70.2467	71047	1011	17122	39302	51396	0	20.30	32.73
21	Matara	Matara	56.1514	108238	1928	23705	42663	65575	0	16.90	42.45
22	Gampaha	Wattala	57.6911	160127	2776	36368	28740	131387	0	6.10	40.21
23	Kalutara	Kaluthara	77.6779	141829	1826	31857	37451	104378	0	12.50	38.35
24	Galle	Bentota	72.3358	46442	642	11015	0	46442	0	22.30	31.14
25	Ampara	Akkaraipattu	60.4089	34939	578	7649	0	34939	0		26.00
26	Kalutara	Panadura	45.0310	163492	3631	37245	33514	129978	0	7.40	40.07

Sector Specific Data					DSD Name	Rank
No. of Landing Sites[h]	Total Employed Pop[b]	Fishery Sector Jobs[b]	# Emplyed in Marine Fishing[a]	% of Marine Fishing from Total Jobs[a]		
43	23049	5995	5938	25.76	Kalpitiya	1
9	15911	2809	1969	12.38	Mundalama	2
84	46825	6752	4295	9.17	Negombo	3
7	11666	2124	1702	14.59	Devinuwara	4
6	18228	1159	1057	5.80	Puttalam	5
9	17734	1987	1385	7.81	Weligama	6
5	12471	1436	711	5.70	Arachchikattuwa	7
25	19678	2365	1823	9.26	Tangalle	8
11	15041	906	727	4.83	Hambantota	9
9	13250	1249	1033	7.80	Dickwella	10
33	18237	521	326	1.79	Habaraduwa	11
25	26796	1554	1091	4.07	Hikkaduwa	12
19	4287	519	379	8.84	Karativu	13
15	41163	1476	972	2.36	Beruwala	14
31	15649	1072	781	4.99	Kalmunai	15
5	20478	449	295	1.44	Ambalantota	16
16	17683	646	448	2.53	Balapitiya	17
7	29596	416	326	1.10	Galle Four Gravets	18
6	5674	340	292	5.15	Ninthavur	19
4	20528	419	280	1.36	Ambalangoda	20
4	31072	395	275	0.89	Matara	21
21	57168	1013	676	1.18	Wattala	22
10	44308	698	591	1.33	Kaluthara	23
7	13339	78	54	0.40	Bentota	24
4	9026	117	83	0.92	Akkaraipattu	25
12	55126	368	238	0.43	Panadura	26

Livestock

Livestock is an important component of the agricultural sector in Sri Lanka. At present there are about 1,136,860 neat cattle, 371,790 buffalo, 377,460 goats, 8,000 sheep, 81,310 pigs, 13,615,290 chickens and 15,244 ducks country wide. Most of the livestock comprise imported high yielding breeds promoted to address the increase in livestock production. Sri Lanka also has several local breeds that are well adapted to the local environment and harsh conditions, but are relatively low yielding. The livestock sector is potentially at risk from the impacts of climate change due to its vulnerability to floods, droughts and sea level rise due to the geographic distribution of the different types of livestock in the country.

Increase in the intensity and frequency of water related disasters such as floods and landslides will adversely affect livestock production in areas that are naturally prone to these disasters. This will adversely affect the dependent farming communities and also affect the nutritional security of the country. Sea level rise and storm surges could affect livestock situated along the coastal belt of the country due to flooding and face issues of water accessibility due to saline intrusion. Increase in temperature and prolonged drought situations will give rise to increased heat stress for livestock thereby affecting their production levels. This will further increase water requirements during drought conditions as well.

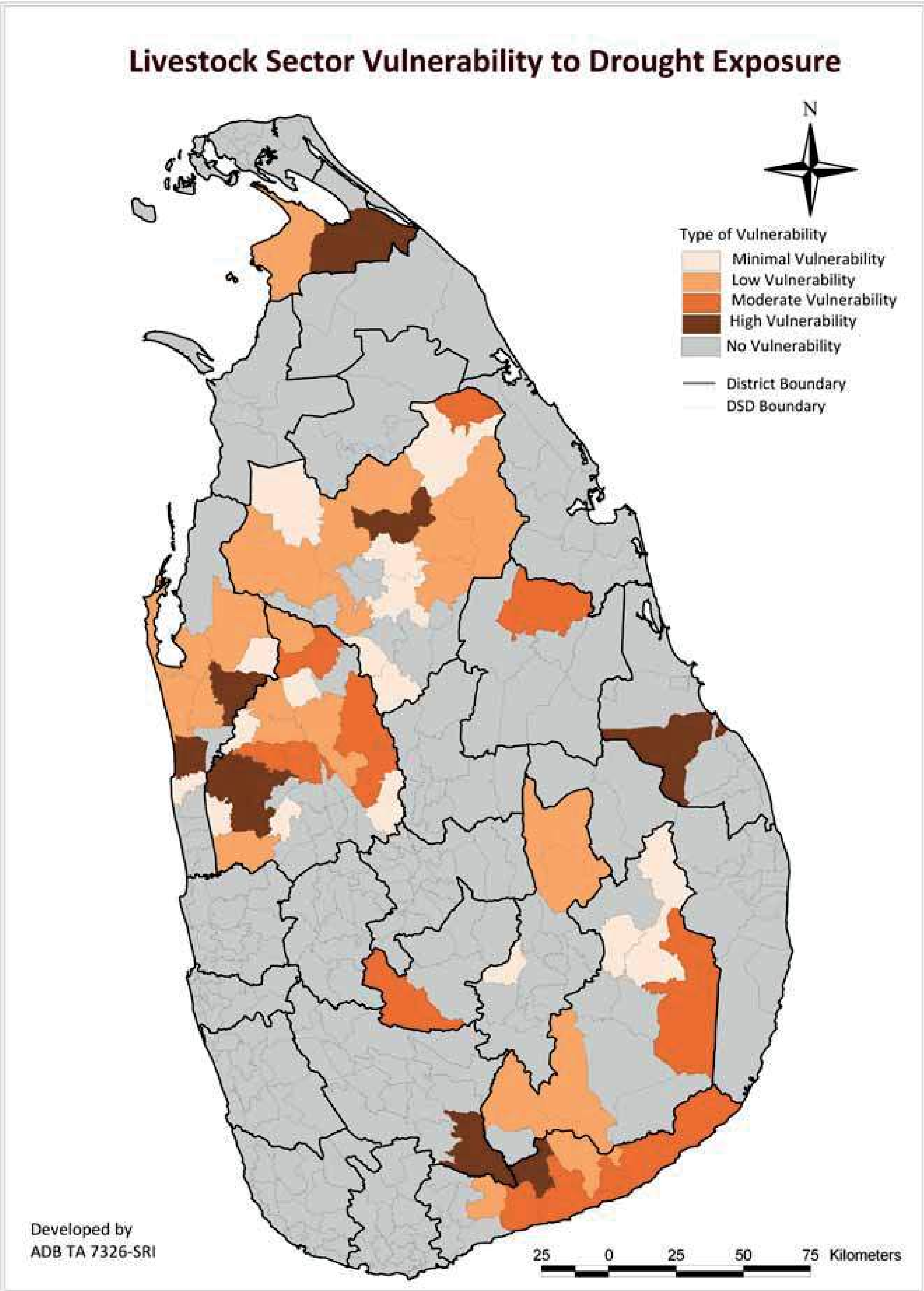
Livestock Sector Vulnerability to Drought Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • number of landholdings with cattle/buffalo • number of landholdings with goats and swine • number of poultry (number of birds)	A composite of data (at DSD level) on: • percentage of population employed in agriculture who have completed secondary education • number of landholdings ≤ ¼ acre • % of females with education above Grade 5 (from among the population employed in agriculture) • Percentage of households with agriculture as primary source of income.
Raw data sources: Census of Agriculture 2002, Department of Census and Statistics	

Some of the key findings include:

- 10 DSDs emerge as highly vulnerable to drought exposure. These DSDs have:
  - 127,350 heads of cattle and buffalo, and 47,085 heads of goats and swine.
  - Over 2.5 million heads of poultry.
- 12 additional DSDs emerge as moderately vulnerable. These DSDs have:
  - 146,811 heads of cattle and buffalo, and 70,878 heads of goats and swine.
  - Over a million heads of poultry.


Livestock Sector Vulnerability to Drought Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Livestock Sector Vulnerability to Drought Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics: Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Demographics: Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Kurunegala	Panduwasnuwara	216.0387	69888	323	18130	0	69888	0	18.90	28.69
2	Puttalam	Anamaduwa	259.0095	33302	129	9039	0	33302	0	16.77	22.53
3	Batticaloa	Eravur Pattu									
4	Kurunegala	Kuliyapitiya West	163.9366	71483	436	18666	6290	65102	91	16.62	32.77
5	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
6	Kurunegala	Bingiriya	195.2943	55763	286	15223	0	55613	150	16.80	24.53
7	Rathnapura	Embilipitiya	383.4799	119563	312	29126	0	119490	73	31.60	21.16
8	Kilinochchi	Karachchi									
9	Anuradhapura	Rambewa	303.6555	31604	104	8230	0	31592	12	20.57	19.54
10	Hambantota	Suriyawewa	189.7447	35529	187	9031	0	35529	0	34.80	17.37
11	Kurunegala	Polpithigama	417.5552	67263	161	18926	0	67263	0	30.00	18.13
12	Kurunegala	Kobeigane	130.8780	32230	246	8581	0	32230	0	19.10	24.70
13	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
14	Hambantota	Tissamaharama	783.8008	60982	78	14829	0	60486	496	32.20	22.31
15	Kurunegala	Wariyapola	201.7589	56880	282	15207	0	56832	48	18.90	29.42
16	Anuradhapura	Padaviya	242.5157	21146	87	5452	0	21146	0	34.33	14.43
17	Kurunegala	Ibbagamuwa	219.4878	76344	348	19589	0	75913	431	24.30	26.50
18	Nuwara Eliya	Ambagamuwa	487.9105	203717	418	47145	14204	47474	142039	22.90	16.74
19	Kurunegala	Galgamuwa	273.2962	47844	175	12759	0	47844	0	25.70	22.00
20	Polonnaruwa	Medirigiriya	570.3679	57899	102	15189	0	57899	0	13.37	14.73
21	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
22	Moneragala	Siyambalanduwa	1065.6754	47438	45	10808	0	47438	0	51.80	13.52
23	Kurunegala	Ganewatta	147.1195	36812	250	9830	0	36770	42	23.20	22.57
24	Badulla	Mahiyanganaya	598.4674	67301	112	16499	0	67301	0	38.57	20.02
25	Kilinochchi	Poonakary									
26	Moneragala	Thanamalwila	661.4470	23172	35	5893	0	23172	0	35.80	14.18
27	Anuradhapura	Medawachchiya	492.1070	40469	82	10338	0	40469	0	21.34	24.09
28	Anuradhapura	Horowpothana	845.8179	29642	35	7578	0	29642	0	24.95	14.78
29	Kurunegala	Pannala	284.9191	114438	402	29467	0	113726	712	17.80	31.16
30	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
31	Anuradhapura	Nuwaragam Palatha Central	389.4952	53665	138	13055	11598	42067	0	20.14	20.32
32	Moneragala	Wellawaya	585.9537	50768	87	12698	0	50768	0	24.90	17.79
33	Puttalam	Karuwalagaswewa	503.9380	20225	40	5550	0	20225	0	23.77	14.80
34	Kurunegala	Nikaweratiya	152.4124	36370	239	9549	0	36370	0	19.40	24.93
35	Anuradhapura	Kahatagasdigiliya	366.6055	33572	92	8619	0	33572	0	19.63	20.03
36	Hambantota	Lunugamvehera	300.3473	25226	84	6922	0	25226	0	33.50	17.85
37	Badulla	Rideemaliyadda	438.2808	45759	104	10681	0	45582	177	51.15	14.89
38	Kurunegala	Mahawa	260.6953	50576	194	13674	0	50576	0	20.90	21.83
39	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
40	Kurunegala	Giribawa	207.1489	28093	136	7831	0	28093	0	24.00	19.56
41	Kurunegala	Kotawehera	182.1192	19273	106	5323	0	19273	0	21.70	26.07
42	Puttalam	Mahakumbuk kadawala	175.8432	16905	96	4686	0	16905	0	28.65	15.18
43	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
44	Hambantota	Angunukolapeles	174.0781	42426	244	10394	0	42426	0	33.00	16.83
45	Anuradhapura	Galenbidunuwawe	288.1528	40888	142	10454	0	40888	0	18.56	21.42
46	Anuradhapura	Nochchiyagama	843.5736	41601	49	11239	0	41601	0	16.98	19.61
47	Anuradhapura	Thalawa	220.5999	50919	231	13375	0	50919	0	19.44	22.25
48	Kurunegala	Rideegama	222.5431	80473	362	21118	0	78808	1665	32.76	26.28
49	Kurunegala	Rasnayakapura	125.8909	18814	149	5071	0	18678	136	23.00	20.46
50	Puttalam	Nawagattegama	171.9949	12956	75	3519	0	12956	0	26.44	13.19
51	Kurunegala	Udubaddawa	117.5985	48800	415	12669	0	48742	58	17.70	29.43

Sector Specific Data				DSD Name	Rank
No. of Cattle & Buffalo[d]	No. of Goats & Swine[d]	Total Heads of poultry[d]	Livestock Landholdings <= 1/4 Acre[d]		
10183	1677	756263	8155	Panduwasnuwara	1
13020	4028	92835	558	Anamaduwa	2
26965	7220	31213	21357	Eravur Pattu	3
7508	1566	320962	4757	Kuliyapitiya West	4
7027	5834	316964	9631	Arachchikattuwa	5
11497	6210	544377	1336	Bingiriya	6
8283	664	14844	626	Embilipitiya	7
20023	11685	116560	13620	Karachchi	8
13208	4544	374983	1435	Rambewa	9
9636	3657	5888	94	Suriyawewa	10
18510		36935	1708	Polpithigama	11
7248	2326	410247	764	Kobeigane	12
12228	1697	8229	523	Ambalantota	13
15496	2475	17281	772	Tissamaharama	14
11027	1748	261608	904	Wariyapola	15
9729	1527	10264	17	Padaviya	16
14330	1034	105528	6353	Ibbagamuwa	17
5462	51301	51301	2043	Ambagamuwa	18
13267	4143	33750	1282	Galgamuwa	19
8149	1473	21600	1035	Medirigiriya	20
9467	3000	48344	3017	Hambantota	21
21898	154	11075	82	Siyambalanduwa	22
10328	829	32299	2122	Ganewatta	23
20146	1949	37354	2202	Mahiyanganaya	24
9984	5471	25771	14645	Poonakary	25
9513	278	3096	36	Thanamalwila	26
10546	3058	19473	410	Medawachchiya	27
18436	2080	11983	180	Horowpothana	28
12701		235613	10597	Pannala	29
2929	3897	111976	20167	Puttalam	30
9675	3814	47370	1479	Nuwaragam Palatha Central	31
11990	584	24645	222	Wellawaya	32
10004	2396	9621	167	Karuwalagaswewa	33
8999	1821	129735	857	Nikaweratiya	34
14464	3204	44905	352	Kahatagasdigiliya	35
8446	2170	26068	169	Lunugamvehera	36
14068	1529	28618	2708	Rideemaliyadda	37
13584	2343	87952	1512	Mahawa	38
2233	9866	47450	20368	Kalpitiya	39
8742	4851	10267	520	Giribawa	40
13914	3545	91880	15	Kotawehera	41
9162	4465	111609	189	Mahakumbuk kadawala	42
7527	5589	73888	16914	Mundalama	43
10270	152	3632	148	Angunukolapeles	44
15440	2788	11197	80	Galenbidunuwawe	45
10133	4456	12719	760	Nochchiyagama	46
7820	2680	109810	2859	Thalawa	47
11496	2282	62409	5935	Rideegama	48
7523	2827	67476	1002	Rasnayakapura	49
6984	2954	18966	235	Nawagattegama	50
6675	4195	462428	5275	Udubaddawa	51

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households [b]	Urban Population [b]	Rural Population [b]	Estate Population [b]	% in Poverty [c]	% Completed Secondary Education[a]
52	Moneragala	Medagama	241.1373	32467	135	7664	0	32467	0	30.20	14.89
53	Anuradhapura	Maha Vilachchiya	624.8276	18557	30	4630	0	18557	0	31.16	17.85
54	Moneragala	Madulla	722.5206	28358	39	6678	0	28358	0	40.70	19.44
55	Anuradhapura	Palagala	226.9676	29837	131	8196	0	29837	0	23.83	21.98
56	Kurunegala	Ambanpola	142.5265	19964	140	5488	0	19964	0	23.10	23.46
57	Badulla	Uva Paranagama	137.2816	76524	557	19213	0	65809	10715	33.35	19.52
58	Anuradhapura	Thirappane	278.9562	23378	84	6143	0	23378	0	18.59	23.27
59	Anuradhapura	Kebithigollewa	611.9821	19457	32	4903	0	19457	0	27.74	18.03
60	Anuradhapura	Galnewa	140.2283	30344	216	8165	0	30344	0	18.46	20.55
61	Anuradhapura	Mihintale	234.9169	26786	114	6657	1523	25263	0	18.97	29.03
62	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
63	Kurunegala	Kuliyapitiya East	113.2748	46966	415	11728	0	46839	127	20.32	27.57

Sector Specific Data				DSD Name	Rank
No. of Cattle & Buffalo[d]	No. of Goats & Swine[d]	Total Heads of Poultry[d]	Livestock Landholdings <= 1/4 acre[d]		
10721	1146	10281	3032	Medagama	52
7911	3403	5771	111	Maha Vilachchiya	53
10591	425	10320	628	Madulla	54
8018	1502	71800	918	Palagala	55
7523	1466	69731	393	Ambanpola	56
7290	1174	19973	5006	Uva Paranagama	57
9480	3528	16612	975	Thirappane	58
6897	557	42200	38	Kebithigollewa	59
5703	1117	68576	439	Galnewa	60
8201	1845	9325	313	Mihintale	61
4441	2874	113164	7344	Chilaw	62
6236		78879	6484	Kuliyapitiya East	63

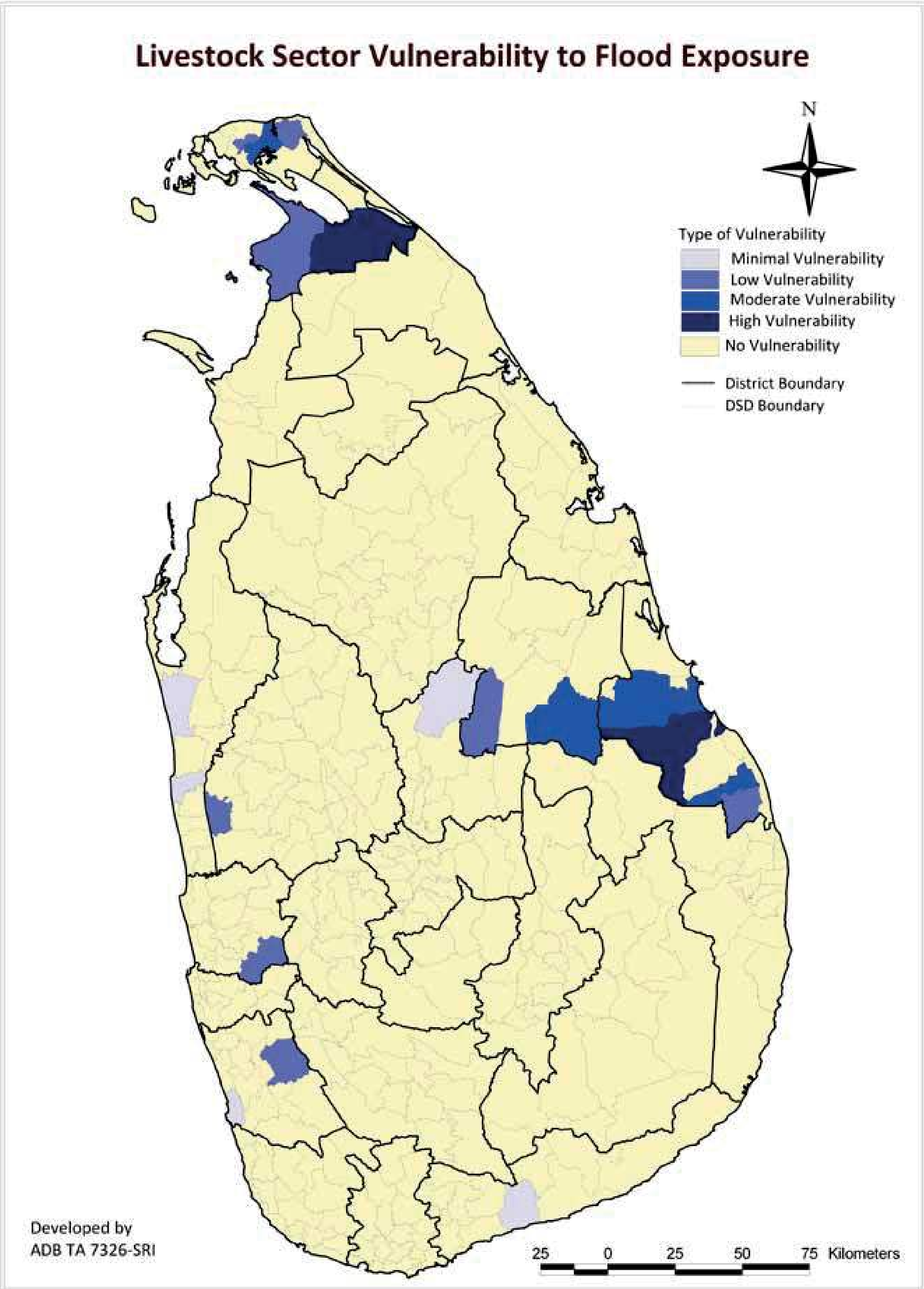
Livestock Sector Vulnerability to Flood Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • total heads of cattle/buffalo • total heads of goats and swine • number of poultry (number of birds)	A composite of data (at DSD level) on: • percentage of population employed in agriculture who have completed secondary education • number of landholdings ≤ ¼ acre • % of females with education above Grade 5 (from among the population employed in agriculture) • Percentage of households with agriculture as primary source of income
Raw data sources: Census of Agriculture 2002, Department of Census and Statistics	

Some of the key findings include:

- Vulnerability to flood exposure in the livestock sector is clustered primarily in the North and East.
- 2 DSDs emerge as highly vulnerable and 4 more as moderately vulnerable to flood exposure. These 6 DSDs combined have:
    - o 83,826 heads of cattle and buffalo, and 41,906 heads of goats and swine.
    - o Almost 285,127 heads of poultry.


Livestock Sector Vulnerability to Flood Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Livestock Sector Vulnerability to Flood Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Kilinochchi	Karachchi									
2	Batticaloa	Eravur Pattu									
3	Polonnaruwa	Dimbulagala	552.3964	63349	115	16757	0	63339	10	22.59	18.60
4	Batticaloa	Koralai Pattu (Valach.)									
5	Batticaloa	Manmunai South - West									
6	Jaffna	Kopay									
7	Gampaha	Dompe	182.1586	130021	714	31962	0	130021	0	21.10	31.48
8	Kurunegala	Udubaddawa	117.5985	48800	415	12669	0	48742	58	17.70	29.43
9	Kalutara	Bulathsinhala	209.4387	59787	285	15611	0	53331	6456	27.40	22.09
10	Kilinochchi	Poonakary									
11	Jaffna	Uduvil									
12	Jaffna	Karaveddy									
13	Polonnaruwa	Elahera	353.1772	39908	113	10446	0	39908	0	18.45	17.46
14	Batticaloa	Porativu Pattu									
15	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
16	Matale	Dambulla	455.1342	60976	134	15285	0	60959	17	19.90	23.88
17	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
18	Puttalam	Chilaw	93.6034	59890	640	14448	23533	36357	0	20.11	21.74
19	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20

Sector Specific Data				DSD Name	Rank
No. of Cattle & Buffalo[d]	No. of Goats & Swine[d]	Total Heads of Poultry[d]	Livestock Landholdings <= 1/4 Acre[d]		
20023	11685	116560	13620	Karachchi	1
26965	7220	31213	21357	Eravur Pattu	2
16320	4419	21495	878	Dimbulagala	3
5667	5459	63700	19894	Koralai Pattu (Valach.)	4
7285	2274	10841	7373	Manmunai South - West	5
7566	10849	41328	28891	Kopay	6
7052	2083	249930	8715	Dompe	7
6675	4195	462428	5275	Udubaddawa	8
3473	482	283390	1513	Bulathsinhala	9
9984	5471	25771	14645	Poonakary	10
3045	7213	56740	33484	Uduvil	11
6173	8403	46167	36780	Karaveddy	12
8833	560	59791	729	Elahera	13
6579	1854	41771	5494	Porativu Pattu	14
7527	5589	73888	16914	Mundalama	15
8874	1592	77151	889	Dambulla	16
12228	1697	8229	523	Ambalantota	17
4441	2874	113164	7344	Chilaw	18
1849	4114	312760	9387	Beruwala	19

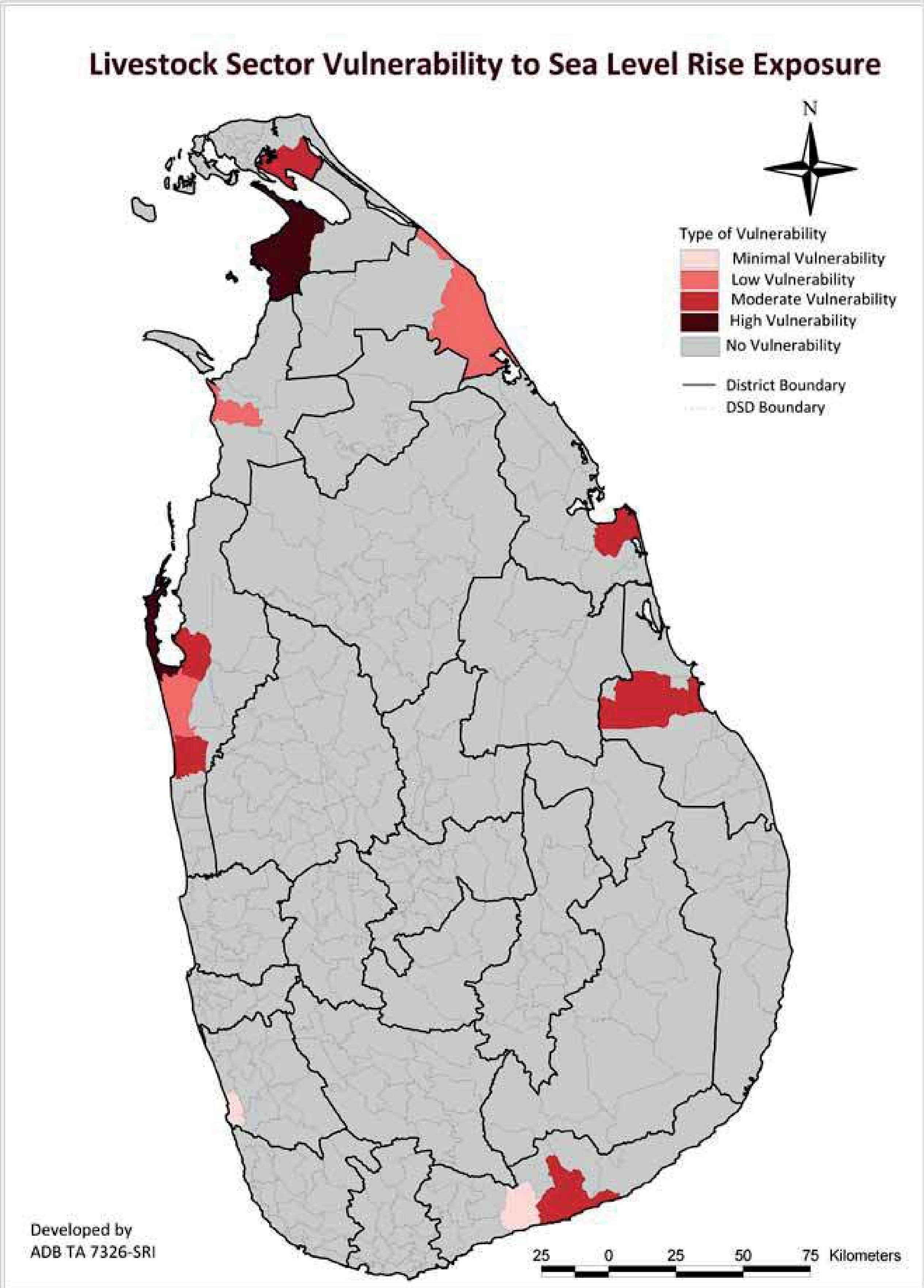
Livestock Sector Vulnerability to Sea Level Rise Exposure

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	**The Adaptive Capacity Index**
A composite of data (at DSD level) on: • total heads of cattle/buffalo • total heads of goats and swine • number of poultry (number of birds)	A composite of data (at DSD level) on: • percentage of population employed in agriculture who have completed secondary education • number of landholdings ≤ ¼ acre • % of females with education above Grade 5 (from among the population employed in agriculture) • Percentage of households with agriculture as primary source of income
Raw data sources: Census of Agriculture 2002, Department of Census and Statistics	

Some of the key findings include:

- Livestock sector vulnerability to sea level rise exposure appears to be generally low, and localized in a very few areas.
- 2 DSDs emerge as highly vulnerable in this regard, and 6 more as moderately vulnerable to sea level rise exposure. These 8 DSDs combined have:
  - o 52,381 total heads of cattle and buffalo, and 41,241 total heads of goats and swine.
  - o Slightly over 701,410 heads of poultry.


Livestock Sector Vulnerability to Sea Level Rise Exposure
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
No Vulnerability
District Boundary
DSD Boundary
Developed by
ADB TA 7326-SRI
25 0 25 50 75 Kilometers

Livestock Sector Vulnerability to Sea Level Rise Exposure

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	DSD Name	Physical Characteristics				Demographics				
			Area (Sq. km)[a]	Total Population[b]	Population Density (Per Sq. km)[a]	No. of Households[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	% in Poverty[c]	% Completed Secondary Education[a]
1	Puttalam	Kalpitiya	158.7548	81780	515	18185	0	81627	153	45.34	13.63
2	Kilinochchi	Poonakary									
3	Batticaloa	Koralai Pattu (Valach.)									
4	Jaffna	Chavakachcheri									
5	Trincomalee	Muttur									
6	Puttalam	Puttalam	178.4049	71091	398	15898	41761	29330	0	25.08	21.59
7	Puttalam	Arachchikattuwa	162.6380	38092	234	9912	0	37402	690	21.82	16.64
8	Hambantota	Hambantota	338.9857	46757	138	10945	11134	35623	0	31.30	23.32
9	Mulattivu	Maritimepattu									
10	Mannar	Nanaddan									
11	Puttalam	Mundalama	241.4497	56294	233	13534	0	56294	0	41.08	14.73
12	Hambantota	Ambalantota	211.3413	64361	305	15334	0	63426	935	33.30	21.36
13	Kalutara	Beruwala	71.6785	144733	2019	29635	33096	111637	0	22.10	28.20

Sector Specific Data				DSD Name	Rank
No. of Cattle & Buffalo[d]	No. of Goats & Swine[d]	Total Heads of Poultry[d]	Livestock Landholdings <= 1/4 Acre[d]		
2233	9866	47450	20368	Kalpitiya	1
9984	5471	25771	14645	Poonakary	2
5667	5459	63700	19894	Koralai Pattu (Valach.)	3
7478	5618	43461	18221	Chavakachcheri	4
7596	2096	43744	28558	Muttur	5
2929	3897	111976	20167	Puttalam	6
7027	5834	316964	9631	Arachchikattuwa	7
9467	3000	48344	3017	Hambantota	8
5956	3045	38855	17099	Maritimepattu	9
8482	1437	30926	6344	Nanaddan	10
7527	5589	73888	16914	Mundalama	11
12228	1697	8229	523	Ambalantota	12
1849	4114	312760	9387	Beruwala	13

Health

Good health is a necessity for intellectual, physical and spiritual growth, and one of the driving forces behind economic and social development of the country. Sri Lanka has one of the leading healthcare systems among developing countries. However, with the looming presence of climate change, Sri Lanka's health sector will have to step up and play a pivotal role in assessing vulnerability and adapting to respond to its potential impacts.

Climate change impacts are expected to be significant in the areas of vector borne diseases (essentially mosquito borne), rodent borne diseases, food and water borne diseases, nutritional status, and other environment related disorders. Mosquito vector borne diseases have emerged as a serious public health problem in Sri Lanka, particularly dengue fever. Dengue is spreading rapidly to newer areas, with outbreaks occurring more frequently and explosively. The prevailing climatic conditions, environmental pollution, rapid urbanization, over-crowding of cities and careless human practices are proving conducive for the rapid breeding of the mosquito vector and the spread of this infection. According to data for 2009, Colombo still remains with the highest incidence rate for dengue followed by Trincomalee and Matara districts. 2009 data showed an incidence rate of 1,420 per 100,000 population.

The main rodent borne disease in Sri Lanka is leptospirosis. This is the second major communicable disease in the country, is currently on the rise, and is expected to further increase due to climate change. The incidence rate for leptospirosis has been in the range of 14 to 20 cases per 100,000 population barring epidemic years of 2003 (with 24/100,000) and 2008 (37/100,000). The main food and water borne illnesses are typhoid, dysentery, cholera (not reported since 1993), diarrhoea, hepatitis A & B, and polio. Of these, dysentery is the most prevalent in Sri Lanka though its incidence has been declining since 2000. Incidence ranged from 14.2 to 59.8 cases per 100,000 population with the case fatality rate being less than 1%, except in 2005 when it was 1.6%. Extreme conditions resulting from climate change induced impacts (floods, land-slides and droughts) are expected to cause more water and food borne diseases. The main vulnerabilities associated with climate change on the health sector are discussed in detail in the *Health SVP* and is not detailed here as the mapping exercise did not take into account the exposure indices for the health sectors for reasons described in the Methodology section of this book.

Vulnerability to Dengue

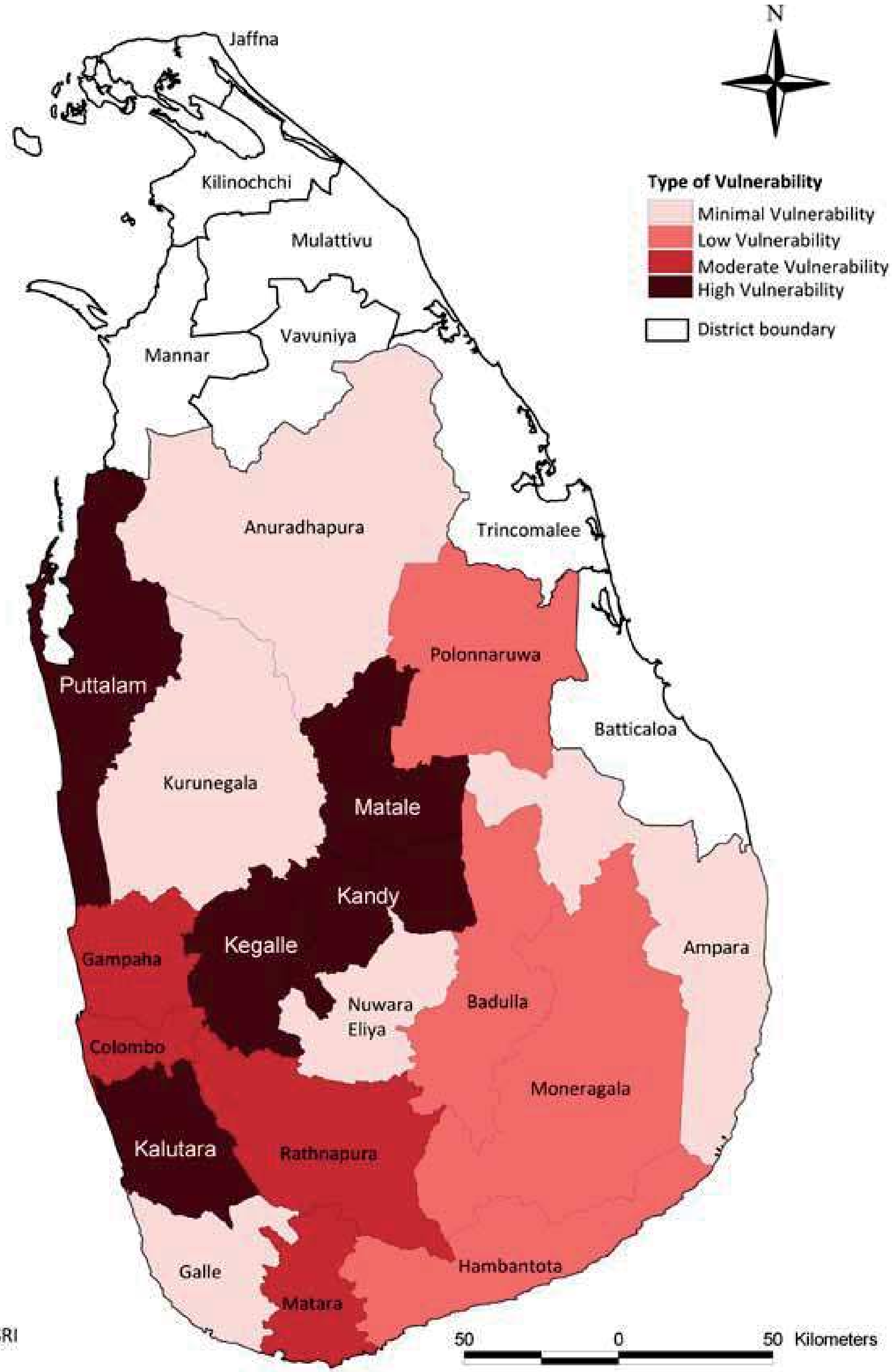
The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
• Average incidence rate for dengue fever (2004 – 2008)	• % completed secondary education • % above poverty line • # of hospital beds • # of hospitals
Raw data sources: Population and Housing Census, 2001; Department of Census and Statistics (2010); Epidemiology Unit; Ministry of Health, provided for preparation of this report, 2010	

Some of the key findings include:

- Matale, Kandy, Kalutara, Kegalle and Puttalam Districts show high vulnerability to dengue.
    - They support a population of 4,660,000 of whom 9% are urban and 86% are rural.
    - Combined, this area has 229 hospitals and 14,385 hospital beds.
- A further 4 Districts show moderate vulnerability to dengue.
    - They support a population of 6,694,000 of whom 27% are urban and 75% are rural.
    - Combined, this area has 202 hospitals and 22,231 hospital beds.

Vulnerability to Dengue



Developed by
ADB TA 7326-SRI

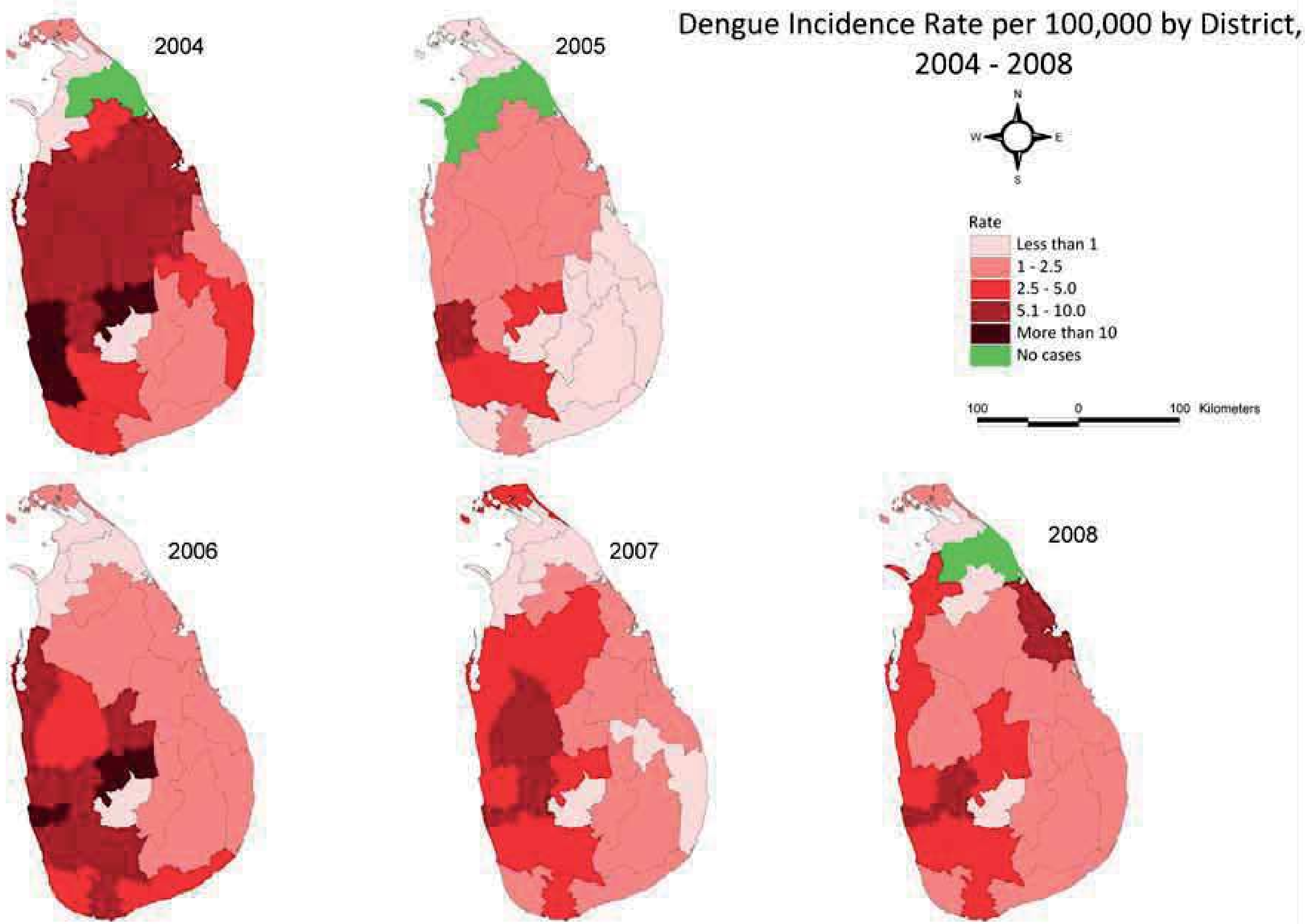
Vulnerability to Dengue

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

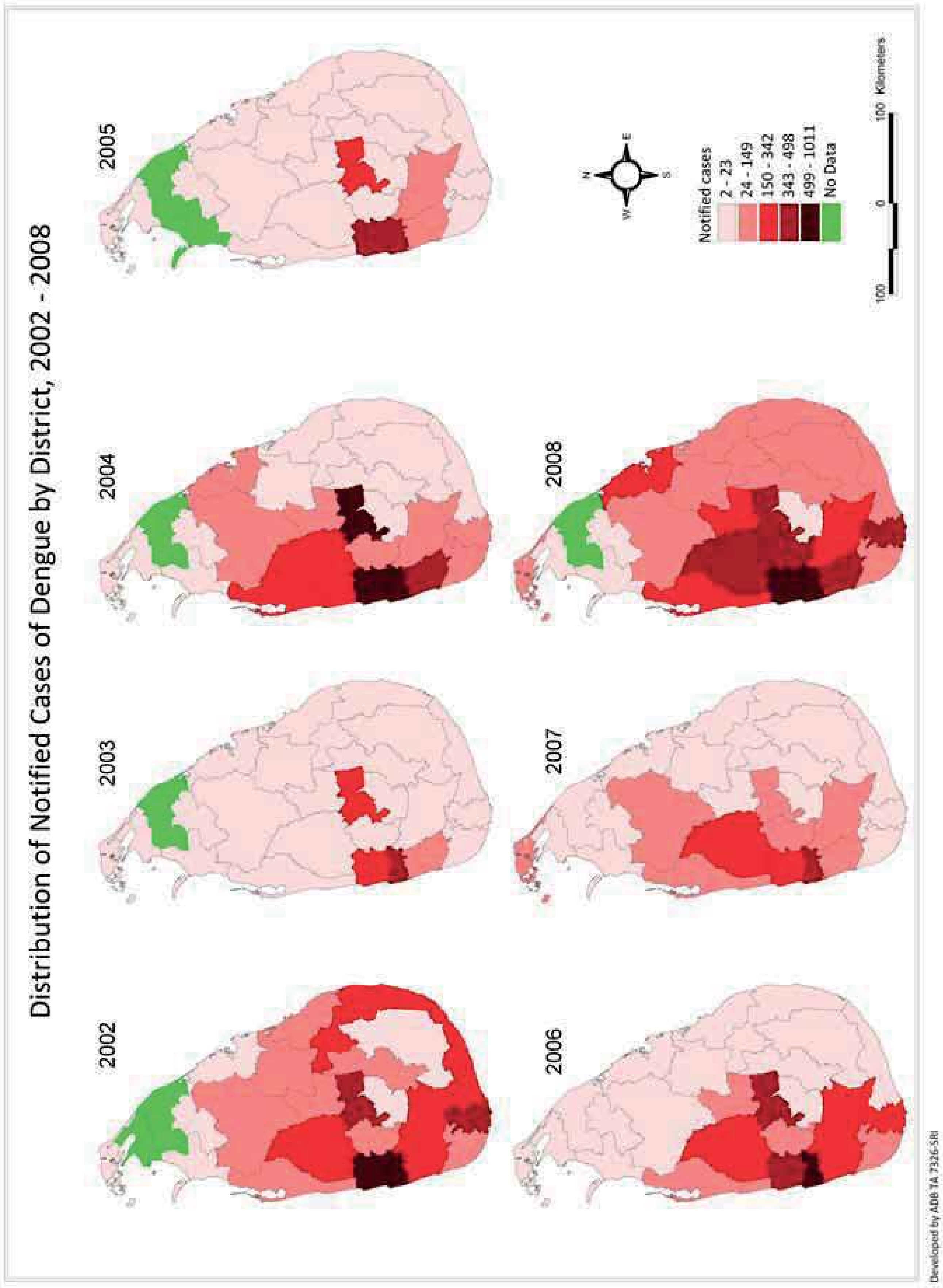
Rank	District Name	Physical Characteristics							Demographics						
		Area (Sq. km)[i]	% Forest Land[l]	Total Extent of Agri. (Acers)[d]	No. of House-holds[b]	No. of Occupied Housing Units[b]	Total Population 2010 ('000)[i]	Population Density (Per Sq. km)-2010[a]	Urban[b]	Rural[b]	Estate[b]	# Completed Secondary Education[b]	% Completed Secondary Education[a]	Pop. Below Poverty Line	% in Poverty (HCI)[c]
1	Puttalam	3072	25	159647	176544	174737	779	254	65294	642210	2173	133288	21.39	104	13.10
2	Kalutara	1598	13	141805	250939	245784	1135	710	113188	915477	37574	314334	33.03	149	13.00
3	Matale	1993	41	122391	110886	108566	497	249	36103	383468	21757	99867	25.23	89	18.90
4	Kegalle	1693	10	149476	195853		818	483	17139	712914	55471	209434	29.71	175	21.00
5	Kandy	1940	17	150007	299870	291454	1431	738	155987	1030172	92869	368009	32.17	230	17.00
6	Ratnapura	3275	20	243003	245743	242882	1125	344	58245	855178	102384	214927	23.43	292	26.60
7	Colombo	699	3	41513	493085	473045	2553	3652	1229572	1014388	7314	888246	44.28	125	5.40
8	Matara	1283	16	156547	177613	174712	839	654	64361	676499	20510	191971	28.00	119	14.70
9	Gampaha	1387	0	143495	487184	475847	2177	1570	300933	1762028	723	714378	38.46	196	8.70
10	Hambantota	2609	21	202304	128008	126362	571	219	21571	503412	1431	110566	23.37	73	12.70
11	Moneragala	5639	41	225218	96598	95966	440	78	0	388226	9149	66552	18.81	150	33.20
12	Polonnaruwa	3293	38	163800	91718	90999	410	125	0	358679	305	67828	21.23	50	12.70
13	Badulla	2861	19	156800	189925	185268	886	310	51536	567178	161269	160203	23.36	197	23.70
14	Kurunegala	4816	5	534464	380213	376352	1563	325	34691	1418882	6642	383985	29.12	238	15.40
15	Nuwara Eliya	1741	25	60274	169540	164886	761	437	43073	283659	376878	108874	17.84	254	33.80
16	Ampara	4415	38	172001	137741	132371	644	146	112536	480461	0	111701	21.58	64	10.90
17	Galle	1652	13	167401	233027	229521	1084	656	109921	863309	17257	263578	29.65	146	13.70
18	Anuradhapura	7179	35	364816	189699	186697	830	116	53151	691573	969	156644	23.61	118	14.90

Sector Specific Data			District Name	Rank
# of Hospitals m and a	# of Hospital Beds j	Average Dengue Incidence Rate (2004-2008) k and a		
40	1676	51.63	Puttalam	1
28	2658	65.73	Kalutara	2
36	1522	49.06	Matale	3
41	2229	50.41	Kegalle	4
84	6300	77.08	Kandy	5
50	3136	41.06	Ratnapura	6
51	11175	102.96	Colombo	7
37	2259	42.94	Matara	8
64	5661	75.79	Gampaha	9
32	1644	21.35	Hambantota	10
28	1350	10.67	Moneragala	11
46	2746	27.52	Polonnaruwa	12
52	3202	13.31	Badulla	13
98	5296	37.79	Kurunegala	14
45	1804	5.50	Nuwara Eliya	15
51	2536	12.91	Ampara	16
48	3511	16.13	Galle	17
122	6676	29.84	Anuradhapura	18

Dengue Incidence Rate per 100,000 by District, 2004 - 2008



Developed by ADB TA 7326-SRI


Distribution of Notified Cases of Dengue by District, 2002 - 2008
2002
2003
2004
2005
2006
2007
2008
Notified cases
2 - 23
24 - 149
150 - 342
343 - 498
499 - 1011
No Data
N
E
S
W
100
0
100 Kilometers
Developed by ADB TA 7326-SRI

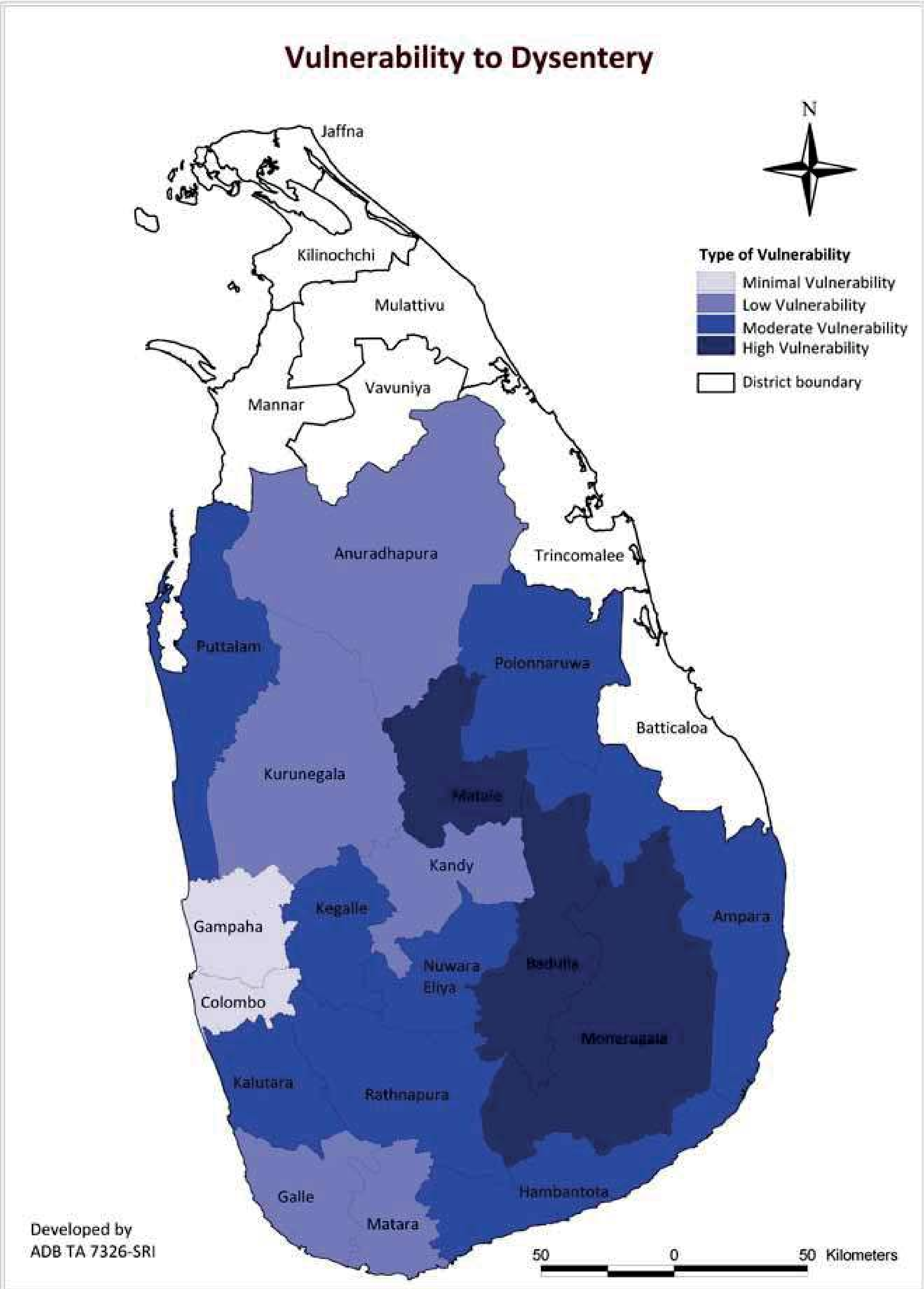
Vulnerability to Dysentery

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
• Average incidence rate for dengue fever (2004 – 2008)	• % completed secondary education • % above poverty line • # of hospital beds • # of hospitals
Raw data sources: Population and Housing Census, 2001; Epidemiology Unit; Ministry of Health, provided for preparation of this report, 2010	

Some of the key findings include:

- Moneragla, Badulla and Matale Districts show high vulnerability to dysentery.
  - They support a population of 1,823,000 of whom 5.4% are urban and 82.7% are rural.
  - Combined, this area has 116 hospitals and 6,074 hospital beds.
- Further 8 Districts show moderate vulnerability.
  - They support a population of 6,243,000 of whom 7.5% are urban and 82.5% are rural.
  - Combined, this area has 333 hospitals and 18,429 hospital beds.

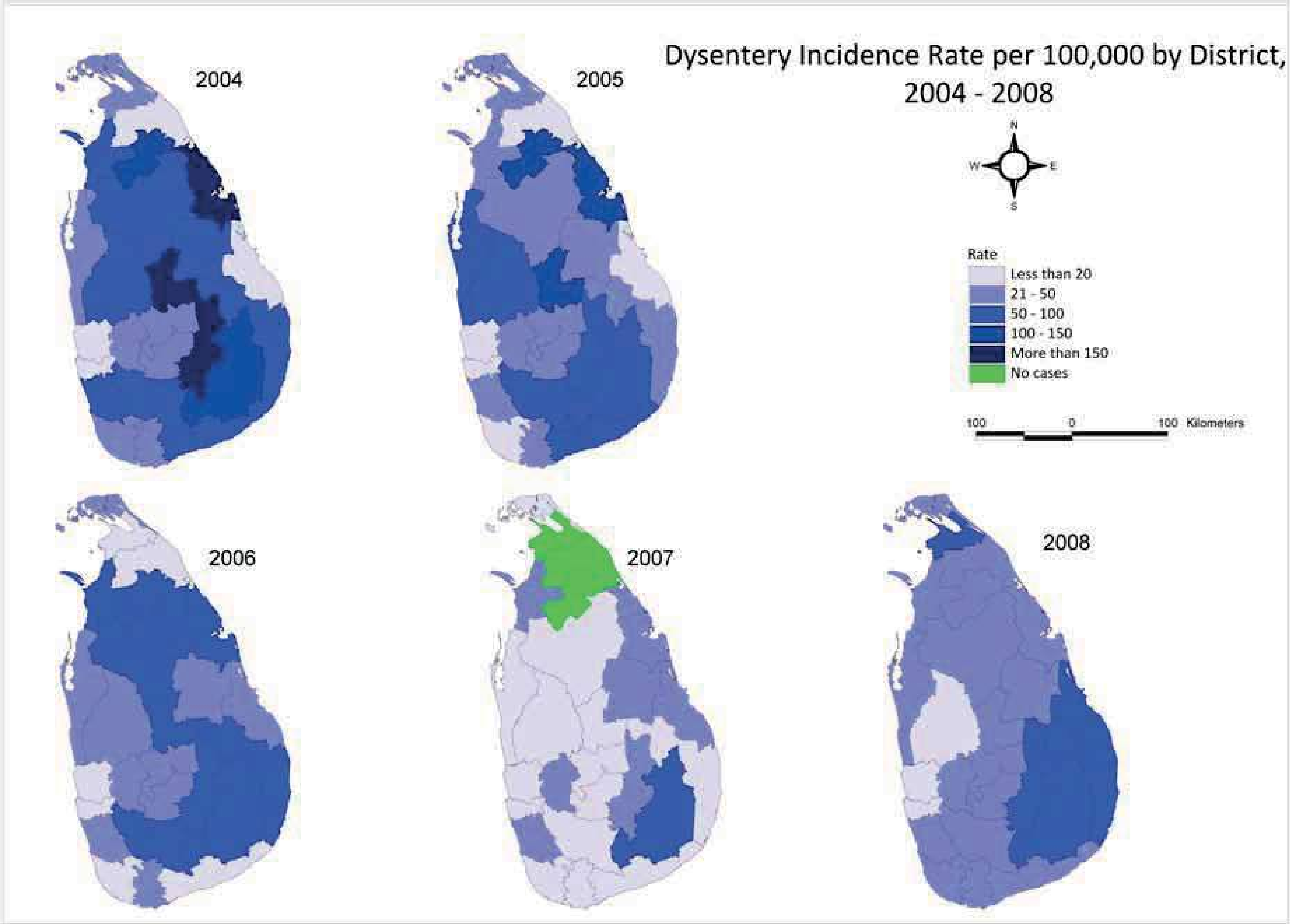

Vulnerability to Dysentery
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
District boundary
Jaffna
Kilinochchi
Mulattivu
Vavuniya
Mannar
Trincomalee
Anuradhapura
Puttalam
Polonnaruwa
Batticaloa
Kurunegala
Matale
Kandy
Ampara
Kegalle
Gampaha
Nuwara Eliya
Badulla
Colombo
Moneragala
Kalutara
Rathnapura
Hambantota
Galle
Matara
Developed by ADB TA 7326-SRI
50 0 50 Kilometers

Vulnerability to Dysentery

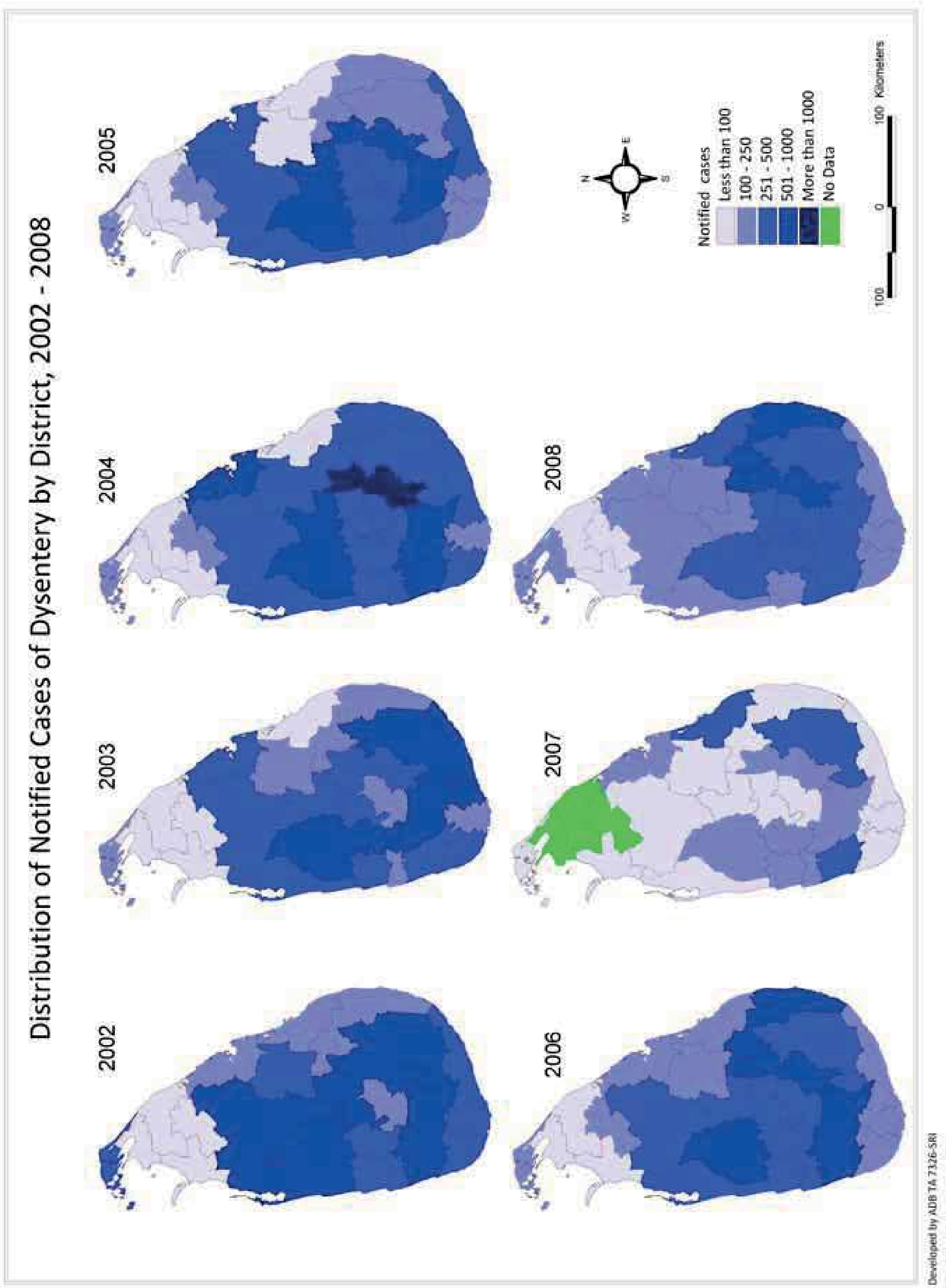
High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	Physical Characteristics							Demographics						
		Area (Sq. km)[i]	% Forest Land[l]	Total Extent of Agri. (Acers)[d]	No. of House-holds[b]	No. of Occupied Housing Units[b]	Total Population 2010 ('000)[i]	Population Density (Per Sq. km)-2010[a]	Urban[b]	Rural[b]	Estate[b]	# Completed Secondary Education[b]	% Completed Secondary Education[a]	Pop. Below Poverty Line	% in Poverty (HCI)[c]
1	Moneragala	5639	40.50	225218	96598	95966	440	78	0	388226	9149	66552	18.81	150	33.20
2	Badulla	2861	19.00	156800	189925	185268	886	310	51536	567178	161269	160203	23.36	197	23.70
3	Matale	1993	40.50	122391	110886	108566	497	249	36103	383468	21757	99867	25.23	89	18.90
4	Ampara	4415	37.50	172001	137741	132371	644	146	112536	480461	0	111701	21.58	64	10.90
5	Ratnapura	3275	20.00	243003	245743	242882	1125	344	58245	855178	102384	214927	23.43	292	26.60
6	Hambantota	2609	20.50	202304	128008	126362	571	219	21571	503412	1431	110566	23.37	73	12.70
7	Nuwara Eliya	1741	24.50	60274	169540	164886	761	437	43073	283659	376878	108874	17.84	254	33.80
8	Puttalam	3072	25.00	159647	176544	174737	779	254	65294	642210	2173	133288	21.39	104	13.10
9	Kegalle	1693	9.50	149476	195853	193578	818	483	17139	712914	55471	209434	29.71	175	21.00
10	Polonnaruwa	3293	38.00	163800	91718	90999	410	125	0	358679	305	67828	21.23	50	12.70
11	Kalutara	1598	13.00	141805	250939	245784	1135	710	113188	915477	37574	314334	33.03	149	13.00
12	Matara	1283	16.00	156547	177613	174712	839	654	64361	676499	20510	191971	28.00	119	14.70
13	Kurunegala	4816	5.00	534464	380213	376352	1563	325	34691	1418882	6642	383985	29.12	238	15.40
14	Anuradhapura	7179	35.00	364816	189699	186697	830	116	53151	691573	969	156644	23.61	118	14.90
15	Galle	1652	13.00	167401	233027	229521	1084	656	109921	863309	17257	263578	29.65	146	13.70
16	Kandy	1940	17.00	150007	299870	291454	1431	738	155987	1030172	92869	368009	32.17	230	17.00
17	Gampaha	1387	0.30	143495	487184	475847	2177	1570	300933	1762028	723	714378	38.46	196	8.70
18	Colombo	699	2.80	41513	493085	473045	2553	3652	1229572	1014388	7314	888246	44.28	125	5.40

Sector Specific Data			District Name	Rank
# of Hospitals [m and a]	# of Hospital Beds[j]	Average Dysentery Incidence Rate (2004-2008) [k and a]		
28	1350	81.56	Moneragala	1
52	3202	85.64	Badulla	2
36	1522	85.81	Matale	3
51	2536	60.76	Ampara	4
50	3136	52.19	Ratnapura	5
32	1644	39.54	Hambantota	6
45	1804	37.94	Nuwara Eliya	7
40	1676	35.05	Puttalam	8
41	2229	39.00	Kegalle	9
46	2746	39.05	Polonnaruwa	10
28	2658	41.00	Kalutara	11
37	2259	22.68	Matara	12
98	5296	35.51	Kurunegala	13
122	6676	36.19	Anuradhapura	14
48	3511	16.99	Galle	15
84	6300	26.75	Kandy	16
64	5661	13.16	Gampaha	17
51	11175	11.60	Colombo	18



Developed by ADB TA 7326-SRI


Distribution of Notified Cases of Dysentery by District, 2002 - 2008
2002
2003
2004
2005
2006
2007
2008
N
E
S
W
Notified cases
Less than 100
100 - 250
251 - 500
501 - 1000
More than 1000
No Data
100
0
100 Kilometers
Developed by ADB TA 7326-SRI

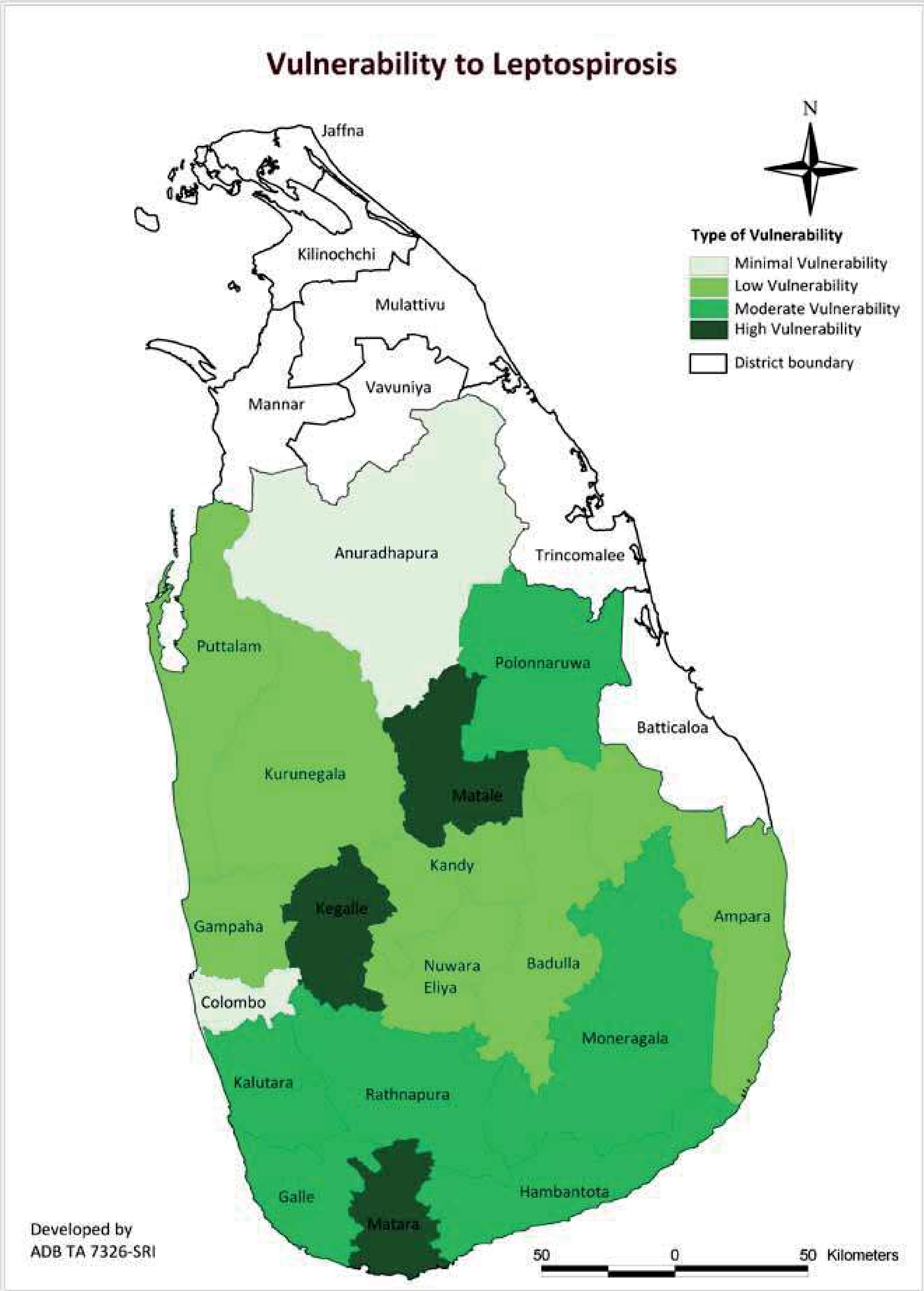
Vulnerability to Leptospirosis

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
• Average incidence rate for dengue fever (2004 – 2008)	• % completed secondary education • % above poverty line • # of hospital beds • # of hospitals
Raw data sources: Population and Housing Census, 2001; Epidemiology Unit; Ministry of Health, provided for preparation of this report, 2010	

Some of the key findings include:

- Matara, Kegalle and Matale Districts show high vulnerability to Leptospirosis.
  - They support a population of 2,154,000 of whom 5.9% are urban and 89% are rural.
  - Combined, this area has 114 hospitals and 6,010 hospital beds.
- A Further 6 Districts show moderate vulnerability to Leptospirosis.
  - They support a population of 4,765,000 of whom 7% are urban and 89% are rural.
  - Combined, this area has 232 hospitals and 15,045 hospital beds.

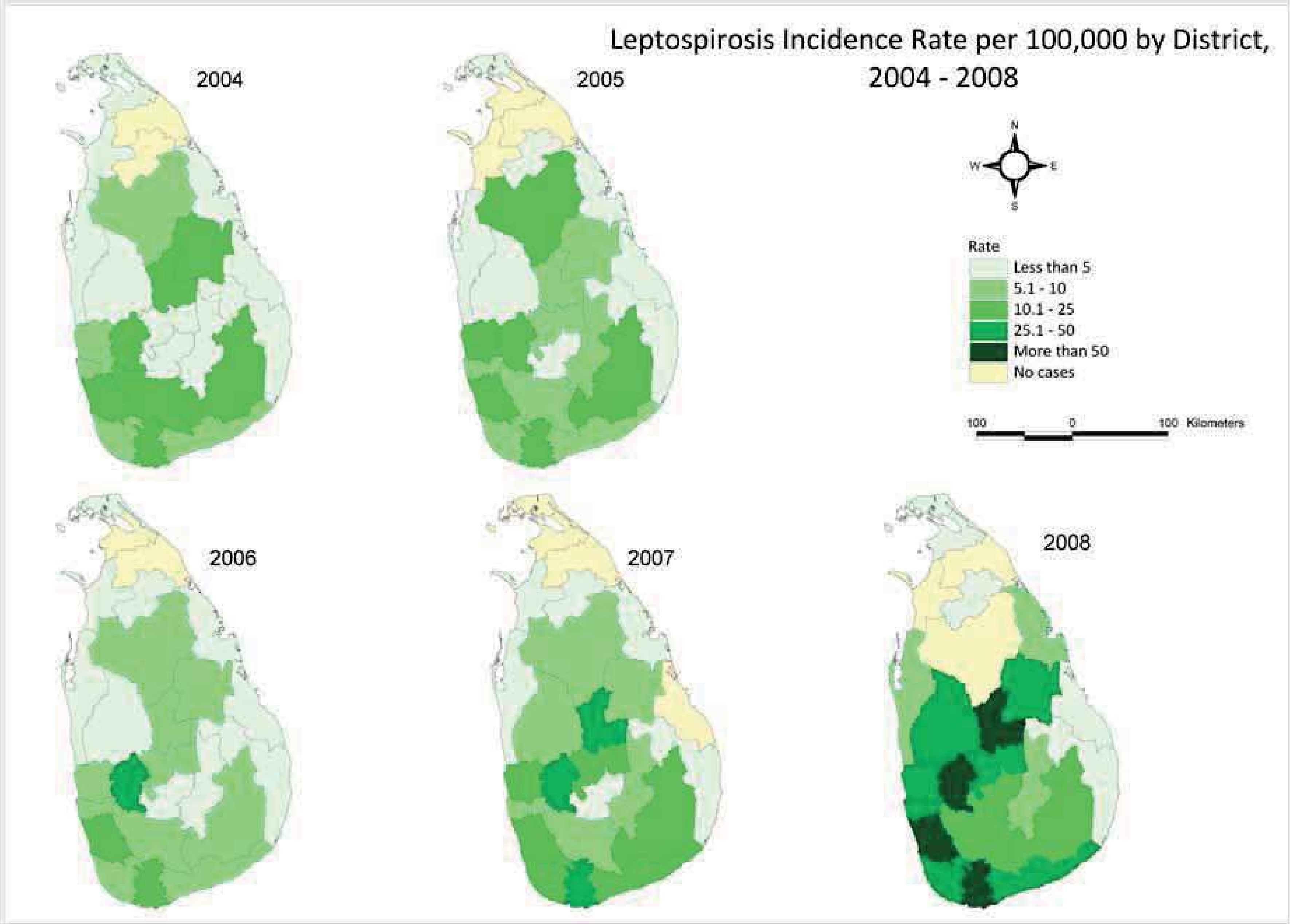

Vulnerability to Leptospirosis
N
Type of Vulnerability
Minimal Vulnerability
Low Vulnerability
Moderate Vulnerability
High Vulnerability
District boundary
Jaffna
Kilinochchi
Mulattivu
Vavuniya
Mannar
Anuradhapura
Trincomalee
Puttalam
Polonnaruwa
Batticaloa
Kurunegala
Matale
Kandy
Kegalle
Ampara
Gampaha
Nuwara
Eliya
Badulla
Colombo
Moneragala
Kalutara
Rathnapura
Galle
Hambantota
Matara
Developed by
ADB TA 7326-SRI
50
0
50 Kilometers

Vulnerability to Leptospirosis

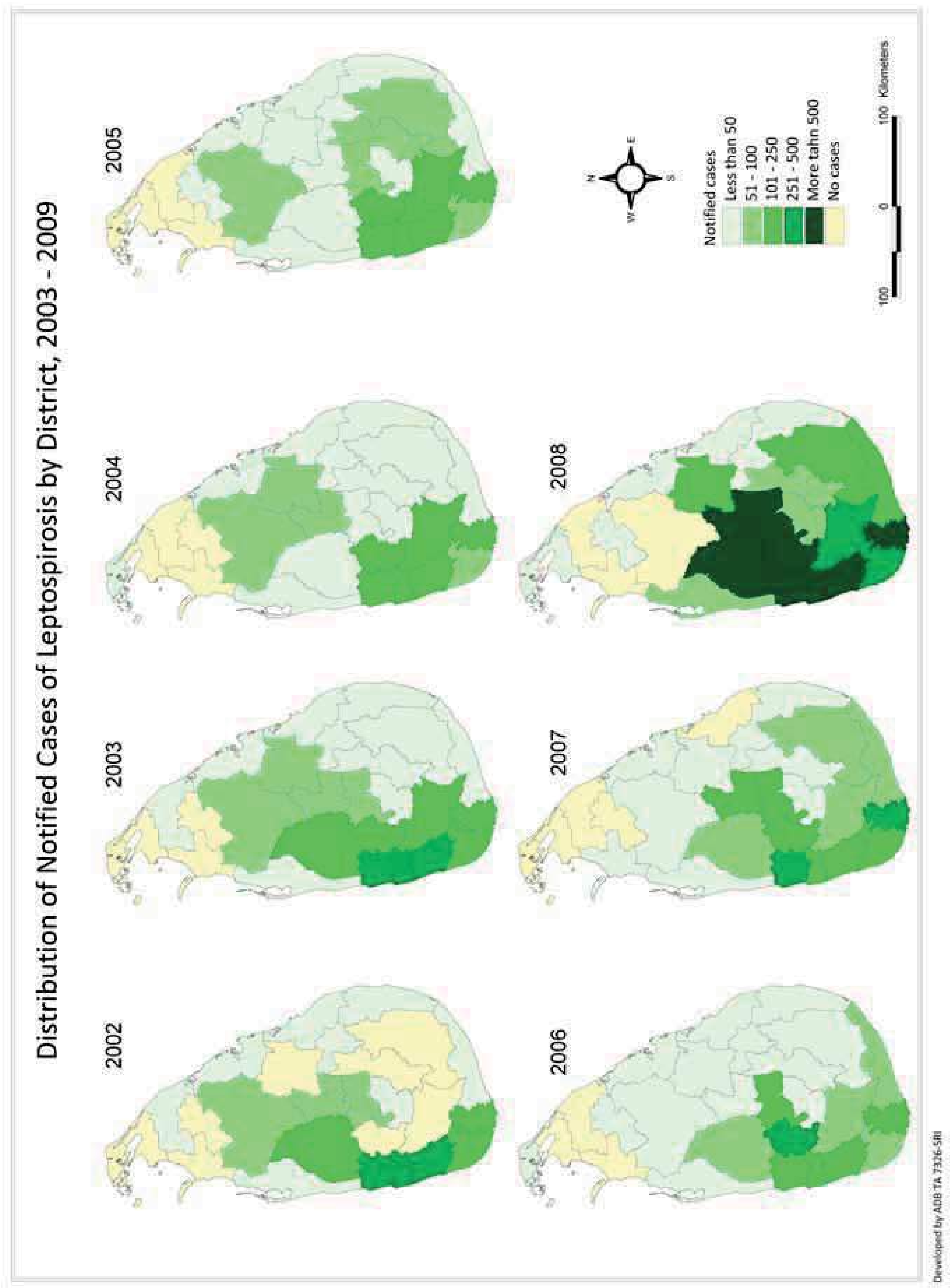
High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

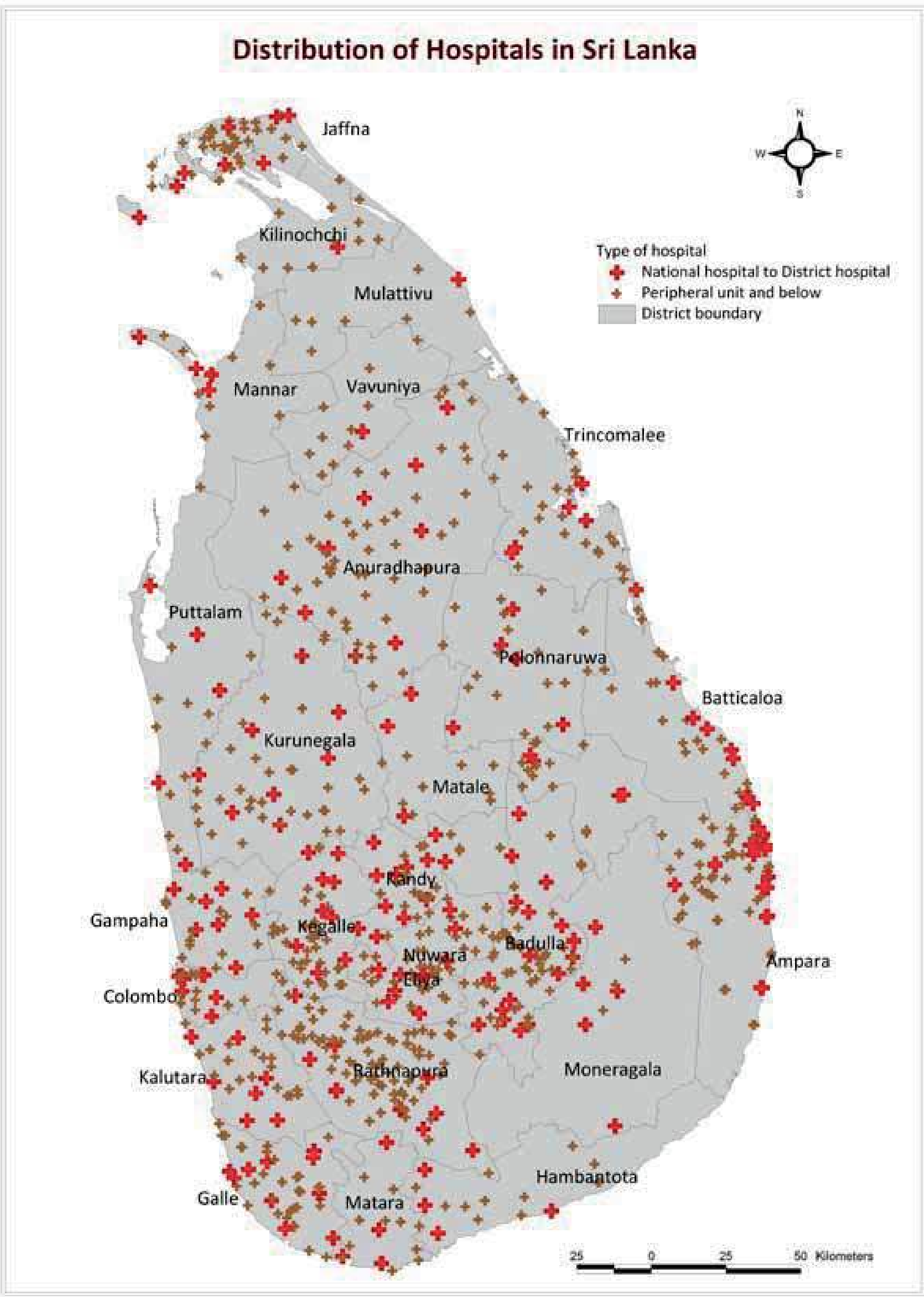
Rank	District Name	Physical Characteristics							Demographics						
		Area (Sq. km)[i]	% Forest Land[l]	Total Extent of Agri. (Acers)[d]	No. of House-holds[b]	No. of Occupied Housing Units[b]	Total Population 2010 ('000)[i]	Population Density (Per Sq. km)-2010[a]	Urban[b]	Rural[b]	Estate[b]	# Completed Secondary Education[b]	% Completed Secondary Education[a]	Pop. Below Poverty Line	% in Poverty (HCI)[c]
1	Matale	1993	40.50	122391	110886	108566	497	249	36103	383468	21757	99867	25.23	89	18.90
2	Kegalle	1693	9.50	149476	195853	193578	818	483	17139	712914	55471	209434	29.71	175	21.00
3	Matara	1283	16.00	156547	177613	174712	839	654	64361	676499	20510	191971	28.00	119	14.70
4	Moneragala	5639	40.50	225218	96598	95966	440	78	0	388226	9149	66552	18.81	150	33.20
5	Kalutara	1598	13.00	141805	250939	245784	1135	710	113188	915477	37574	314334	33.03	149	13.00
6	Hambantota	2609	20.50	202304	128008	126362	571	219	21571	503412	1431	110566	23.37	73	12.70
7	Ratnapura	3275	20.00	243003	245743	242882	1125	344	58245	855178	102384	214927	23.43	292	26.60
8	Polonnaruwa	3293	38.00	163800	91718	90999	410	125	0	358679	305	67828	21.23	50	12.70
9	Galle	1652	13.00	167401	233027	229521	1084	656	109921	863309	17257	263578	29.65	146	13.70
10	Badulla	2861	19.00	156800	189925	185268	886	310	51536	567178	161269	160203	23.36	197	23.70
11	Puttalam	3072	25.00	159647	176544	174737	779	254	65294	642210	2173	133288	21.39	104	13.10
12	Nuwara Eliya	1741	24.50	60274	169540	164886	761	437	43073	283659	376878	108874	17.84	254	33.80
13	Kurunegala	4816	5.00	534464	380213	376352	1563	325	34691	1418882	6642	383985	29.12	238	15.40
14	Kandy	1940	17.00	150007	299870	291454	1431	738	155987	1030172	92869	368009	32.17	230	17.00
15	Ampara	4415	37.50	172001	137741	132371	644	146	112536	480461	0	111701	21.58	64	10.90
16	Gampaha	1387	0.30	143495	487184	475847	2177	1570	300933	1762028	723	714378	38.46	196	8.70
17	Anuradhapura	7179	35.00	364816	189699	186697	830	116	53151	691573	969	156644	23.61	118	14.90
18	Colombo	699	2.80	41513	493085	473045	2553	3652	1229572	1014388	7314	888246	44.28	125	5.40

Sector Specific Data			District Name	Rank
# of Hospitals [m and a]	# of Hospital Beds[j]	Average Leptospirosis Incidence Rate (2004-2008) [k and a]		
36	1522	49.13	Matale	1
41	2229	37.25	Kegalle	2
37	2259	31.30	Matara	3
28	1350	16.04	Moneragala	4
28	2658	24.18	Kalutara	5
32	1644	12.49	Hambantota	6
50	3136	11.78	Ratnapura	7
46	2746	12.64	Polonnaruwa	8
48	3511	16.71	Galle	9
52	3202	6.29	Badulla	10
40	1676	4.12	Puttalam	11
45	1804	3.59	Nuwara Eliya	12
98	5296	12.34	Kurunegala	13
84	6300	13.21	Kandy	14
51	2536	2.76	Ampara	15
64	5661	15.95	Gampaha	16
122	6676	5.68	Anuradhapura	17
51	11175	13.54	Colombo	18



Developed by ADB TA 7326-SRI


Distribution of Notified Cases of Leptospirosis by District, 2003 - 2009
2002
2003
2004
2005
2006
2007
2008
N
E
S
W
Notified cases
Less than 50
51 - 100
101 - 250
251 - 500
More tahn 500
No cases
100
0
100 Kilometers
Developed by ADB TA 7326-SRI



Developed by ADB TA 7326-SRI

Biodiversity and Ecosystem Services

Biodiversity underlies the goods and services that are crucial for human survival and wellbeing due to a host of vital supporting, regulating, provisioning and cultural ecosystem services. Biodiversity is determined by many factors, including mean climate and climate variability, as well as disturbance regimes caused by changes of tectonic, climatic, biological, anthropogenic and other origin. It is now generally accepted that global biodiversity will be significantly affected by climate change, although its precise impacts are still unsure.

Components of biodiversity provide us with freshwater for domestic and industrial uses, and underpin the socio-economically vital areas of agriculture and livestock production, fishery, forestry, tourism, traditional medicine and several important manufacturing industries. Therefore, the value of conserving the country's biodiversity has been recognized and incorporated into national planning.

While the current and probable future impacts of climate change on agro-biodiversity are being addressed, the possible impacts of climate change on wild biodiversity are mostly speculative. Nonetheless, the socio-economic and ecological implications of biodiversity loss in Sri Lanka will be considerable and wide ranging, because of probable changes in forests and other terrestrial systems, inland wetlands and coastal and marine systems and the species they contain. These changes will have inevitable impacts on national food security; rural livelihoods, nutrition and health; and overall economic development, particularly in the fields of tourism and external trade.

Although all impacts of climate change on biodiversity may not be preventable, it is recognized that genetically diverse populations of species, and species rich ecosystems, have much greater potential to adapt to climate change. Conservation of biodiversity and maintenance of ecosystem structure and function may, therefore, be one of the most practical climate change adaptation strategies that Sri Lanka can adopt to conserve the country's natural heritage, and to ensure an uninterrupted flow of ecosystem services and bio-resources that are essential for national development. The various issues associated with climate change such as changing rainfall patters, increased temperatures, drought, flood and landslides on the different ecosystems both terrestrial and aquatic ecosystems are discussed in detail in the *SVP on Biodiversity and Ecosystem Services*.

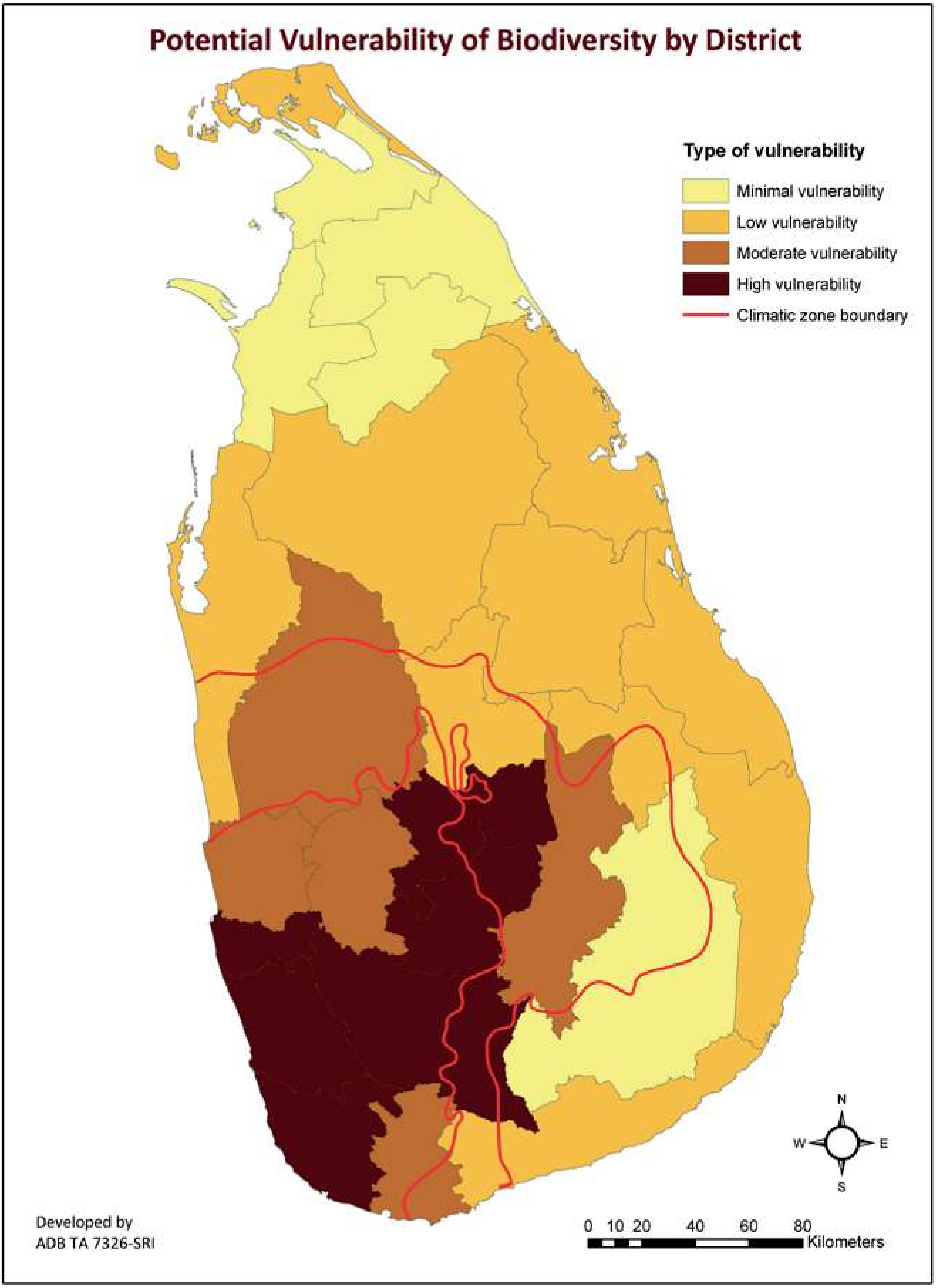
Potential Vulnerability of Biodiversity by District

The indicators used for the Sensitivity Index and the Adaptive Capacity Index are:

The Sensitivity Index	The Adaptive Capacity Index
A composite of data (at DSD level) on: • number of threatened butterfly species per district (IUCN and MOENR, 2007)27 • number of threatened vertebrate species per district27 (IUCN and MOENR, 2007) • number of threatened flowering plants per district (IUCN and MOENR, 2007)27 (These three groups have been taken as representative groups that could be expected to be affected by climate change)	A composite of data (at DSD level) on: • Forest cover (ha) per district (2007 census data) • Human population density per district (2007 census data) • Home garden size per district (calculated using the 1:50,000 land use map to obtain home garden area per district, and the number of housing units per district from the 2001 Census)

Some of the key findings include:

- Six districts appear to be highly vulnerable in terms of biodiversity. These districts are Galle, Kalutara, Colombo, Ratnapura, Nuwara Eliya and Kandy. They have:
    - o a total human population of 7,306,445, of whom nearly 16.4% are below the poverty lin.e
    - o 2,181 km^2 of forests.
    - o 1,583 (57.8% of all currently listed) nationally threatened species.
    - o an average home garden size of 52.6 perches per household unit.
    - o Most of the biodiversity rich lowland and montane wet zone forests.
- Historically, Ratnapura, Kalutara, Galle, Colombo districts are also highly vulnerable to floods and Nuwara Eliya and Rathnapura Districts are highly vulnerable to landslides.
- A further 5 Districts (Matara, Badulla, Gampaha, Kegalle and Kurunegala are in the moderately vulnerable category. They have:
    - o a total population of 5,850,776.
    - o a total forest cover of 248 km^2.
    - o 562 (18.03%) of all currently listed nationally threatened species.

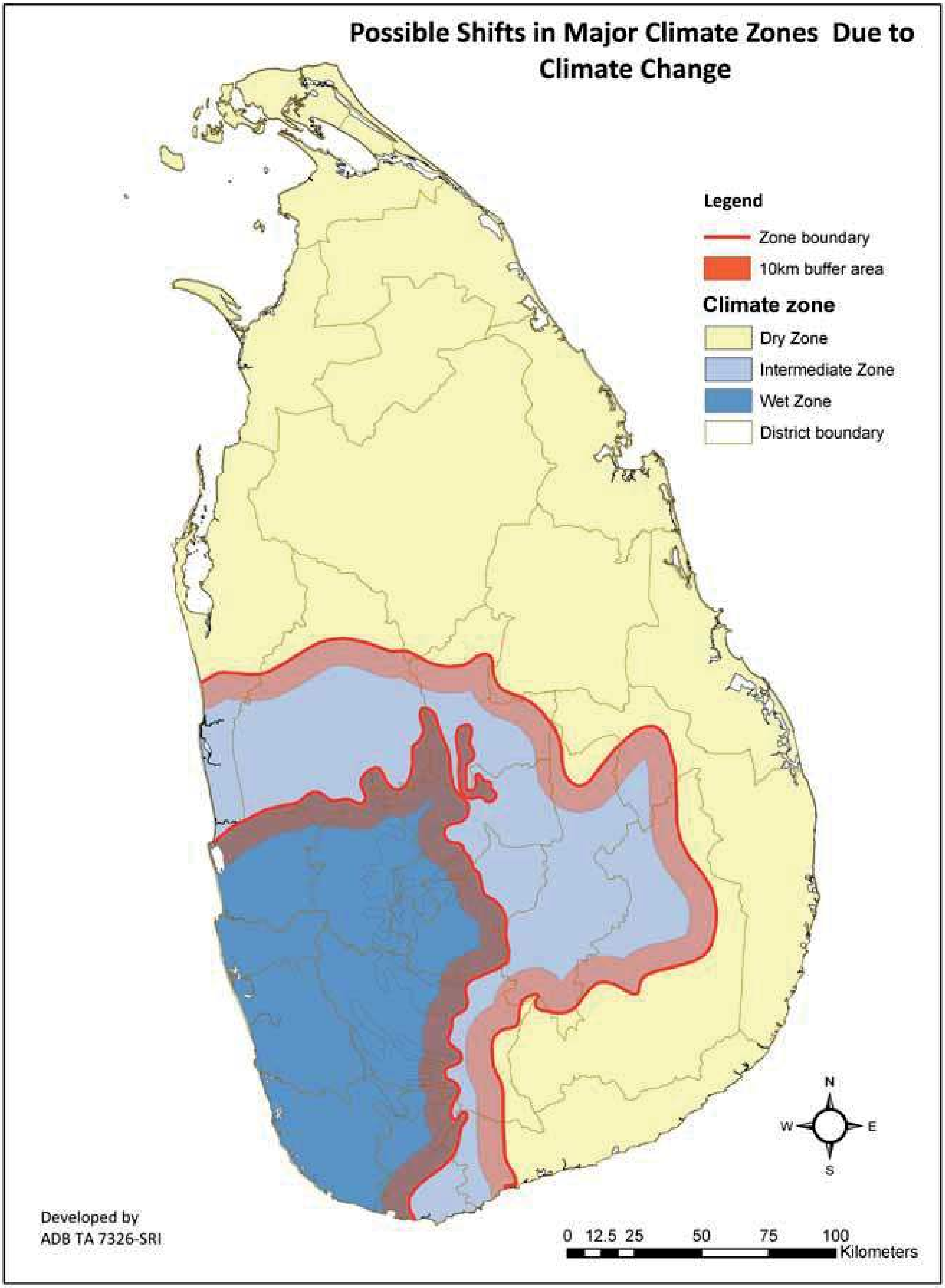

Potential Vulnerability of Biodiversity by District
Type of vulnerability
Minimal vulnerability
Low vulnerability
Moderate vulnerability
High vulnerability
Climatic zone boundary
N
W
E
S
0 10 20 40 60 80
Kilometers
Developed by
ADB TA 7326-SRI

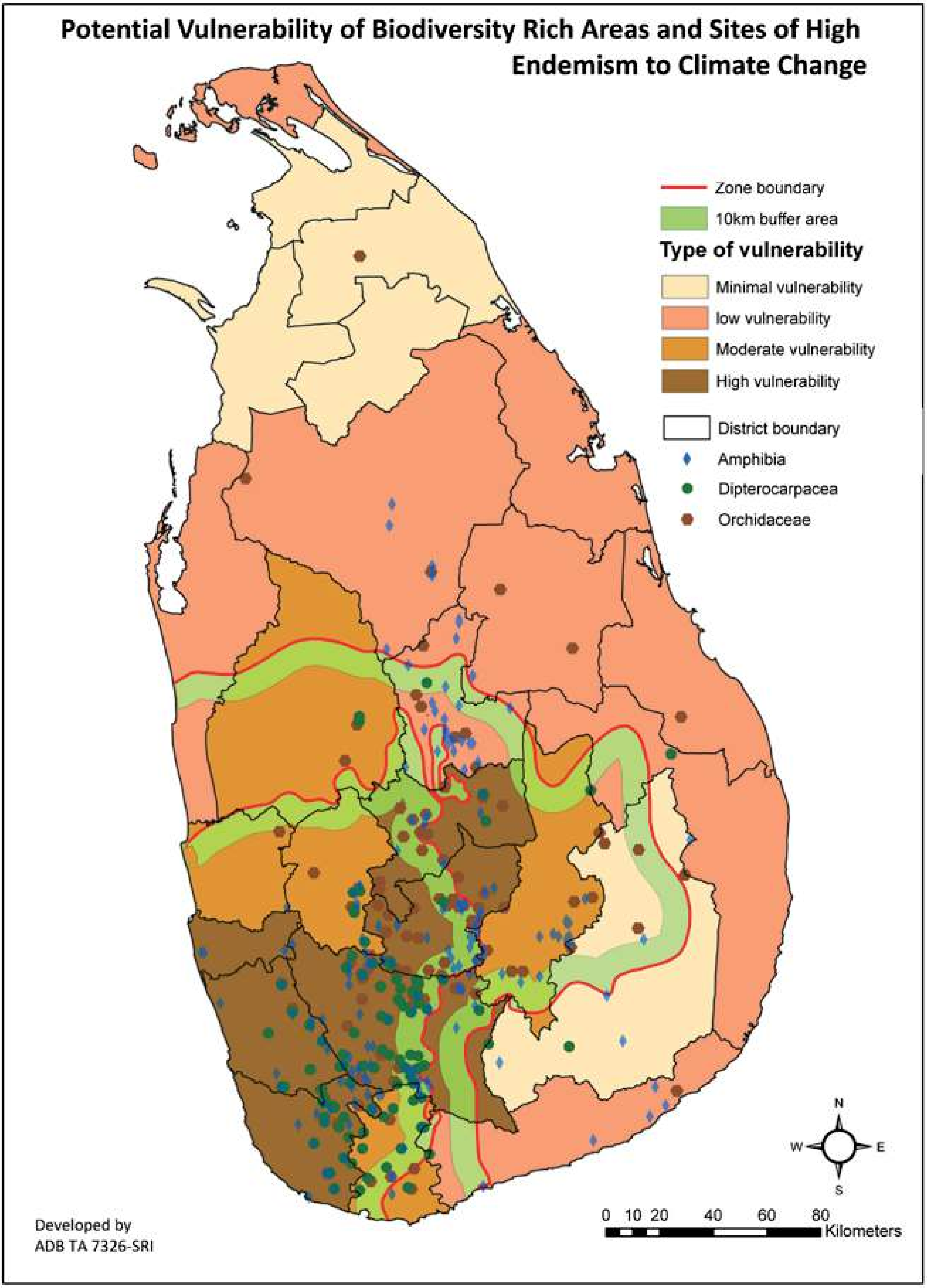
Biodiversity Sector Vulnerability

High Vulnerability | Moderate Vulnerability | Low Vulnerability | Minimal Vulnerability

Rank	District Name	Physical Characteristics						Demographics						
		Area (Sq. km)[i]	Total Population 2010 ('000)[i]	Total Population 2001[b]	Population Density (Per Sq. km) 2010[a]	No of Households[b]	No of Occupied Housing Unit[b]	Urban Population[b]	Rural Population[b]	Estate Population[b]	# Completed Secondary Education[b]	% Completed Secondary Education[a]	Pop. Below Poverty Line	% in Poverty (HCI)[c]
1	Ratnapura	3275	1125	1015807	344	245743	242882	58245	855178	102384	214927	23.43	292	26.60
2	Kandy	1940	1431	1279028	738	299870	291454	155987	1030172	92869	368009	32.17	230	17.00
3	Colombo	699	2553	2251274	3652	493085	473045	1229572	1014388	7314	888246	44.28	125	5.40
4	Galle	1652	1084	990487	656	233027	229521	109921	863309	17257	263578	29.65	146	13.70
5	Kalutara	1598	1135	1066239	710	250939	245784	113188	915477	37574	314334	33.03	149	13.00
6	Nuwara Eliya	1741	761	703610	437	169540	164886	43073	283659	376878	108874	17.84	254	33.80
7	Gampaha	1387	2177	2063684	1570	487184	475847	300933	1762028	723	714378	38.46	196	8.70
8	Kegalle	1693	818	785524	483	195853	193578	17139	712914	55471	209434	29.71	175	21.00
9	Badulla	2861	886	779983	310	189925	185268	51536	567178	161269	160203	23.36	197	23.70
10	Matara	1283	839	761370	654	177613	174712	64361	676499	20510	191971	28.00	119	14.70
11	Kurunegala	4816	1563	1460215	325	380213	376352	34691	1418882	6642	383985	29.12	238	15.40
12	Puttalam	3072	779	709677	254	176544	174737	65294	642210	2173	133288	21.39	104	13.10
13	Jaffna	1025	611		596	0								
14	Hambantota	2609	571	526414	219	128008	126362	21571	503412	1431	110566	23.37	73	12.70
15	Matale	1993	497	441328	249	110886	108566	36103	383468	21757	99867	25.23	89	18.90
16	Batticaloa	2854	543		190									
17	Anuradhapura	7179	830	745693	116	189699	186697	53151	691573	969	156644	23.61	118	14.90
18	Ampara	4415	644	592997	146	137741	132371	112536	480461	0	111701	21.58	64	10.90
19	Polonnaruwa	3293	410	358984	125	91718	90999	0	358679	305	67828	21.23	50	12.70
20	Trincomalee	2727	374		137									
21	Moneragala	5639	440	397375	78	96598	95966	0	388226	9149	66552	18.81	150	33.20
22	Mannar	1996	104		52									
23	Vavuniya	1967	174		88									
24	Mulattivu	2617	148		57									

Sector Specific Data					District Name	Rank
% Forest Land[1]	Recorded Threatened Vertebrates[1]	Recorded Threatened Flora[1]	Recorded Threatened Butterflies[1]	Average Home Garden Size (perch)[a]		
20.0	116	264	38	76	Ratnapura	1
17.0	90	310	10	68	Kandy	2
2.8	28	22	3	19	Colombo	3
13.0	76	187	6	62	Galle	4
13.0	59	126	14	44	Kalutara	5
24.5	79	150	5	47	Nuwara Eliya	6
0.3	26	10	1	37	Gampaha	7
9.5	51	98	3	69	Kegalle	8
19.0	67	90	7	100	Badulla	9
16.0	37	101	3	87	Matara	10
5.0	21	44	3	89	Kurunegala	11
25.0	15	21	8	54	Puttalam	12
1.1	8	7	0	90	Jaffna	13
20.5	38	32	5	125	Hambantota	14
40.5	57	71	3	131	Matale	15
21.0	2	9	0	44	Batticaloa	16
35.0	25	68	1	123	Anuradhapura	17
37.5	18	15	0	110	Ampara	18
38.0	15	26	0	117	Polonnaruwa	19
48.0	11	10	1	76	Trincomalee	20
40.5	35	56	5	234	Moneragala	21
60.0	6	5	4	114	Mannar	22
51.0	9	1	0	166	Vavuniya	23
60.0	8	0	0	131	Mulattivu	24

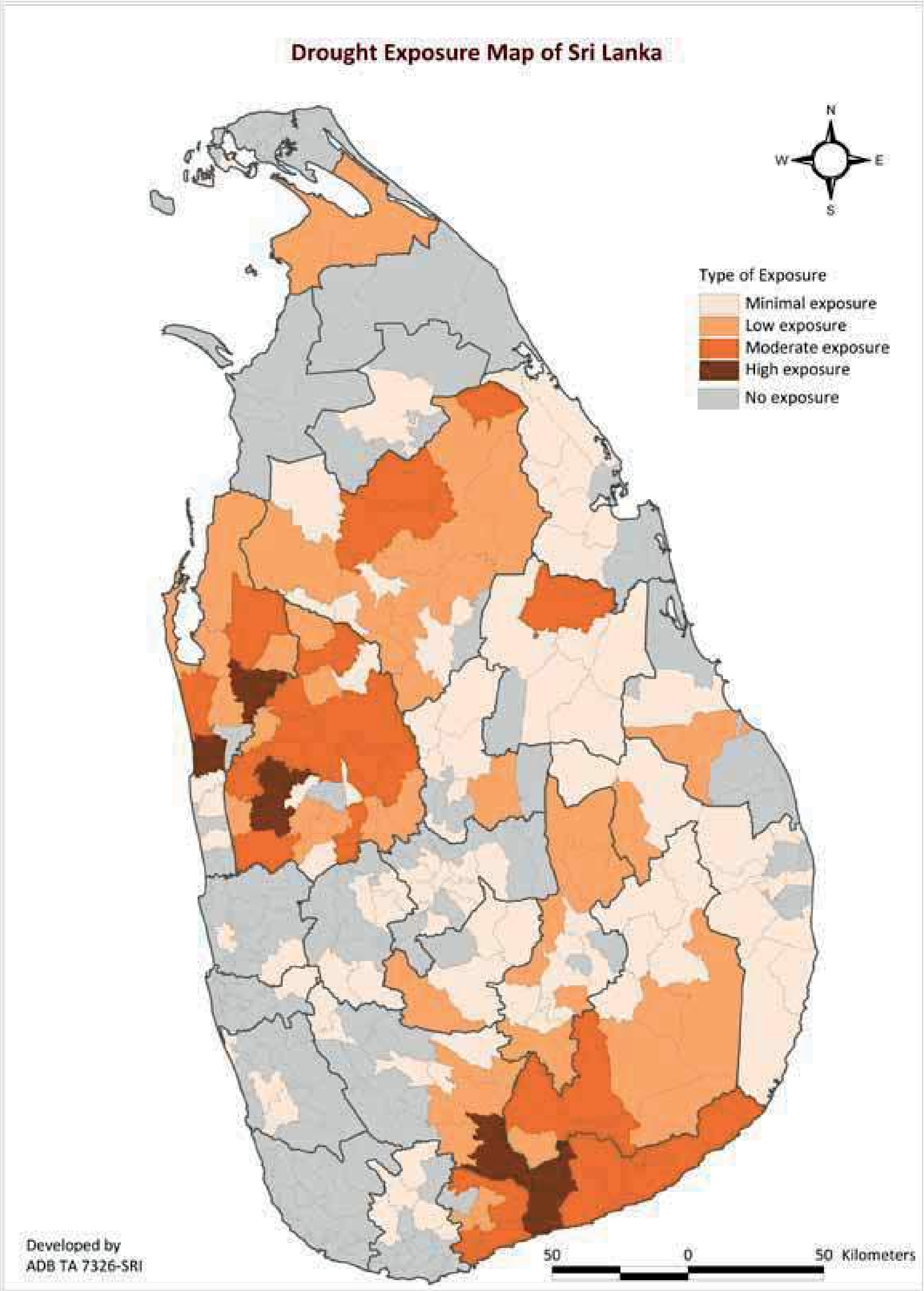

Possible Shifts in Major Climate Zones Due to Climate Change
Legend
Zone boundary
10km buffer area
Climate zone
Dry Zone
Intermediate Zone
Wet Zone
District boundary
N
W
E
S
Developed by
ADB TA 7326-SRI
0 12.5 25 50 75 100
Kilometers

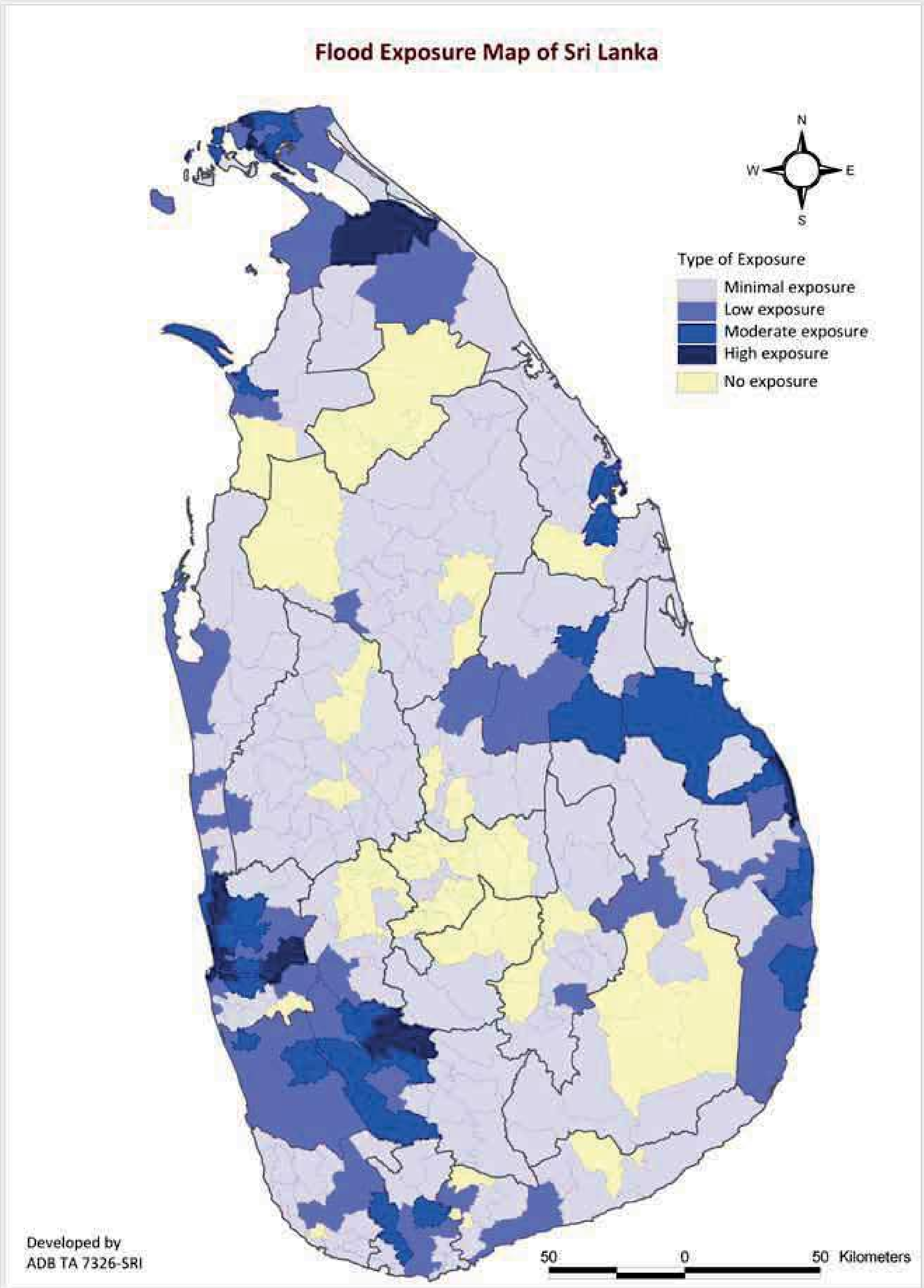

Potential Vulnerability of Biodiversity Rich Areas and Sites of High Endemism to Climate Change
Zone boundary
10km buffer area
Type of vulnerability
Minimal vulnerability
low vulnerability
Moderate vulnerability
High vulnerability
District boundary
Amphibia
Dipterocarpacea
Orchidaceae
N
W
E
S
0 10 20 40 60 80
Kilometers
Developed by
ADB TA 7326-SRI

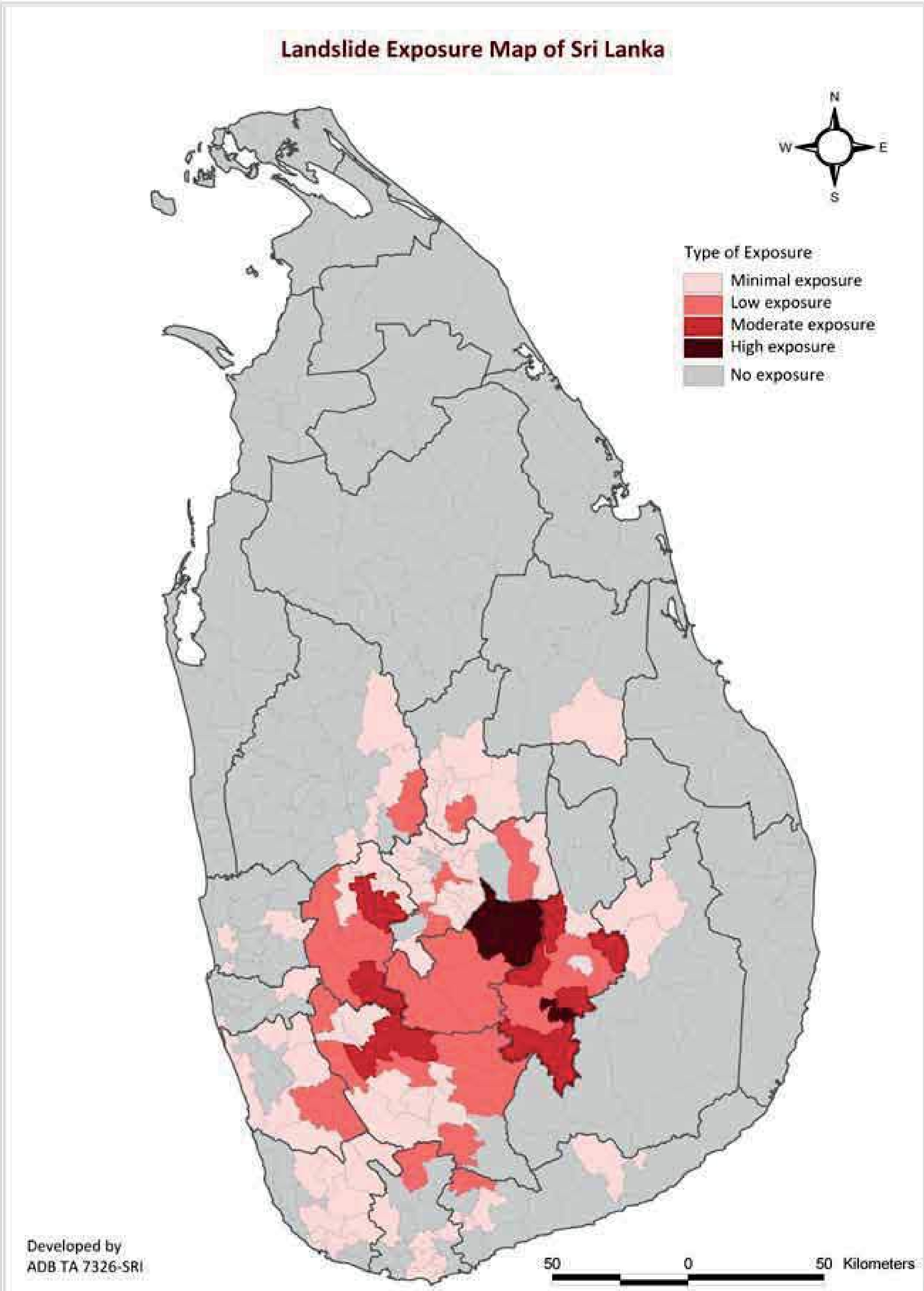
Appendices

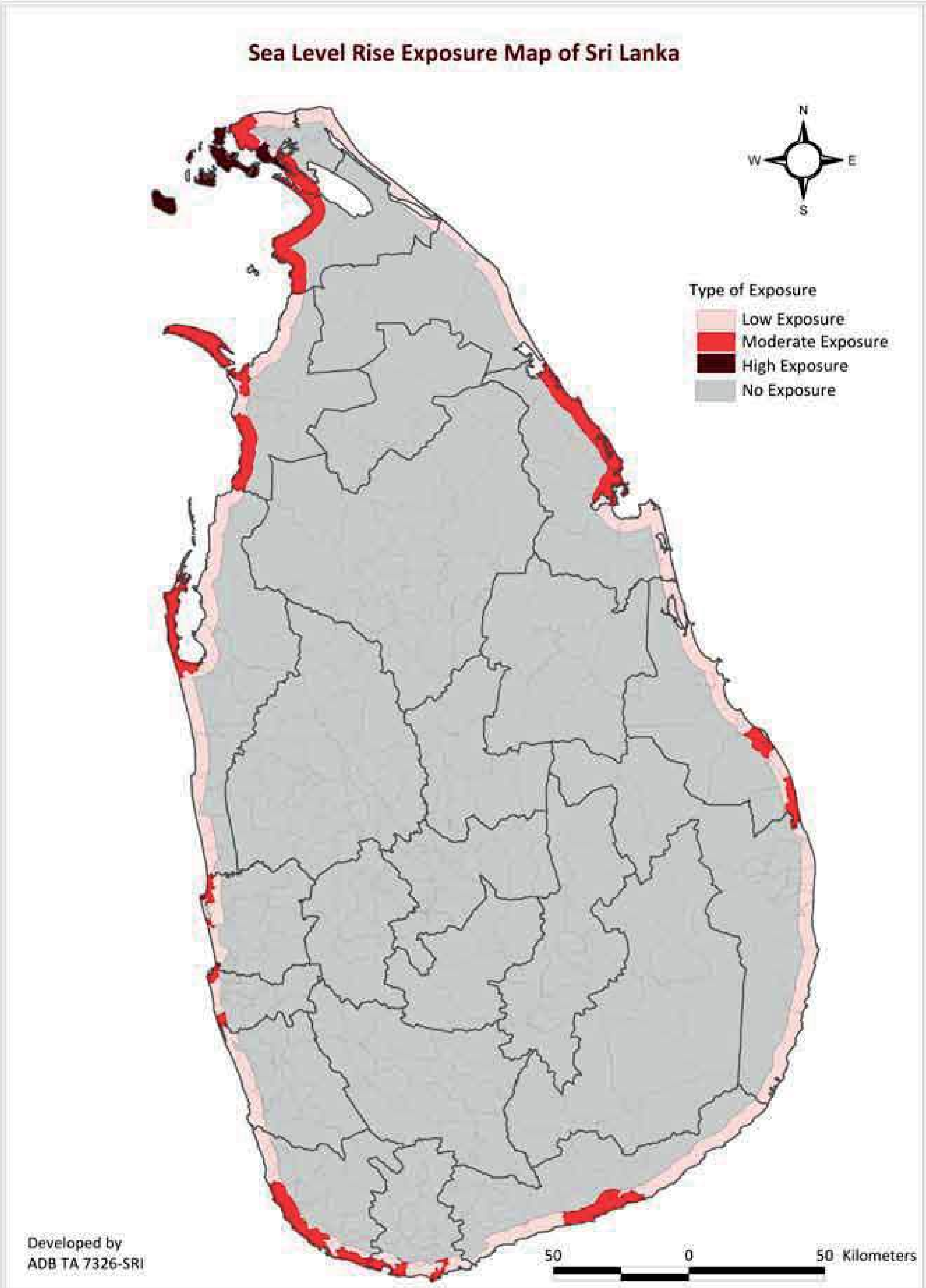
APPENDIX A

Exposure Maps




Flood Exposure Map of Sri Lanka
N
W
E
S
Type of Exposure
Minimal exposure
Low exposure
Moderate exposure
High exposure
No exposure
Developed by
ADB TA 7326-SRI
50
0
50 Kilometers


Landslide Exposure Map of Sri Lanka
N
W
E
S
Type of Exposure
Minimal exposure
Low exposure
Moderate exposure
High exposure
No exposure
Developed by
ADB TA 7326-SRI
50
0
50
Kilometers


Sea Level Rise Exposure Map of Sri Lanka
N
W
E
S
Type of Exposure
Low Exposure
Moderate Exposure
High Exposure
No Exposure
Developed by
ADB TA 7326-SRI
50
0
50 Kilometers

APPENDIX B

District Data Tables

District Name	Physical Characteristics					Demographics				
	Area (Sq. km)[a]	Estimated Mid-year Population (2010)[b] ('000)	Total population (2001)[c]	Population Density (2010), (per Sq. km)[d]	No. of House-holds[c]	Urban Popula-tion[c]	Rural Popula-tion[c]	Estate Popula-tion[c]	% in Poverty[e]	% Completed Secondary Education
Ampara	4415	644	592997	146	137741	480461	480461	0	10.9	21.58
Anuradhapura	7179	830	745693	116	189699	691573	691573	969	14.9	23.61
Badulla	2861	886	779983	310	189925	567178	567178	161269	23.7	23.36
Batticaloa	2854	543		190					10.7	
Colombo	699	2553	2251274	3652	493085	1014388	1014388	7314	5.4	44.28
Galle	1652	1084	990487	656	233027	863309	863309	17257	13.7	29.65
Gampaha	1387	2177	2063684	1570	487184	1762028	1762028	723	8.7	38.46
Hambantota	2609	571	526414	219	128008	503412	503412	1431	12.7	23.37
Jaffna	1025	611		596						
Kalutara	1598	1135	1066239	710	250939	915477	915477	37574	13	33.03
Kandy	1940	1431	1279028	738	299870	1030172	1030172	92869	17	32.17
Kegalle	1693	818	785524	483	195853	712914	712914	55471	21.1	29.71
Kilinochchi	1279	156		122						
Kurunegala	4816	1563	1460215	325	380213	1418882	1418882	6642	15.4	29.12
Mannar	1996	104		52						
Matale	1993	497	441328	249	110886	383468	383468	21757	18.9	25.23
Matara	1283	839	761370	654	177613	676499	676499	20510	14.7	28.00
Moneragala	5639	440	397375	78	96598	388226	388226	9149	33.2	18.81
Mulattivu	2617	148		57						
Nuwara Eliya	1741	761	703610	437	169540	283659	283659	376878	33.8	17.84
Polonnaruwa	3293	410	358984	125	91718	358679	358679	305	12.7	21.23
Puttalam	3072	779	709677	254	176544	642210	642210	2173	13.1	21.39
Ratnapura	3275	1125	1015807	344	245743	855178	855178	102384	26.6	23.43
Trincomalee	2727	374		137						
Vavuniya	1967	174		88						

Housing Characteristics					Transport							
									Roads within 500 m from coastline			
Permanent[c]	Semi-Permanent[c]	Improvised[c]	Not Classified[c]	Total Housing Units[c]	Main Roads [f & d]	Secondary Roads [f & d]	Rail Roads [f & d]	Track and Foot Path (km) [f & d]	Main Roads[d]	Secondary Roads[d]	Rail Roads[d]	Track and Foot Path (km)[d]
87347	39806	3917	1301	132371	374.5900	427.1100	0.0000	3568.5800	10.9940	46.5880		65.4810
99710	84703	853	1431	186697	647.3000	792.9600	136.6900	7641.2500				
120557	62426	194	2091	185268	533.2800	818.7700	67.7900	3698.3000				
					202.7600	223.5800	54.3400	2811.8000	13.0780	9.9270		100.4300
408473	54234	1293	9045	473045	203.1700	1280.6500	110.4200	691.5700	26.5310	94.4610	30.1380	1.9600
166119	60304	1722	1376	229521	429.8000	735.7000	75.6000	2332.0900	77.1200	41.8330	55.5310	50.6730
380985	83351	5251	6260	475847	638.3900	1337.5700	84.1400	2005.9900	18.5420	37.6600		15.3010
75720	49367	590	685	126362	262.3700	952.2300	0.0000	2881.1700	16.4270	27.2300		48.3550
					282.9200	741.7600	50.9600	2639.1600	88.3030	168.3900	3.4790	562.5610
193973	48347	1094	2370	245784	286.1600	936.0600	34.4900	2082.9900	21.5080	29.6710	26.1790	35.7780
211576	76634	430	2814	291454	563.5700	1096.0700	78.0200	2539.9500				
133244	57960	980	1394	193578	390.6100	718.9000	22.6100	2114.6700				
					122.2400	139.7700	43.0500	2132.0200	0.7450	2.7750		102.1390
241602	127978	4493	2279	376352	760.1900	1491.6000	147.2100	7245.9200				
					112.2700	243.0100	67.2100	1298.3000	19.3000	20.5170	7.3450	87.7110
61990	45588	461	527	108566	285.8500	431.5800	10.5200	2078.9400				
126683	46118	1096	815	174712	336.2200	528.2700	20.1200	1327.0400	35.2670	25.7630	7.4230	33.3340
46691	48327	380	568	95966	404.7200	370.2300	0.0000	2834.2600				
					111.1300	128.4100	24.2200	2521.3900		9.8600		81.1050
106766	54618	300	3202	164886	529.0200	451.3000	66.3100	3765.5700				
54193	35566	431	809	90999	190.5900	291.7200	108.8300	2615.3100				
107965	55263	9908	1601	174737	393.1400	583.8700	122.4000	3521.2300	31.2820	53.8050	2.9610	151.9050
148266	92413	406	1797	242882	514.3000	830.8000	0.0000	3419.6100				
					157.2800	221.4100	46.7200	3190.3200	28.0610	84.8980	8.4350	302.5630
					163.5600	137.8900	81.9000	1886.9100				

Tourism					Source of Drinking Water (No. of Households)					
livelihoods Dependent on Tourism[c]	% of Livelihoods Dependent on Tourism[d]	No of Hotel Rooms [g and d]	No. Guest House Rooms [g and d]	Total Rooms[d]	Wells[c]	Tubewells[c]	Tap[c]	Other[c]	Wells and Taps within Premises[c]	Wells and Taps Outside Premises[c]
1617	1.0	23	85	108	114229	2898	13439	4359	72229	42542
3258	1.1	486	146	632	138729	26630	18137	3538	53761	77174
2914	1.0	168	311	479	76362	6174	71667	31737	55509	71709
			37	37						
23823	2.8	3702	888	4590	167675	3930	307322	2876	328951	138071
7587	2.4	2186	608	2794	172707	6036	44334	7336	108134	75113
15483	2.0	1840	705	2545	342265	25489	108422	2432	307287	112656
2095	1.3	450	211	661	70828	7925	42704	5342	43118	55715
			112	112						
8909	2.5	2012	536	2548	186123	7272	46495	7223	123652	79848
9879	2.4	1358	387	1745	132393	23512	115022	23791	102864	117981
4346	1.7	74	125	199	130458	909	35637	26140	65512	68918
				0						
5946	1.2	45	242	287	342354	13802	14795	5422	168354	140958
				0						
3210	2.1	559	168	727	58853	18125	24830	8072	29945	41179
2748	1.1	279	295	574	107534	1762	49703	16474	86229	49511
1345	0.9	145	125	270	59203	7486	13472	15402	24274	29518
				0						
3704	1.3	448	156	604	38713	4622	85585	35258	42828	67628
1518	1.1	343	124	467	64893	10235	10000	5236	30362	28444
3387	1.5	176	138	314	124003	23831	19899	5756	75736	59758
3803	1.0	117	135	252	105930	3868	68415	63798	64455	82386
		238	82	320						
			24	24						

Irrigation Water							Total Agricultural Operators[i]	Land Utilization within Agricultural Holdings					
Area of Tanks (Sq. km)[d]	No of Tanks[d]	Rainfed Paddy Area (Acres)[h]	Irrig. paddy Area (Acres)[h]	Agri. and Forestry sector Employment[c]	% Agri. and Forestry Sector employment[d]	HH with Agri. as Primary Source of Income[i and d]		Total Extent of Holdings (Acres)[i]	Aswed-dumized Paddy (Acres)[i]	Temp. Crops other than Aswed-dumized Paddy (Acres)[i]	Permanent Crops (Acres)[i]	Forest Land (Acres)[i]	Other Land (Acres)[i]
108.18	387	9802	62536	65523	40.4	39267	54416	172001	115996	17221	23625	7056	8103
547.00	3375	4189	66665	147745	51.7	91595	147664	364816	189614	49826	71360	23938	30078
24.99	142	3266	21349	164492	55.9	60872	89270	156800	50386	33167	48247	12706	12294
71.72	246	26401	20046			15257	20645	74335	59215	7098	5448	506	2068
0.30	6	4144	1526	17958	2.1	7300	27003	41513	9944	1782	21920	1447	6420
		15559	196	93428	29.3	55371	103562	167401	37256	2309	162462	8341	-42967
0.52	26	10682	3085	31393	4.2	22112	87212	143495	26075	2856	97830	2728	14006
89.23	855	1443	25043	65905	40.0	54060	86271	202304	67007	29522	80779	12024	12972
10.47	144	709	0			16041	25011	31895	13405	6350	9236	672	2232
0.66	7	12939	2147	54873	15.4	28294	75235	141805	34850	3669	81230	8562	13494
2.20	52	4907	10761	89081	21.9	41793	104008	150007	36356	6737	73479	8171	25264
0.05	10	6734	2254	64066	24.7	30658	82667	149476	18778	4662	106516	6778	12742
27.60	269	6185	7735			8059	13385	38472	19282	6673	9382	811	2324
175.07	4057	30186	47504	170200	33.1	112743	245424	534464	154245	32351	278166	35600	34102
113.66	463	24	9958			4180	5136	20967	14387	1559	3305	505	1211
25.59	249	3971	13726	61436	39.3	33591	63880	122391	37603	14608	51831	9127	9222
2.91	19	10163	7308	85197	35.2	46680	89908	156547	36232	2175	98915	5635	13590
96.75	1055	5228	13560	87643	60.6	56684	80368	225218	38243	60680	84195	21094	21006
118.21	591	2902	7582			8154	11679	39230	17874	10593	8088	528	2147
0.60	39	174	6275	173404	61.6	27694	46105	60274	13893	13373	23147	4600	5261
130.87	315	1234	55849	68804	50.2	40985	57842	163800	112619	5298	24825	8036	13022
89.94	959	1842	16870	41485	18.1	27116	67064	159647	32563	11135	85337	18146	12466
6.30	26	4844	10570	164996	44.0	79804	133242	243003	33672	15245	151970	22290	19826
118.33	682	7495	22413			13387	18650	50797	33863	3927	7800	2152	3055
113.00	921	1402	14917			7382	12694	32824	14682	9918	3434	1844	2946

Paddy Statistics Related to Sea Rise Exposure		Plantation Sector			Inland Fishing				
Paddy Areas Below 2m Within 5km from Coastline (Acres)[d]	Paddy Area Within 500m from Coastline (Acres)[d]	Tea (Acres)[i]	Rubber (Acres)[i]	Coconut (Acres)[i]	# Employed in Inland Fishing[d]	Inland Fishing as % of Total Jobs[d]	Lagoons Area (Acres)[d]	Tanks Area (Acres)[d]	Lakes and Reservoirs Area (Acres)[d]
34	38449	0	0	12310	2104	1.30	15585	23461	19192
	0	0	0	34497	1576	0.55	0	124102	0
	0	75709	1068	6708	290	0.10	0	6465	10061
273	18190	0	0	8739			26076	17536	662
16	2587	380	17450	18024	819	0.10	0	74	615
3446	15121	63330	16497	30999	1307	0.41	62	0	3326
87	5745	30	7605	106572	3691	0.49	8409	161	0
40	17865	1088	175	51234	1470	0.89	4244	15464	58
1871	44747	0	0	8535			6237	2679	0
643	10300	17717	73764	27864	994	0.28	15	142	753
	0	55842	3040	19490	182	0.04	0	485	5255
	0	18922	87902	38080	78	0.03	0	10	0
809	27159	0	0	6114			21955	6290	0
52	0	101	7055	331057	772	0.15	0	45051	5216
392	21609	0	0	2249			5048	20007	0
988	0	12676	4626	25450	124	0.08	0	6255	1847
	10912	58573	9219	35578	1434	0.59	95	713	0
	0	2279	4608	26444	277	0.19	0	29109	5823
187	8458	0	0	6562			13887	23251	0
	0	124208	81	2577	88	0.03	0	90	7062
2	0	0	0	16408	1423	1.04	0	30054	361
616	11189	0	0	113896	4232	1.84	119077	19568	10338
	0	94767	54725	39461	203	0.05	0	7227	333
4961	45131	0	0	5209			2117	22305	442
	0	0	0	1921			0	19902	32

a - Statistical Abstract – 2009, Department of Census & Statistics http://www.statistics.gov.lk/abstract2009/chapters/Chap1/AB1-1.pdf

b - Estimated Mid-year Population by Sex and District - 2010, Department of Census and Statistics, http://www.statistics.gov.lk/PopHouSat/Mid%20Year%20Population/midyearsex%20&district.pdf

c - Census of Population and Housing -2001, Department of Census and Statistics

d - Calculated by the TA Team

e - Household Income and Expenditure Survey - 2006/07 Department of Census and Statistics, http://www.statistics.gov.lk/poverty/PovertyIndicators.pdf

f - 1:50,000 Topographic Maps – Department of Survey

g - Sri Lanka Tourism Development Authority

h - Asweddumized Extent of Paddy by Mode of Irrigation and DS Division 2005/06 Maha, http://www.statistics.gov.lk/agriculture/Paddy%20Statistics/PaddyStats.htm Department of Census and Statistics

i - Census of Agriculture, 2002, Department of Census & Statistics

j - Department of Coast Conservation

k - Ministry of Health

Marine Fishery					Livestock				Health				
No. of Landing Sites[j]	Employed Population Aged 10 Years and Over[c]	Fishery Sector Jobs[c]	# Employed in Marine Fishing[d]	% of Marine Fishing from Total Jobs[d]	No. of Cattle and Buffalo[i]	No. of Goats and Swine[i]	Total Heads of Poultry[i]	Livestock Land Holdings <= 1/4 Acre[i]	# of Hospitals[k]	# of Hospital Beds[k]	Average Dengue Incidence Rate (2004 – 2008) [k and a]	Average Dysentery Incidence Rate (2004 – 2008) [k and a]	Average Leptospirosis Incidence Rate (2004 – 2008) [k and a]
121	162322	5877	3773	3.62	9847	1889	4534	67778	51	2536	12.91	60.76	2.76
	285806	1576		0.55	13174	2614	9696	26351	122	6676	29.84	36.19	5.68
	294223	290		0.10	18211	2558	6628	38733	52	3202	13.31	85.64	6.29
					5030	4287	6692	78897	37	1489	12.87	33.94	0.82
26	855142	2434	1615	0.28	2117	626	2137	143495	51	11175	102.96	11.60	13.54
92	318680	3832	2525	1.20	3694	907	3936	85243	48	3511	16.13	16.99	16.71
105	756186	8662	4971	1.15	8710	4342	12334	245819	64	5661	75.79	13.16	15.95
44	164923	4937	3467	2.99	4273	543	2210	26309	32	1644	21.35	39.54	12.49
					14905	19876	9081	66526	44	2355	16.69	28.09	0.32
37	356837	2795	1801	0.78	3603	1400	4999	122692	28	2658	65.73	41.00	24.18
	407554	182		0.04	10566	3798	9250	88723	84	6300	77.08	26.75	13.21
	258980	78		0.03	5158	2095	4963	77202	41	2229	50.41	39.00	37.25
						0	0	4174	15	408	1.28	38.90	0.41
	514553	772		0.15	27074	5861	17598	90104	98	5296	37.79	35.51	12.34
					1986	612	2352	9478	16	441	9.82	41.55	0.72
	156179	124		0.08	5911	1965	5454	21154	36	1522	49.06	85.81	49.13
29	242175	5829	4395	2.41	3501	532	2550	61073	37	2259	42.94	22.68	31.30
	144600	277		0.19	11568	481	4718	8603	28	1350	10.67	81.56	16.04
						0	0	6349	9	497	0.68	17.60	0.00
	281546	88		0.03	8273	2465	6811	17768	45	1804	5.50	37.94	3.59
	137078	1423		1.04	3947	1286	4186	12319	46	2746	27.52	39.05	12.64
127	229425	20712	16480	9.03	9434	7696	14099	65515	40	1676	51.63	35.05	4.12
	375365	203		0.05	3070	1074	3812	56617	50	3136	41.06	52.19	11.78
					6053	1801	8617	33333	29	1111	34.19	83.91	3.37
					3226	1120	4918	8649	11	435	19.70	83.64	1.46

Documents in this series:

- National Climate Change Adaptation Strategy for Sri Lanka (NCCAS) 2011-2016 (Sinhala, Tamil and English versions)
- Information, Education and Communications Strategy for Climate Change Adaptation in Sri Lanka
- NCCAS Brochures (Sinhala, Tamil and English versions)
- Sector Vulnerability Profiles (SVPs):
  - Urban Development, Human Settlements and Economic Infrastructure
  - Agriculture and Fisheries
  - Water
  - Health
  - Biodiversity and Ecosystem Services
- Survey on Public Perceptions of Climate Change in Sri Lanka 2010
- Climate Change Vulnerability Data Book

Prepared with assistance from
ADB TA 7326 (SRI)
Strengthening Capacity for Climate Change Adaptation

Implemented by:
Climate Change Secretariat
Ministry of Environment
Sri Lanka

www.climatechange.lk

ADB

Annex X

Third National Communication of Climate Change in Sri Lanka

Ministry of Environment
Sri Lanka

Third National Communication of Climate Change in Sri Lanka

Climate Change Secretariat
Ministry of Environment
Sri Lanka

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

Third National Communication of Climate Change in Sri Lanka

Submission to the UNFCCC Secretariat

by

Ministry of Environment

Sri Lanka

Financial Support by

Global Environment Facility (GEF) through

United Nations Development Programme (UNDP)

Climate Change Secretariat, Ministry of Environment

Tel: +94 112034198 Fax: +94 112879978

Email: climatesec@gmail.com

Web Site: www.climatechange.lk

ISBN: 978-624-5817-25-2

October, 2022

MESSAGE OF THE MINISTER OF ENVIRONMENT

Climate never remained unchanged in the atmosphere during the human history. It is the average daily weather over a long period of time, may be that of few decades or even a century. Climate is what we expect and experience, and it deals with probability. Throughout human history, human beings have been dealing with this climate probability, predicting it possibility of occurrence and making whatever possible adjustments to live with it.

In water-deficit, tropical and sub-tropical countries, the use of irrigation devices of all forms and meticulous water management systems put in place, both damaging consequences of frequent droughts and floods caused to human settlements and many forms of people's livelihoods are compelled the human beings to predict and prepare to live with them.

All inhabitants are not in sensible for adjustments to live with natural hazards. Over the past several decades, we witnessed that unending destructive interference with the nature by the human everywhere in the world, more to satisfy the greed than to frugally meet the basic needs, has increased the severity of climate around us, which is accentuated by the undeniable release of greenhouse gases that imbalances the atmospheric behavior. Isn't that today we reap what the people everywhere in the world have sown?

Melting of ice in polar caps and the mountainous regions in cold temperate lands accumulate more water to the oceans causing sea level to rise. This leads to the inundation of low-lying coastal areas where the millions of people live in engaged with diverse forms of livelihoods. The coastal towns and cities with sparse vegetation that is unable to ameliorate climate at least in some conductive form, for comfortable living and working in them are actually forming "heat islands" today. Further, the variability, severity and the rhythm of occurrence of prolonged droughts and flash floods are becoming more destructive to the sustainable human existence.

Water shortage is a critical factor in the survival of humans, all other living beings and vegetation all round, all of them having a symbiotic relationship. It may be reminded here that Sri Lanka is custodian of a unique hydraulic civilization based on a myriad of big and small reservoir networks meeting the water needs of all those animate and inanimate ones, amidst the existing climatic vagaries, a model which needs international consideration. Besides, such country-specific considerations, the globally expanding climatic vagaries, as evidenced in rising temperature across all climatic regions, requires all big and small nations to join hands in bringing about lasting climate resilience improvements. The foreword march taken by the United Nations Framework Convention on Climate Change (UNFCCC) in this regard is laudable.

Eng. Nazeer Ahamed, (M.P.)
Minister of Environment

MESSAGE OF THE SECRETARY OF MINISTRY OF ENVIRONMENT

Sri Lanka is one of the most vulnerable tropical island nations to adverse effects of climate change in the world. Prolong droughts, flash floods in lowlands and landslides in highlands due to intensive rainfall, and sea level rise are major adverse impacts that the country is experience during past decades. These adverse impacts directly affect to livelihood of the nations, human health, development programmes, human settlements and infrastructures, and to the environment including biodiversity and ecosystem in different scales.

However, Sri Lanka's GHG emission to global contribution is less than 1% and per capita emission is 1.07 tonne in 2010. In this circumstances, Sri Lanka has endeavored in this Third National Communication (TNC) Report submitting to the United Nations Framework Convention on Climate Change (UNFCCC) in developing the country's greenhouse gas inventory, and identifying knowledge gaps in climate vulnerabilities in moving towards with potential adaptation actions, mitigation options, gaps & constraints, and supports needed for addressing climate related issues in the country.

The measures to be taken are immediate and long-term for building resilience to overwhelmed the adverse effects of climate change. In this context, the country has submitted its nationally determined contributions (NDCs) to the UNFCCC, stating among other things, a greenhouse gas (GHG) emission reduction by 14.5% (4% unconditionally, 10.5% conditionally) in power generation, transport, industry, waste management, forestry and agriculture with respective to business as usual scenario for the period of 2021-2030.

The Ministry of Environment being the focal point to the UNFCCC, is being implemented the national adaptation plan (NAP) since 2016 and the components of which are closely interlinked with the NDCs on adaptation, consists of nine sectors for building resilience to meet the climate change adverse impacts. In the long run, implementation of NDCs and NAP is mindful to keep abreast with fulfillment of the Sustainable Development Goals (SDGs).

As a sequel to the above indicated, I take this opportunity on behalf of the Ministry of Environment to express my appreciation and gratitude to all those who contributed towards the preparation of this report. I also wish to place on record the unfailing services performed by the officials of the Ministry of Environment, particularly by its Climate Change Secretariat for their tireless and invaluable contributions. A special appreciation is warmly extended to the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP) Country Office in Sri Lanka for financial assistance provided for the preparation of this document.

Dr. Anil Jasinghe
Secretary
Ministry of Environment

FOREWORD

Sri Lanka is a Non-Annex 1 party to the United Nations Framework Convention on Climate Change (UNFCCC) since 1993. Submission of National Communications to the UNFCCC Secretariat is an obligation under the Article 4 and 12 of the Convention. In accordance with the paragraph 1 of Article 4, each Party shall communicate to the Conference of Parties (COPs), through the UNFCCC Secretariat on national circumstances, challenges, gaps and needs on climate change.

Preparation of the Third National Communication (TNC) of Climate Change in Sri Lanka was a process of wider consultation of stakeholders *inter alia* government, private sector, civil society organizations, academia, media and individual experts to ensure inclusiveness, transparency, completeness, relevancy, accuracy and quality. The leadership for the preparation of TNC of Sri Lanka was taken by the Climate Change Secretariat of the Ministry of Environment which is the national focal point to the UNFCCC. Global Environment Facility (GEF) extended the financial support for the preparation of TNC through United Nations Development Programme (UNDP) Sri Lanka.

The TNC of Climate Change in Sri Lanka reflects the present social, economic and environmental circumstances, anthropogenic greenhouse gases emissions by sources and removals by sinks, potential emission reduction actions, climate vulnerability and risks, adaptation actions to be taken for building resilience in most vulnerable sectors, communities and areas, needs of financial assistance, technology transfer, capacity building, awareness and education on climate change, research and systematic observations, prevailing gaps and constraints of addressing climate change, challenges and preparation of national communications.

This report provides a set of robust recommendations that are relevant to facilitate more effective coordination and planning for climate change mitigation and adaptation at national and provincial level, in addition to the implementation of institutional capacities and processes relating to climate change.

The successful completion of the TNC preparation was possible through the effective collaboration of line ministries, departments and other government agencies, private sector, civil societies, academia, national and international experts, UN organizations including UNDP Sri Lanka. In this respect, I highly appreciate those who contributed to complete this national effort including the officials of the Ministry of Environment and Climate Change Secretariat.

Being the national focal point to the UNFCCC, the Ministry of Environment is pleased to present this report to the UNFCCC Secretariat on behalf of the government of Sri Lanka and her people.

Dr. R.D.S. Jayathunga
Addl. Secretary (Environment Development)
Ministry of Environment

CONTRIBUTORS

Ministry of Environment		
Dr. Anil Jasinghe	:	Secretary
Mr. M.G.W.M.W.T.B. Dissanayake	:	Addl. Secretary (Environment Policy & Planning)
Dr. R.D.S. Jayathunga	:	Addl. Secretary (Environment Development)
Ms. Kumudini Vidyalankara	:	Director, Climate Change Secretariat
Mrs. Nandani Abeyrathna	:	Accountant
Mrs. Dakshini Perera	:	Assistant Director
Ms. Ambika Tennnakoon	:	Environment Management Officer
Mrs. Hasula Wickramasinghe	:	Programme Assistant
Mr. Nelson Fernando	:	Development Officer
UNDP Sri Lanka		
Dr. Vishaka Hidellage	:	Former Assistant Country Director
Dr. Buddika Hapuarachchi	:	Policy Specialist and Team Leader
Mrs. Tharuka Dissanaike	:	Former Policy and Design Specialist, Environment
Mrs. Sureka Perera	:	Programme Quality and Design Analyst
Mr. Sumudu Silva	:	Technical Coordinator, TNC
Mitigation Team		
Dr. Janaka Rathnasiri (Late)	:	Team Leader (GHG Inventory)
Mr. Samantha Kumarasena	:	Team Leader (Mitigation Options)
Prof. Erandathie Lokupitiya	:	National Expert (GHG Inventory)
Prof. Hemanthi Ranasinghe	:	National Expert (Mitigation Options)
Dr. Rangika Bandara	:	GHG Inventory (Forestry and Other Land Use)
Dr. Dharmakeerthi Wickramasinghe	:	GHG Inventory (Agriculture)
Ms. Ramya Wijesekara	:	GHG Inventory (Waste)
Dr. Parakrama Karunarathna	:	Mitigation Options (Energy and IPPU)
Prof. Sarath Nissanka	:	Mitigation Options (Agriculture and Forestry)
Prof. Ajith de Alwis	:	Mitigation Options (Waste)
Mr. Jagathdeva Vidanagama	:	Technical Coordinator (Mitigation)
Vulnerability and Adaptation Team		
Mr. Sena Peiris	:	Team Leader
Ms. Vositha Wijenayake	:	National Expert (Vulnerability and Adaptation)
Mr. Nihal Cooray	:	Expert (Human Settlement)
Mr. Kirthi Rasaputra	:	Expert (Economic Infrastructure)
Mr. A.V. Suraweera (Late)	:	Expert (Tourism)
Dr. Shiromani Jayawardena	:	Expert (Climate Scenario)
Mr. K.H.M.S. Peremalal	:	Expert (Climate Scenario)
Prof. W.W.D.A. Gunawardana	:	Expert (Livestock)
Dr. P.W.A. Perera	:	Expert (Agriculture)
Dr. D.D.G.L. Dahanayaka	:	Expert (Fisheries and Coastal)
Dr. P.A.D.H.N. Gunathilaka	:	Expert (Health)
Mr. Ananda Jayaweera	:	Expert (Water Resources)
Mr. Lahiru Udayanga	:	Expert (GIS and Methodological Expert)
Dr. J.M.S.B. Jayasundara	:	Socio Economic Analyst
Mr. Susantha Udagedara	:	Technical Coordinator (Adaptation)

Individual Expertise

Dr. Athula Senarathne	:	Expert (National Circumstances)
Dr. G.P.T.S. Hemakumara	:	Expert (Education, Awareness, Training and Capacity Building)
Dr. Asela Kulathunga	:	Expert (Technology Transfer, Research and Systematic Observations)
Dr. Anna Sikharulidze	:	International Consultant

Independent Review Panel

Dr. L.P. Batuwitage	:	Former Addl. Secretary (Environment Policy & Planning)
Dr. Thusitha Sugathapala	:	Senior Lecturer, University of Moratuwa
Mr. Buddhika Hemashantha	:	Member of National Expert Committee on Climate Change Mitigation
Mr. Vidura Ralapanawa	:	Former General Manager, MAS Holdings
Mr. S.A.M. Azmy	:	Member of National Expert Committee on Climate Change Adaptation
Mr. Avanthi Jayathilaka	:	Consultant, EML (Pvt) Ltd
Mr. Gamini Senanayake	:	Independent Consultant

Consultancy Firms

Sri Lanka Climate Fund (Pvt) Ltd
National Cleaner Production Center
Business and Industry Development Services (Pvt) Ltd

Editorial

Dr. M.U.A. Tennakoon	:	Chief Editor

Final Verification, Reviewing and Editing

Dr. R.D.S. Jayathunga	:	Addl. Secretary (Environment Development)
Ms. Ambika Tennnakoon	:	Environment Management Officer

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Centre
AFOLU	Agriculture, Forestry and Other Land use
AWD	Alternate wetting and drying
BAU	Business as usual
BCEF	Biomass Conversion and Expansion Factor
BEF	Biomass Expansion Factor
BIMSTEC	The Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
BOD	Biological Oxygen Demand
BOI	Board of Investment of Sri Lanka
BRT	Bus Rapid Transit
$CaCO_3$	Calcium Carbonate
CBSL	Central Bank of Sri Lanka
CC&S	Carbon Capture and Storage
CCC	Ceylon Chamber of Commerce
CCS	Climate Change Secretariat
Cd	Cadmium
CDC	Centre for Disease Control
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
CFC	Chlorofluorocarbon
CFL	Compact Fluorescent Lamp
CH_4	Methane
CIMA	Chartered Institute of Management Accountancy
CKDu	Chronic Kidney Diseases of Unknown etiology
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent
COP	Conference of Parties
CPC	Ceylon Petroleum Corporation
CTCN	Climate Technology Centre and Network
Cu	Copper
DAPH	Department of Animal Production and Health
DMC	Disaster Management Centre
DoE	Excise Department of Sri Lanka
DOM	Dead Organic Matter
DoM	Department of Meteorology
DSDs	Divisional Secretariat Divisions
DSM	Demand Side Management
DWC	Department of Wildlife Conservation
EF	Emission Factor
FAO	Food and Agriculture Organization
FIM	First Inter Monsoon
FSMP	Forest Sector Master Plan
GCE A/L	General Certificate of Education - Advance Level
GCE O/L	General Certificate of Education - Ordinary Level

GCF	Green Climate Fund
GDP	Gross Domestic Production
GEF	Global Environment Facility
GHG	Greenhouse Gas
GJ	Giga Joules
GPG	Good Practice Guidance
GSMB	Geological Survey & Mines Bureau
GWP	Global Warming Potential
HFC	Hydroflurocarbon
HH, Com & Agri.	Household, Commercial and Agriculture
HWP	Harvested Wood Product
ICTZ	Intertropical Convergence Zone
IPCC	Intergovernmental Panel on Climate Change
IPCC-GL	IPCC Guidelines
ISO	International Organization for Standardization
ktoe	Kilotonne of Oil Equivalent
LKR	Sri Lankan Rupees
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LRT	Light Rail Transit
LTGEP	Long Term Generation Expansion Plan
LULUCF	Land Use, Land Use Change and Forestry
MALF	Ministry of Agriculture, Land and Forestry
MCF	Methane Correlation Factor
MMDE	Ministry of Mahaweli Development and Environment
MOE	Ministry of Environment
MRI	Medical Research Institute
MRT	Mass Rapid Transit
MSW	Municipal Solid Waste
Mt	Million tonne
N_2O	Nitrous oxide
$NaHCO_3$	Sodium Bicarbonate
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan for Climate Change Impacts in Sri Lanka
NAP - LD	National Action Programme for Combating Land Degradation in Sri Lanka
NARA	National Aquatic Resources Research and Development Agency
NCPC	National Cleaner Production Centre
NCV	Net Calorific Value
NDCs	Nationally Determined Contributions
NEM	North East Monsoon
NEPS	National Energy Policy and Strategies
NGOs	Non-Governmental Organizations
NGRS	National Green Reporting System
NMVOC	Non Methane Volatile Organic Compound
NO_x	Nitrogen Oxides
NSWMSC	National Solid Waste Management Support Center

PCs	Provincial Councils
PCW	Puttalam Cement Works
PFCs	Perfluorocarbons
PMU	Project Management Unit
QA/QC	Quality Assurance/Quality Control
R&D	Research and Development
RCP	Representative Concentration Pathway
SAARC	South Asian Association for Regional Cooperation
SDGs	Sustainable Development Goals
SF_6	Sulphur hexafluoride
SIM	Second Inter Monsoon
SLSEA	Sri Lanka Sustainable Energy Authority
SNC	Second National Communication
SNCCA	Sri Lanka National Centre for Climate Applications
SO_2	Sulphur dioxide
SO_x	Sulphur oxides
SWDSs	Solid Waste Dumping Sites
SWM	South West Monsoon
Tier I	Tier one
TNC	Third National Communication
TVET	Technical, Vocational Education and Training
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WHO	World Health Organization
WMAWP	Waste Management Authority of Western Province
WMO	World Meteorological Organization

UNITS

g	gramme
Gg	Gigagramme
ha	hectare
J	Joule
kg	Kilogramme
km	kilometer
mm	millimeter
0C	degree Centigrade
PJ	Peta Joule
t	tonne (1,000kg)
w	watt
yr	Year

EXECUTIVE SUMMARY

The Third National Communication (TNC) of Climate Change in Sri Lanka consists of seven chapters. The first chapter provides the national circumstances on climate change and associated concerns.

Sri Lanka is located in the Indian Ocean closer to the Indian sub-continent, is exposed to a range of climate vulnerabilities leading to disaster-prone weather extremes, spawned by uncertain monsoons and turbulent atmospheric conditions that frequently arise mostly in the Bay of Bengal and sometimes associated with the Intertropical Convergence Zone (ITCZ). Three-fourths of this island of 65,525 km^2 is below 300 m in elevation and the remaining one-fourth is in the central highlands characterized by mountain ranges, plateaus, peaks above 2,000 m determining the temperature, rainfall and drainage patterns in the country.

There is evidence of temperature rising. Average temperature in Sri Lanka is projected to increase by a maximum of 3.3°C or a minimum of 2.3°C by 2080, over the present level of temperature. Historically, rainfall had been decreasing. Rainfall received during the period of 1961-1990 had been 7% less than the rainfall received during the period of 1931-1960, nevertheless, the amounts and variabilities of rainfall have increased over the recent decades.

The Department of Meteorology has identified short term (2020-2040), medium term (2040-2060) and long term (2070-2090) rainfall changes related to the four monsoons, following the RCP 4.5 and RCP 8.5 scenarios of Fifth Assessment Report of IPCC. As a result, future trends of rainfall are continuous to be increased in the wet zone with increased floods, landslides and coastal lowland submergence. The dry and intermediate zones in the country are expected to have more and more rainfall failures, frequently leading to droughts of varying magnitude and duration.

These anticipated climate changes, among other development constraints, are likely to damage people's livelihoods recurrently. About 30% of the country's population is engaged in agriculture in which the majority works in grain production mostly in the dry and intermediate zones who cultivate cereals and perennial crops which are liable to face water shortages due to drought and destined to face losses in both production and productivity, threatening the food security in the country. Plantation agriculture mostly in the wet zone due to intensive rainfalls, is liable to fall in productivity seriously reducing the country's export earnings.

Nearly two million people engaged in coastal and marine fishing contributing 2% to GDP will face economic hardships together with damages to dwellings and their total coastal environment due to sea level rise. The major consequence of sea level rise due to global warming is coastal inundation and that sea level rise around Sri Lanka appears to be even marginally higher than the global averages and a shoreline retreat of 200,000 to 300,000 m^2 per year not only a threat to coastal fishing and up-coming coastal tourist industry but increased intrusion of salt water in to interior fresh water bodies will also devastate agricultural lands. Myriads of other economic activities associated with small and medium scale industries and services in towns and hamlets within the coastal belt of about 2 km where 40% of the country's population work and live would be economically devastated.

Climate induced disasters are threatening the economic growth. In 2016 alone, the estimated flood-induced damages cost was about LKR 99.8 billion and in 2017, climate-induced disasters' losses were about US$ 1,623 million. These are significant financial constraints for a country like this small island.

A retarded GDP growth limits the annual public expenditure. For example, the GDP share of public expenditure declined from 20% in 2010 to 17.3% in 2014. Public expenditure on the country's healthcare, free education, many other social welfare commitments, development programmes and other public expenditure required, are suffered.

To monitor, supervise and follow-up the above stated economic pursuits together with due and consistent watch on moving climate change in the country and in its environment, the necessary and adequate institutional arrangements are there in national, regional and local levels. The national government comprises of ministries, departments, statuary bodies, state owned enterprises.

There are nine provincial councils and 335 local authorities including 23 municipal councils and 41 urban councils. This is an adequate network of organizations to deal with the ongoing and impending climate changes in the country. However, not all these organizations are well versed in climate change and climate change resilience improvement, because climate change is relatively a new area of government involvement. However, the redeeming feature is that climate is now the concern of all public organizations. An overall coordination effort involving all of them is, therefore, necessary.

The Ministry of Environment has the command through the Climate Change Secretariat, which is duty bound to coordinate climate related overarching activities of ministries, departments, statutory bodies, provincial councils and local authorities, public-private enterprises, NGOs, private sector organizations and individuals and other organizations concerned with social responsibilities.

The second chapter of TNC Report is presented the national greenhouse (GHG) inventory of 2010. It provides the estimates of anthropogenic emissions by source and removals by sink of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The TNC Report also provides information on gaseous emissions such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and information on emissions of precursor carbon monoxide (CO), nitrogen oxide (NO_x). The Guidelines of Intergovernmental Panel on Climate Change (IPCC) were used to calculate emissions from energy, industrial processes and product use (IPPU), agriculture, forestry and other land use (AFOLU) and waste sectors. The emissions in the GHG inventory have been estimated using Tier I method from 2006 IPCC Guideline for the time period of 2000-2010. Emission from each sector was calculated in unit of mass and in CO_2 equivalents using the Global Warming Potential (GWP) values.

Emissions from energy sector amounted in 14,154.16 Gg CO_2-eq, IPPU sector in 448.57 Gg CO_2-eq, agriculture sector in 6,505.67 Gg CO_2-eq, waste sector in 976.22 Gg CO_2-eq, LULUCF sector in 21,460.13 Gg CO_2-eq. The total emissions is 43,544.75 Gg CO_2-eq and the removals of carbon by sink is -39,826.3 Gg CO_2-eq. Hence, the total emission exceeds the sink by 3,718.45 Gg CO_2-eq. The total emission in 2010 excluding LULUCF was 22,084.62 Gg CO_2-eq and it is a 25% increase from the year 2000 that the GHG Inventory prepared for the Second National Communication. Consequently, the per capita CO_2-eq emission has increased from 0.78 tonne in 2000 to 1.07 tonne in 2010.

Vulnerability to adverse effects of climate change is so alarming and the Global Climate Risk Index published by the Germanwatch has ranked the country as the 4th in 2018, 2nd 2019 and 6th in 2020 as the most vulnerable country in the world with an annual loss of US$ 2129 million. The World Bank estimates that 7.7 percent (US$ 50 billion) of GDP, needs to be allocated to face climate disasters by 2050.

The vulnerability and adaptation measures chapter presents the degree of climate change risks due to droughts, floods, landslides and sea level rise affecting agriculture, livestock, fisheries, industry, water sources, health, biodiversity and ecosystems, human settlements and tourism in line with nationally determined contributions (NDCs) and national adaptation plan (NAP), in keeping with different geographical scales such as Districts and Divisional Secretariats. It also proposes robust and flexible adaptation measures towards evidence-based policy and decision making by comparing the existing risk map evidences with climate anomalies of short term (2020-2040), and midterm (2040-2060) durations using the high emission scenarios of Representative Concentration Pathway (RCP 8.5). Impacts and its vulnerability, government policy frameworks, adaptation measures needed are under each sector highlighted.

For climate resilience building, the government of Sri Lanka has identified inter alia: (a). rehabilitation of ancient tank cascade (*Ellangawa*) system in the dry zone covering nearly two-thirds of the island's land area to combat the prolonged drought situations by storing rainwater; (b). enrichment of catchment vegetation and water supply sources of tanks, protection of water sources of the Central Highlands and river basins to ensure perennial water sources while reducing soil erosion; and (c). diverting excess water in the wet zone to the thirsty dry zone over-coming the adverse impacts of the droughts likely to be frequent in long time to come.

The 4th chapter presents the actions already taken and potential mitigation measures that can be implemented to reduce anthropogenic emission of greenhouse gases in energy, industrial processes and product use (IPPU), agriculture, forestry and other land use (AFOLU) and waste sectors. The mitigation analysis of these sectors was totally based on the GHG inventory in the 2nd chapter. Potential mitigation measures were analyzed for the different sectors for the period of 2010-2030. Two types of scenarios constructed as the baseline and the mitigation scenarios.

The baseline scenario reflects a future in which there will be no additional policies or programmes designed to reduce GHG emissions or enhance carbon sinks. A baseline scenario is considered a critical element in the abatement assessment since the benefits and incremental cost of mitigation options are directly linked to the sound definition of the baseline scenario. Therefore, the baseline scenario was constructed based on the trends, plans and policies prevailing from 2010 to 2018. In this scenario, the most recent and current emission levels were projected to future emission levels envisaged for each type of activity up to 2030. The projections were based on assumptions of population growth, GDP and other macro variables obtained from official sources.

The mitigation scenario was structured according to a set of criteria reflecting country specific conditions such as potential for large impacts of GHG reduction, economic impacts, consistency with national development goals, potential effectiveness of implementation policies, sustainability of an option, data availability for evaluation and other sector specific criteria.

The fifth chapter indicates the education, training, awareness and capacity building related to climate change in the country. Increasing climate change awareness among school children is gradually expanding and their climate change knowledge will help themselves while in school and thereafter to understand the climate change impacts and potential solutions. The concern about climate change and its consequences are also being increasingly felt by the government, semi-government, private sector and civil societies. At present there is a growing interest in universities too, either to dove-tail the subject of climate to existing academic disciplines of relevance or to attempt and develop fresh courses. 402 public sector training centers, over 400 private sector and civil societies provide short term training courses on climate change to boost public awareness.

Non-formal training is through an organized training process that occurs outside the formal learning environments. Non-formal training is possible by coming together of the people with similar interests who can then exchange their ideas and viewpoints cross pollinating and enriching their practical knowledge. Non-formal education is a very strong system of training that needs frequent attention of the due authorities to increase public awareness on climate change and people's capacity building to be sure-footedly resilient to climate change.

The sixth chapter revealed the needs of technology transfer, research and systematic observations in addressing climate change. The chapter is started with given a reference to the obligations of the UNFCCC for the both developed and developing countries' responsibilities on technology transfer, research and systematic observations in order for addressing climate change issues. Then, the Technology Need Assessment conducted by the Climate Change Secretariat in 2014 has been highlighted. Technical Assistance for Climate Smart City Programme for Kurunegala city from the Climate Technology Center and Network (CTCN) has also been indicated. Further, supports extended by the regional level interventions and technical cooperation such as SAARC, BIMSTEC, ADPC, Regional Integrated Multi-Hazards Early Warning for Africa and Asia, and SNCCA have been highlighted. The need of educational and outreach activities on climate smart technology in order to change conventional management practices have been recognized.

The need of advanced software, tools and models for effective analysis of long-range weather forecasting for agricultural planning and crop recommendation are highlighted. Also, introduction of effective land and water management techniques for central highlands and other marginal areas to minimize land degradation and to improve land and water productivity due to climate change adverse impacts are recommended.

Several appropriate and potential technologies for building resilience in most vulnerable sectors such as agriculture, livestock, tourism, water and irrigation etc. have been recommended to address the prolonged droughts and flash floods. Improving knowledge of agricultural machinery, training and capacity building among farmers on climate smart technologies are required to promote conservation farming techniques, integrated pest management etc. in areas where vulnerable to climate change.

In order to minimize the adverse impacts of landslides, settlements and land use changes in landslide-prone and other vulnerable areas potential technologies have been recommended. Numerous technology needs to address the impacts of sea level rise in the coastal and marine sectors have been identified. Technology needs to improve the energy efficiency and infrastructure have been identified and potential technologies have been proposed including innovative and existing technologies. Further, separate technology interventions for different settlement categories have been identified for predicted climate scenarios.

Barriers and constraints identified for technology mobilization in adaptation and mitigation sectors have been well recognized and measures for overcome those have been recommended including fiscal policy reforms aiming at reducing costs of infrastructure development.

A large number of research and systematic observations for different sectors of climate change adaptation and mitigation have been identified covering climate change predictions, vulnerability and adaptation measures, potential GHG emission reductions and removals, technology demonstrations and piloting etc.. Finally, a great need has been identified to modernize the data management, data sharing and information dissemination using digital system for easy recording and analysis.

The chapter seven identifies the existing gaps and constraints for the preparation of national communications, and implementation of climate actions. It proposes actions to be implemented to address these gaps and constraints. The preparation of this chapter has been through desk research, expert consultations, sectoral and national level stakeholder consultations. Gaps and constraints indicated in the SNC have been evaluated and updated in this chapter.

The key gaps and constraints identified for addressing climate change impacts and fulfilling the obligations under the UNFCCC are gaps in institutional structure and coordination among different entities working on fulfilling obligations related to climate change activities; gaps in laws, policies, and regulations pertaining to adaptation and mitigation actions; gaps and lack of availability of data for adaptation and mitigation measures that focus on climate change impacts in Sir Lanka; gaps in capacity building and research; gaps in financial resources available and the amount needed to implement the activities related to climate change in the country.

Based on these gaps and constraints, the chapter proposes activities needed to address them. Activities that are highlighted among other are amending policies and regulations and development of a law for implementing activities related to climate change in Sri Lanka; capacity building activities on climate change for stakeholders; development of coordination and institutional structures for effective and efficient implementation of climate action; mobilizing climate finance to address support needs. Assessing the vulnerability and building resilience to meet the adverse effects of climate change, and potential GHG emission reductions, means of implementation (finance, technology transfer and capacity building) for Sri Lanka should be provided.

CHAPTER ONE

National Circumstances

CHAPTER ONE
National Circumstances

1.0 Introduction

Sri Lanka is a tropical island in the Indian Ocean few kilometers off the southern tip of India at 5°54′ - 9°52′ North latitude and 79°39′ - 81°53′ East longitude. Economically, the country is ranked as a lower middle-income country. Nearly a third of the population is still dependent on agriculture related livelihoods which are sensitive to growing impacts of climate change. Her central location in the Indian Ocean closer to main sea lanes presents prospects for trade and service-based growth in the economy. In the recent period, successive governments have declared the intention for transforming the country into an economic hub joining the growth centers in the East and West, taking advantage of the country's unique location. The country's unique geographical position offers both opportunities and challenges.

On the other hand, the same location factor exposes Sri Lanka to a diverse range of vulnerabilities. Sri Lanka frequently experiences disaster prone weather extremes spawned by uncertain monsoons and turbulent atmospheric conditions arising in Bay of Bengal. The country's water resources that fulfill a vital role in economic, social and cultural life are heavily dependent on precipitation patterns determined by these forces. Moreover, being an island nation with densely populated low-lying coastal belt, the country is vulnerable to sea level rise. Sri Lanka's national circumstances are shaped by its physiographic, demographic and socio-economic conditions that are under the strong influence of the institutional setup of the country.

1.1 Geography

The geography of the country is characterized by three major features; a mountainous region located at the south-central part of the island, lowland plains extend radially from the central highland to the coast and, low-lying coastal fringe runs around the country. Nearly three quarters of the land area lie below the 300 m and the rest is under hilly terrain. The central highland area is characterized by several ranges of mountains, plateaus and peaks. Sri Lanka's tropical location closer to the Intertropical Convergence Zone (ITCZ) and the unique geographical formation characterized by central mountain region determine the country's climatic and drainage patterns significantly. The intermediate plain areas are characterized by undulating landscape with ridges and valleys. The plain, which is broad and flat in north and east and rugged in south-west, is intermittently disturbed by residual rocks. The coastal fringe that lies below the 30 m is characterized by sandy beaches and several other coastal land forms.

Geologically, 90% of lands in Sri Lanka is underlain with metamorphic rocks of Precambrian origin. The Precambrian rock formations are crystalline in nature and are subdivided in to 3 major groups.

1. Highland complex (HC): Occupies a broad belt running across the central part of the island from southwest to north east. The lithology of HC is comprised of quartzites, gneisses, charnockites and pegmatites.
2. Wanni complex (WC): Occupies the north-western part of the island. Made up of complex lithology that includes quartzites, gneisses, granites, charnockites and amphibolites.
3. Vijayan complex (VC): Located in the southeast parts of the island and comprised of gneisses, migmatites and pegmatites.

Wanni complex and Vijayan complex are flanking the Highland complex from two sides. North-western and northern parts of the country are underlain with sedimentary formations of Jurassic and Miocene origin. Geological properties of these rock formations have mainly determined the types of soils, occurrence of groundwater and availability of various types of economically useful minerals.

1.2 Population

A majority of the population still lives in rural areas even though rapid urbanization can be observed around major urban centers and along the main transport corridors of the country. Sri Lanka is a country with highest level of population density in the world. Moreover, population is geographically concentrated in areas that are more susceptible to climate change impacts such as coastal zone. Hence, adaptation measures aimed at facing the impacts of climate change have to take population parameters into serious consideration.

The midyear population in 2016 was estimated as at 21.20 million. This included 10.26 million males (48.5%) and 10.93 million females (51.5%). Of the total population, 15.44 million was in the age category of "15 years or above".

According to the Intergovernmental Panel on Climate Change (IPCC), population growth is a key factor contributing to climate change. It leads automatically to increase in energy consumption thereby contributing to GHG emissions. On the other hand, population growth increases the number of victims to climate change impacts too. High growth and density of population makes the adaptation efforts more difficult due to high demand created for critical resources such as water and other ecosystem services.

Having low population growth rate and relatively low per capita emissions, Sri Lanka's marginal contribution to global GHG emissions can be considered also as low. Nevertheless, its location in a disaster-prone tropical region and high population density makes her citizens vulnerable to climate change in significant manner.

1.3 Climate

Sri Lanka does not experience significant seasonal variation in temperature within a year. As a result, average pattern of climate in a given locality is determined mainly by the seasonal variation in rainfall. However, regional variations in temperature can be observed depending on the altitude of locations. Average annual temperature in lowland areas usually vary over 26.5°C whereas in central highland areas average temperature could significantly be lower than this. For instance, average temperature in Nuwara Eliya at 1,800 m mean sea level is around 15°C.

Based on the temporal distribution of rainfall within a year, four rainfall seasons have been inherited in the country (please see figure 3.2, 3.3, 3.4 and section 3.3.1).

Sri Lanka receives mean annual rainfall around 1,850 mm as a cumulative outcome of all four rainfall seasons that can be considered a relatively high level of rainfall compared with many other countries. In spite of that, country faces problems in water availability due to two major reasons as rainfall in Sri Lanka shows high inter-annual variation, and spatial distribution of rainfall in the country shows high regional variation. The average rainfall in different locations could vary over the wide range of 1,000 mm to 5,000 mm. The south western quarter, especially the western slopes of central highland, can be identified as the wettest region having the mean annual rainfall over 5,000 mm. On the contrary, mean annual rainfall in south-eastern (e.g. *Yala* area) and north-western (e.g. Mannar) coastal areas is usually around 1,000 mm.

1.3.1 Observed and projected changes in climate

Recent studies indicate that the normal pattern of climate is undergoing changes. Two major sources, namely, observed changes and projected changes provide evidence on climate change. Observed changes are based on past meteorological data recorded from different locations of the country over several years. Projected changes are predictions on future trends in climatological parameters that are based on global climate models.

Temperature: Information from many studies suggests that ambient air temperature is rising all over the country (Basnayake, 2007; Chandrapala, 1996; Eriyagama et al., 2010; Nissanka et al., 2011). Mean air temperature anomalies have shown increasing trends in many stations around the country (Basnayake, 2007). Warming trend has been manifested by many number of warm days and nights, fewer number of cold days and nights, increase in mean daytime maximum and mean night time minimum air temperatures and growing number of dry days (Basnayake, 2007; Samarasinghe, 2009; Zubair et al., 2005). It appears that increase in night time minimum air temperature contributes more to average increase in annual temperature than day time maximum air temperature (Basnayake, 2007). Evidence also indicates that the warming trend has become faster in recent years (Basnayake, 2007; Chandrapala, 2007). However, warming trend is not uniform throughout the country and the highest rate of increase was reported from Puttalam area (Chandrapala, 2007). Besides the warming trend observed all over the country, studies have shown increased average air temperature in urban locations due to urban heat island (UHI) effect (Manawadu and Liyanage, 2008). Lack of vegetation cover, high heat absorption by built-up environments and concentration of waste heat emissions from multiple sources are the major factors responsible for this situation.

Rainfall: While there is overwhelming evidence about changes in normal pattern of rainfall all over the country, there is no clear indication over direction of change or nature of emerging patterns unlike in the case of temperature. According to some studies that compared the mean annual rainfall in recent and past periods, average rainfall shows a declining trend (Basnayake, 2007; Jayatillake et al., 2005). It was estimated about 7% reduction of rainfall during the period 1961-1990 compared with 1931-1960 period (Chandrapala, 1996; Jayatillake et al., 2005). The magnitude of these changes could vary depending on the rainfall season and the geographical location. Few studies have also indicated that number of consecutive wet periods has decreased while the number of consecutive dry days has increased (Ratnayake et al., 2005; Premalal, 2009). However, Punyawardena et al., 2013 reported that in central highlands areas, heavy rainfall events have become more frequent during the recent period. In spite of differences in opinion over the overall direction of change, researchers seem to agree that variability of rainfall has increased over time and current pattern of spatial distribution may be changing. Some studies suggest that changes in spatial distribution can lead to shifting of agro-ecological boundaries (Eriyagama et al., 2010; Mutuwatte et al., 2013).

Extreme events: Emerging evidence appears to suggest that intensity and frequency of extreme event relating to rainfall (e.g. heavy rainfall events and total absence of rainfall over lengthy spells) are increasing (Imbulana et al., 2006; Ratnayake et al., 2005). Such extreme events have a direct association with hazards such as floods, landslides and droughts. High rainfall events show a strong correlation with landslides (Ratnayake et al., 2005). In the recent period, Sri Lanka experienced high incidence of extreme events. Extended drought occurred in certain parts of dry zone during 2016-2018 has been reported as the worst since 1970s. This has affected the agricultural production significantly. During the same period, certain locations in wet zone experienced catastrophic events of floods causing heavy life, economic and property damages. In central highlands, extreme rainfall events were often associated with disastrous landslides that caused tragic losses of human life and property damages.

Understanding future climate circumstances is an important step to face the impacts of climate change in successful manner. This requires projection of possible future scenarios of climate and few efforts have been made to project the future climate in Sri Lanka. The recent projections by the Department of Meteorology (DoM) in 2016 can be considered the most important among them. The DoM predicted rainfall and temperature under standard emission scenarios developed by IPCC known as Representative Concentration Pathway (RCP). Projections have been developed under moderate (RCP 4.5) and high emission (RCP 8.5) scenarios using a multi-model ensemble projection (Please see the section 3.3.1).

One regional study conducted by ADB that covered Sri Lanka among six other countries in South Asia made projections under different IPCC scenarios until 2080, indicates that average temperature in Sri Lanka could rise by 3.6°C, 3.3 °C and 2.3°C under A2, A1B and B1 scenarios respectively by 2080 (Table 1.1). It also predicts rainfall of the country could increase by 39.6, 35.5 and 31.3 percent respectively under A2, A1B and B1 scenarios by 2080. According to this projection average number of consecutive dry days per year will also increase progressively over time.

Table 1.1 Temperature and precipitation projections under different scenarios

Climate parameter		2030			2050			2080	
	A2	**A1B**	**B1**	**A2**	**A1B**	**B1**	**A2**	**A1B**	**B1**
Precipitation (%)	7.4	11.0	3.6	15.8	25.0	16.5	39.6	35.5	31.3
Temperature (°C)	1.0	1.1	1.0	1.8	1.5	1.3	3.6	3.3	2.3

Source: Ahmed and Supachalasai (2014)

In addition to changes in atmospheric parameters, changes in oceanic environment especially, sea level rise, too are expected due to climate change. Being an island with densely populated low-lying coastal zone, sea level rise could be expected to create significant adverse impacts in Sri Lanka. Studies suggest that Sri Lanka had undergone sea level variations in number of stages in geological history (Katupotha, 2015).

The sea level rise could lead to inundate low-lying areas in the coastal zone. According to the hazard profiles developed by the Disaster Management Center of Sri Lanka (DMC), the estimated district level inundation due to sea level rise by 2100 could vary from 1,534 hectares in the Colombo district to 14,809 hectares in the Puttalam district (DMC, 2012). A recent study conducted by the UNHABITAT (2017) on climate change in urban areas indicated that certain coastal cities will be moderately exposed to sea level rise. Out of 14 coastal towns examined, 7 (Colombo, Negambo, Mannar, Galle, Trincomalee, Batticaloa and Hambantota) will experience moderate and low level impacts of sea level rise by 2050 such as inundation of low-lying areas and salt water intrusion posing challenges to local authorities perhaps even forcing affected sections of population to migrate.

1.4 Local Knowledge on Climate

There is significant evidence that farmers in many areas of Sri Lanka have knowledge on local climate developed over generations of collective experience. This is a shared knowledge among community members that guide their livelihood decisions. Farmers get access to this shared knowledge through a social process of knowledge transmission that involve fellow community members and elders of the society. The local climate knowledge usually covers detailed understanding about local weather patterns and set of local indicators that provide the basis for prediction of rainfalls. These local climate indicators are usually signs appear in local environment.

A prominent example of local climate knowledge is local agricultural calendar based on two farmer-defined seasons known as *Yala* and *Maha* (please see Section 3.3). Farmers' knowledge about generations of experience about seasonality of annual rainfall is embedded.

Farmers are also assisted by local climate indicators that help to predict forthcoming weather events that can be considered as indigenous weather forecasts. These forecasts may have time lags that may extend from few hours to few months. Farmers use wide range of local indicators to make their predictions and few common indicators reported by researchers include; animal/plant behaviour, observations on wind/sky/clouds, local hydrological phenomena, thermal changes, indicator species and cosmological phenomena.

Evidence suggests that farmers find reliability of local weather predictions is declining. It appears that changes taking place in local climate patterns and environment has made it difficult to observe certain indicators thereby rendering local weather predictions less reliable. For instance, certain observations on animal/plant behaviour have become rare due to clearance of local forest patches. Therefore, such phenomena can no longer be relied upon to make regular decisions. As a result, some parts of indigenous knowledge have become obsolete with limited current use. Another factor that has led to decline in local climate predictions is limited experience and knowledge of young farmers about indigenous knowledge. Also, local knowledge on weather change observations are unable to predict by the communities due to present climate change effects.

1.5 Forests and ecosystems

Sri Lanka is listed as one of 36 'Biodiversity Hot Spots[1]' in the world together with Western Ghats region of India. The country has a rich endowed biodiversity that covers a range of terrestrial and aquatic ecosystems with over 9,400 described species of fauna and flora. The diverse climatic and topographic conditions found within a relatively small area (Section 1.1-1.2) are one source of diversity and richness in forests and ecosystems in the country. Sri Lanka's forests and ecosystems are characterized with high level of endemism that exceed over 20% in certain categories of fauna and flora (Weerakoon, 2012). Forests and ecosystems in Sri Lanka have been classified in the National Atlas of Sri Lanka-2007 (2nd edition) has 10 categories (Table 1.2).

According to the latest forest cover estimate in 2015, the forest cover in Sri Lanka is about 29.7% of the land area. Forests in the south-western quarter have the highest biological diversity. Out of total forest area only 5% is coming under the montane and the sub-montane categories. Besides the rich endowment of biodiversity, forests in central hills and the wet zone play highly important role as upper watersheds of country's radial drainage system.

In spite of natural richness, forests and ecosystems in the country has undergone a rapid process of degradation due to anthropogenic causes. Hence, the situation of forests and ecosystems in the country can be considered as fragile. The key challenges faced by forests and ecosystems in the country are deforestation

1 The term 'hot spot' implies that the biodiversity in the country has high level of endemism that has been threatened.

and degradation of natural forests; degradation of critical habitats such as mangroves and wetlands; risk of extinction of species due to over exploitation; spread of invasive alien species; and human-wildlife conflict.

Table 1.2 Classification of forests and ecosystems in Sri Lanka

Forest type	Characteristic climatic and topographical features	Climatic Zone
Montane Forest	Above 1,500 m elevation. Temperatures ~ 15°C. Rainfall >1,800 mm with no moisture deficit period.	Wet zone (Montane)
Sub Montane Forest	Within elevations of 1,000 to 1,500 m. Temperatures 15°-20°C. Rainfall > 1,800 mm.	Wet zone (Sub Montane)
Lowland Rain Forest	Extending from the coastal plains to 1,000 m. Temperatures >20°C. Rainfall >2,500 mm, no moisture deficit period vegetation.	Wet zone (lowland)
Moist Monsoon Rain Forest	Found at <1,000 m. Temperature >20°C. Rainfall 1,800-2,500 mm with a peak from October - January with a dry period of 3 months.	Intermediate Zone
Dry Monsoon Rain Forest	At elevations of <600 m often on slopes. Rainfall 1,000-1,800 mm from mid-October to January with a dry period of 3-6 months.	Dry zone
Riverine Dry Forest	Found along flood plains and river valleys. Elevation <600 m. Rainfall 1,000-1,800 mm.	Mostly Dry zone
Mangrove Dry Forest	Present along intertidal sheltered coastlines, usually associated with river mouths and lagoons.	Coastal area / Lowland/ Both in wet and dry zones
Grasslands	Four types divided according to climatic zones; *patana* (montane), *talawa* (lowland wet zone), *damana* (lowland dry zone) and *villu* (wetlands).	All climatic zones
Trop. Thorn and Degraded Forests	Mostly disturbed areas flanking dry mixed evergreen forests with thorny shrubs and sparse trees.	Dry zone
Sand Dunes	Raised beaches of sands characterized with stunted vegetation.	Coastal belt in northern and eastern areas

Source: UNREDD Sri Lanka (2017) and Survey Department (2007)

Sri Lanka has experienced gradual decline of forest cover since the second half of the 19th century due to anthropogenic causes. Historically, growth of export-based plantation economy in the wet zone, colonial policy on commercial timber extraction and, land resettlement and irrigation development in the dry zone were among the major drivers responsible for large-scale deforestation and degradation of forests in the country from the mid nineteenth century to the late twentieth century.

The above historical drivers, though not effective today in the same scale, have set the trends for subsequent phases of deforestation and degradation of forests that still continues. Major drivers currently responsible for deforestation in Sri Lanka include infrastructure development activities, encroachment for commercial highland agriculture in dry zone, encroachment for smallholding tea plantations in the wet zone and rehabilitation and resettlement programmes. However, recent estimates based on forest cover assessments indicate that the rate of deforestation has significantly decreased during 1992-2010 (7,147 ha/year) compared with the period of 1956-1984 (42,200 ha/year) (Fernando et al., 2015).

There are threatened ecosystems that need special attention such as inland and coastal wetlands which offer numerous ecosystem services. The Asian Wetland Directory of 1989 identified 41 wetland sites of international important in Sri Lanka, covering 274,000 ha in total (CEA, 2006). This includes 6 wetland sites also identified under the Ramsar Convention for their international significance.

Majority of wetland ecosystems in the country are currently under the threat of degradation due to human activities. Urban wetlands in areas of high population densities are under the threat becoming garbage disposal sites or being converted into build-up areas. Wetlands in coastal zones also are affected by pollution from urban and industrial effluents, infrastructure and tourism development, garbage disposal, shrimp farming and encroachments. Wetlands are important habitats for migratory birds. Rising temperature and regular droughts lead to high evaporation rates and periodical drying up of wetland habitats. Another issue is inundation of brackish water wetlands with freshwater. These fluctuations in environmental conditions make it difficult for migratory birds to stay in these habitats thereby affecting biodiversity of the systems negatively.

Invasive alien species (IAS) have emerged as a major threat to Sri Lanka's ecosystems. The invasive species damage both natural as well as agro-ecosystems by competing, dominating and damaging local species. Further, climate change could possibly increase the threat by favouring invasive species which usually have broad environmental and climatic tolerances, wider geographic ranges, fast growth rates, early maturity for an efficient reproduction, high dispersal ability and increased potential for rapid micro-evolutionary changes.

Intensified human-wildlife conflicts have emerged as another area of concern that affects ecosystems of the country. This is an outcome of extending frontiers of agricultural and human settlements that increases the risk of hostile interactions between humans and wildlife. This has resulted in growing numbers of crop and property damages and life threats to humans as well as wildlife. Among others, human-elephant conflict has attracted attention of many stakeholders, and the Department of Wildlife Conservation has introduced number of programmes to overcome this problem. Significant costs on both sides have been incurred by the conflict. During 2014-2016, 212 human deaths and 4,070 incidents of property damages reported (DWC, 2016). In 2015, the DWC has disbursed Rs. 25.7 million as compensation for wildlife damages to victimize families and spent Rs. 19.1 million to capture and translocation of marauding elephants.

Growing impacts of climate change such as extended droughts are likely to intensify the human-wildlife conflicts. Associated losses to local ecosystems can aggravate the situation further. Hence the problem needs special attention and suitable options of adaptation need to be identified.

1.6 Land resources and land uses

Land resources are critical for economic and social wellbeing of the people. About a third of population is dependent on agriculture whose livelihoods are directly dependent on land resources. The total land area of the country is 65,610 km^2. This land area has been allocated for several land uses that come under the broad categories of urban lands, agricultural lands, forests, water and barren lands. The population growth has reduced the per capita availability of land from 1.8 ha in 1900 to 0.3 ha in 2010.

65% of land area in the country has been utilized for agricultural land use. Urban lands including built up areas occupy less than 1%. Of the agricultural land uses, homestead gardens (15.7%), paddy (12.7%) and plantation (10.5%) are the major crops. Sparsely used croplands (22%) and scrubs (2.1%), which are mainly former shifting cultivation lands, also occupy a significant extent. Over 5% of land is covered either with water (4.6%) or barren lands (1.2%).

The National Action Program for Combatting Land Degradation in Sri Lanka 2015-2024 (NAP-LD, 2014) identified that many land uses in the country are affected by land degradation. Among many forms of land degradation, soil erosion due to agricultural uses and degradation due to non-agricultural activities as mining are the most critical.

Soil erosion in upcountry areas has serious off-site effects such as flash floods, drying up of streams, rapid siltation and capacity reduction of reservoirs. Major on-site effects of soil erosion are loss of top soil, declining soil fertility and landslides. Significant soil erosion can also be observed in low country dry zone areas due to spread of commercial highland farming in encroached land in catchments of irrigation reservoirs.

Mining is another major cause of land degradation in Sri Lanka. Mining can lead to degrade entire profiles of land, causing heavy soil erosion, weakening soil structure and damaging surrounding lands and properties with sediments and dust.

Landslides are another cause of land degradation. The National Building Research Organization (NBRO) has identified number of locations in Nuwara Eliya, Badulla, Kegalle, Ratnapura, Kalutara, Galle and Matara districts as landslide prone areas. Catastrophic events of landslides have taken place in locations such as Meeriyabedda (Badulla district) in 2014 and Samasarakanda (Kegalle district) in 2016. Despite increased vulnerability caused by frequent extreme rainfall events in the recent period, all other land based factors responsible for landslides are human induced. They include clearance of vegetation cover for agricultural and settlement purposes, poorly designed constructions and infrastructure development activities and poor storm water and drainage management. High population densities and growing land scarcity in wet zone areas act as key underline drivers.

1.7 Water resources

Water resources in Sri Lanka are heavily dependent on rainfall. Surveys on groundwater have indicated that groundwater potential in the country is limited (Panabokke, 2008). In a normal year, the country used to get a relatively abundant supply of water from monsoon and inter-monsoon rains. Water available from rainfall is distributed over 103 river basins through a radial pattern of drainage. Despite this relatively positive scenario, however, high inter-annual variation and uneven spatial distribution of rainfall often lead to serious issues of water scarcity. In such circumstances, competing demands from household, agriculture, energy and industrial sectors have to be met under immense difficulties. Growing uncertainties of rainfall due to climate change could worsen this situation further.

As far as spatial distribution of rainfall is concerned, wet zone receives year-round rainfall compared with dry and intermediate zones. The wet zone occupies one third of country's land and houses over 55% of the population. The per capita availability of land in wet zone is far below the country's average and acute scarcity of land is the major limiting factor that wet zone faces. On the other hand, dry zone where the majority of arable land is located constantly faces the challenge of water scarcity caused by uneven spatial distribution of rainfall. The water supply in the dry zone is a time bound matter determined by limited rainfall and high rates of evaporation. On average, dry zone experiences uneven seasonal distribution of rainfall within a year. Unevenly distributed rainfall together with high rate of evaporation creates an acute deficit in water supply nearly for 5 months. Inter-annual fluctuations could lead to further scarcity, resulting in lengthy dry spells or drought conditions. Situation of water scarcity could vary within the dry zone itself, depending on the availability of irrigation facilities and accessibility to groundwater.

Demand for water in Sri Lanka originates from 4 major uses as irrigation, domestic, industry and energy purposes. The water demand projection by Amarasinghe et. al;1999 shows that in 2025, the highest demand for water originates from irrigation in dry zone. As a result, severe water scarcity can be expected at least for one season in 13 out of 16 dry zone districts and moderate water scarcity is expected in the wet zone. Domestic and industrial demand is comparatively low and 62% of it would originate from wet zone. The above projections are applicable under existing low water use efficiency scenario and this can be improved by increasing the water use efficiency in irrigation. For instance, it shows that the country would require around 11 km^3 of water annually by 2025 for both irrigation and domestic/industrial purposes under low water use efficiency scenario. This may be reduced to 6 km^3 if the water use efficiency in irrigation could be increased.

Prospects for meeting water demand from groundwater also have serious limitations. Seven types of aquifers have been identified in Sri Lanka, namely: shallow karstic limestone, coastal sand, deep confined, laterite, alluvial, shallow regolith and deep fractured zone (Survey Department, 2007). Shallow aquifers still play an important role in household supply of water through domestic wells in many areas. Dry zone areas have two sources of groundwater of limited potential; 'shallow regolith aquifer' and deeper fracture zone aquifer (Herbert et al., 1988). The former is found more widespread at depths ranging from 3-12 m and is currently being tapped heavily for agriculture through agro-wells. The latter has more sporadic distribution and is found in deeper zone ranging from 40 m and below. Sedimentary formations provide significant groundwater potential in the northern region, especially in Mannar, Killinochchi and Jaffna districts, which is being heavily exploited for agricultural, household and industrial needs of water (Thushyanthy et al., 2012; Villholth et al., 2010).

Besides the above-mentioned situation relating atmospheric and geological sources of water supply, number of other factors could positively and negatively affect the availability of water resources in the country. Among others, two major factors could be expected to intensify the situation of water scarcity in future, namely, destruction of critical watersheds and water pollution. Two major concerns associated with watersheds in Sri Lanka are degradation of critical upper watersheds, destruction of reservoir catchments and degradation of riverine lowland habitats.

Sri Lanka has a radial drainage pattern where the strategic role of central highlands is critical. Hence, the vegetation cover in central highlands plays a major role as upper watersheds of major river basins originate there. Vegetation cover in upper watersheds regulates the stream flow of rivers, ensuring water availability for many parts of the country. Having opened for establishing of plantation crops from early nineteenth century, continuous degradation of upper watersheds remains a major problem of water management in the country.

The landscape in downstream lowland areas of the dry zone is studded with network of numerous irrigation tanks. Besides high loads of sediments carried from degraded upper watersheds, rapid clearing of surrounding catchments has become a major threat for sustainability of these reservoirs. The entire irrigation network has been organized as cascade systems (locally known as '*Ellnaga*') of small, medium and large tanks that functions as a huge rainwater harvesting system. Besides the critical role played by upper watersheds, proper management of catchments of individual tanks also is highly important for the sustainable functioning of the system.

Sri Lanka has a radial drainage pattern and major rivers that originate in upper watersheds in central highlands passes through lowland plains before reaching the coastal zone. Not only the upper watersheds but lowland riverine habitats also play an important role for ensuring the water availability while offering many ecosystem services such as serving as floodplains and housing biodiversity rich habitats. Lowland riverine habitats have come under threat due to increased human activities such as clearance of vegetation, sand mining and encroachments. Unlike degradation of upper watersheds and reservoir catchments, this is an area that has received less attention of policy makers and researchers in spite of clear signs of habitat degradation are visible.

Studies have predicted undesirable impacts on water resources due to changing patterns of rainfall, rising temperature and increased incidence of extreme events. Destruction and degradation of watersheds and riverine habitats would lead to increase the stress of such undesirable impacts further. Therefore, importance of conservation of upper watersheds, reservoir catchments and riverine habitats as a measure of adaptation to climate change cannot be underestimated.

Water pollution further increases the scarcity of water in addition to being a major environmental problem faced by the country. Few major sources of pollutants responsible for the problem in different areas are solid waste and domestic wastewater, industrial pollutants, fertilizers and agro-chemicals. In urban areas, solid waste and domestic wastewater are the major sources of water pollution. Open dumping of garbage and their dispersal through runoff flow in rainy periods channel pollutants into water sources.

In rural areas where agriculture dominates, fertilizer and agro-chemicals are the major sources of water pollution. Fertilizer and agro-chemicals applied to crops end up in surface or groundwater leading to adverse health conditions and destruction of aquatic biodiversity. Water pollution caused by these major sources lead to reduction of water available for agricultural, domestic and industrial purposes. This would increase the vulnerability of communities that are faced with rising scarcity of water due to impacts of climate change.

1.8 Coastal and marine resources

Sri Lanka has 1,700 km long coastline around the island which in most parts is a low-lying coastal belt. The coastal zone is rich with numerous coastal and marine ecosystems such as mangroves, salt marshes, dunes, beaches, barriers and spits, coral reefs, seagrass beds, lagoons and estuaries and other water bodies. Marine resources of the country lay beyond the coastal zone are comprised of Exclusive Economic Zone (EEZ), Contiguous Zone, Territorial Sea and Historical Waters (Survey Department, 2007).

About 40% country's population is concentrated in townships in the coastal zone. Major economic activities based on the coastal and marine resources include fisheries and aquaculture, tourism, ports and shipping, manufacturing industries, paddy farming, urban utilities and service sectors and power generation facilities. Around 300,000 families make their living out of fisheries in coastal, off-shore and deep-sea areas (Ministry of Fisheries, 2016).

Coastal zone represents the interface between land and sea and therefore it is an area of high ecological importance. Island nations like Sri Lanka stand to face the greatest challenge due to climate change impacts such as sea level rise and ocean acidification. Coastal and marine ecosystems are identified among the most vulnerable ecosystems to climate change adverse impacts. The recent disasters have clearly shown the vulnerability of country's low-lying coastal areas to future rise in sea level too.

Inundation of low-lying areas and salt-water intrusion are the major impacts that can be expected due to rise in sea level. Coastal ecosystems such as mangroves have an important role to play in reducing the impacts of sea level rise, as well as the highest sequestration of CO_2. Hence, loss of ecosystem services due to destruction of mangroves can be identified as a major factor that would increase the vulnerability of coastal communities to sea level rise.

Problems of coastal erosion and destruction of coastal habitats are the most critical issues associated with coastal resources depletion in Sri Lanka. Coastal erosion due to both natural and manmade causes is a serious challenge faced by coastal resources managers. Major impacts of coastal erosion include shoreline retreat, intrusion of salt water into freshwater sources, loss of productive lands and development on salinity in coastal lands.

Physiographic and environmental conditions described in this chapter provides the basis for understanding the nature of climate change impacts in Sri Lanka and physical/natural conditions under which the country has to take actions against those impacts. In essence, it outlines the natural/physical conditions that determine the vulnerability of different economic sectors and communities to the impacts of climate change and the broad scope available for making appropriate adaptation and mitigation choices. More in-depth aspects will be discussed further in respective Chapters on 'Vulnerability and Adaptation Measures' and 'Mitigation Analysis and Options' with relevant technical details. Not only the physiographic and environmental factors, the country's prospects for facing the impacts of climate change are shaped by human factors too, which involves the current situation and trends associated with population, socio-economic conditions and institutional arrangements. These aspects are discussed in the forthcoming sections of this chapter.

1.9 Economic Development

Sri Lanka's economy has reported ups and downs over time under the influence of internal drivers as well as external factors. Sri Lanka adopted the liberal economic policies 1977 onward. Since then, the successive governments followed an outward oriented strategy of export driven growth replacing hitherto followed inward looking import substitution strategy. Transformation from import substitution strategy to the export promotion strategy called for deep structural changes in the economy. The key element of government policy to achieve this was creating conditions necessary to attract foreign direct investments (FDI) for export-driven ventures that can create employment opportunities. The government followed a policy of setting up specialized export processing zones and offering incentive packages for investors. Moreover, the export promotion strategy was complemented by opening the economy for trade and capital flows and adopting a liberal exchange rate regime. Parallel to these structural changes, all governments invested on development of agriculture and rural infrastructure with the aim of connecting rural economies to the domestic and global markets. This has enhanced the market access for agricultural products and facilitated commercialization of rural economies further. The government introduced these changes while continuing the free health and education services to the public and social welfare programmes.

Sri Lanka reported Rs. 9,889,379 million gross domestic product (GDP) at market price in 2019. This amounted to a per capita GDP of 3,852 US$. The service sector, manufacturing sector and, agriculture and forestry sector contributed to the GDP in 2019 as 57.4%, 5.8% and 15.6% respectively.

Climate-induced disasters have emerged as a major threat to economic development, incurring significant economic losses on regular basis in the fast decades. Sri Lanka has been ranked the second in the Global Climate Risk Index 2019 by Germanwatch with annual losses of 3,129 US$ million (PPP) due to climate-induced disasters in 2018. Economic losses and damages due to flood events in May 2016 alone have been estimated at Rs. 99.8 billion that amounted to 0.89% of the GDP.

1.10 Agriculture

The agriculture sector covers broad subsectors of crop production, livestock, fisheries and aquaculture. Table 1.3 provides relative contributions of major subsectors of agriculture sector during the period of 2010-2015. In this section, situation in selected agricultural production activities of paddy, livestock and fisheries is reviewed briefly.

Table 1.3 Contribution to GDP by agriculture in Rs. billion

Year	2010	2011	2012	2013	2014	2015
Agriculture	544.91	569.95	592.44	611.68	639.69	670.11
Share of GDP (%)	8.5	8.2	7.8	7.8	7.8	7.8

Source: Department of Census and Statistics (2016)

Agriculture is the most sensitive sector to climate change among all sectors. Extreme events such as droughts and floods have severely affected the agricultural production and farm assets in the recent period. Not only the extreme events, slow-onset impacts such as rising temperature and sea level rise also affect agriculture which are less visible but equally or more damaging. Given the high share of employment in agriculture, such impacts create significant livelihood outcomes affecting a larger section of population. Vulnerability of agriculture sector is directly connected to impacts on water resources, which is directly dependent on climate conditions. Sri Lanka has invested heavily on agricultural water supply that needs special attention in adaptation to climate change.

Paddy production is the main livelihood of rural population in the country. Total production of paddy has shown a steady growth over the years. It has increased more than five folds from 0.9 million Mt in 1960 to 4.8 million Mt in 2015. Paddy production is closely correlated with expansion of area under cultivation. Cultivation area has increased from 595,000 ha to 1,253,000 ha during the period of 1960-2015. Even though paddy is cultivated in all districts of the country nearly a half of the national production comes from four districts in the dry zone; Polonnaruwa (13.1%), Ampara (12.8%), Anuradhapura (11.2%) and Kurunegala (10.3%). Share of production from dry zone districts exceeds 75% while the contribution from wet zone districts is usually less than 10%.

Despite measures taken to enhance the rice production through various supply-side measures such as irrigation schemes, the production base has remained susceptible to climate related hazards which became intensified recently. As a result, crop failures and production losses have become regular incidents in paddy and other field crops. There are no systematic studies undertaken to assess the losses and damages caused by climate change on agriculture.

In 2015, Sri Lanka imported 631.6 million liquid milk equivalents (LME) of dairy products that amounted to 61% of the total supply in the country (DAPH, 2015). Despite high import dependency, relative share of domestic production of milk has increased gradually to 39% in 2015 from 33% in 2011.

Climate change could affect the local milk production negatively, making it difficult to achieve the national production targets. Factors such as limited area of grazing land, declining yield potential of animals due to heat stress and increased incidence of drought would act as barriers for development of local milk production. Hence, suitable adaptation measures to address climate change impacts are essential for maintaining the growth momentum in the livestock sector.

Being an island with a high density of inland water bodies too, the fisheries sector is expected to play an important role in the economy of Sri Lanka. Fish production in Sri Lanka can be categorized under three major sub sectors; coastal, offshore and deep sea, and inland fisheries and aquaculture. The highest contribution still comes from the coastal sub sector that amounts to 51% of the total fish production. However, rapid growth in deep sea subsector can be observed with more investments on multi-day fishing crafts since 1990s. Supply from domestic sources, is supplemented by substantial amount of imports of processed fish too.

In the recent period, rising incidence of unpredictable weather events have caused significant disturbances to fishing and associated livelihoods, leading to significant damages on life and fishing assets. Moreover, sea level rise and ocean acidification, major physical effects associated with climate change, is likely to create significant impacts over coastal and marine fisheries in the long run. Observed and projected threats highlight the necessity of building resilience in fisheries sector.

1.11 Industry and services

The GDP share of industry has fluctuated in the range of 20.6 - 30.1% during the period of 2010-2016 with an average share of 28%. Assisted by various government incentives and structural facilities such as free trade zones and industrial zones, this sector has attained a healthy growth during last 3 - 4 decades and remained competitive even under adverse conditions in the global economy.

Impacts of climate change on industry are multi-faceted and some industrial activities produce significant level of emissions too. In Sri Lanka's context few major impacts appear to be critical such as availability of agro-based raw materials, industrial water supply and infrastructure vulnerability to extreme weather events. Supply of raw materials for agro-based industries is heavily dependent on climate and rising scarcity of water creates difficulties for industrial water supply. Recent floods in wet zone areas, especially in Kelani river basin, have brought severe damages on industrial facilities. Hence, industrial sector deserves special attention not only in mitigation measures but national efforts in adaptation too.

Services are the dominant sector in the economy that contributed 57% to GDP in 2016. It has shown a slow but steady growth throughout the period, starting from 54.6% in 2010.

Service sector is involved with activities leading to mitigation of as well as adaptation to climate change. While some service sector activities (e.g. transportation) are main contributors to GHG emissions, many of them (e.g. health, tourism) are highly vulnerable to impacts of climate change too. Some services provide the essential basis for designing and implementation of both mitigation and adaptation measures (e.g. public administration and defence, insurance, financial services). Hence, the service sector has multifaceted involvement with climate change.

1.11.1 Transport service

There are 4 major modes of transport operating in Sri Lanka; road transport, rail transport, shipping and aviation. Transport sector covers both passenger and cargo. Total length of the road network in Sri Lanka was 31,450 km in 2016 including expressways. The total length of rail track network in Sri Lanka in 2015 was 1,568 km. Sri Lanka has 4 foreign vessels arriving shipping ports (Colombo, Galle, Trincomalee and Hambantota) and two international airports (Katunayake and Mattala). Road transport has both public and private transport options whereas other modes are mainly public transport modes. Public road transport reported 65,688 million passenger kilometers in 2016 whereas railways covered 7,413 passenger kilometers. The rest come from government owned and regional transport companies. The national airline has flown 12,855 passenger kilometers in 2016. Sri Lanka's vehicle fleet has rapidly been growing. The total fleet of vehicles has increased more than 3 times during the period of 2000-2015.

An important development in transport sector is growing popularity of hybrid and electric vehicles among private car users. Both hybrid and electric vehicles help to raise fuel use efficiency of vehicles in the country thereby contributing to reduce both the fossil fuel dependency and emissions. The Government has promoted the hybrid and electric vehicles by offering import tax incentives. As a result, significant growth in the share of hybrid and electric cars in local vehicle fleet can be observed. In 2015, out of the total of 99,600 petrol cars imported, 40,800 (41%) were petrol hybrids (Department of Motor Traffic, 2016). Besides, promoting low emission vehicles, the government is also making efforts to shift from private to public modes of transport.

Transportation is too a vulnerable sector to impacts of climate change. For instance, regular disturbances to transport sector occurs due to extreme weather events throughout the country. The tendency seems to be rising over time and this creates fiscal burdens for rehabilitation and maintenance of transport infrastructure frequently. Hence, the transport sector also needs the support of appropriate adaptation measures to cope up with projected impacts of climate change in addition to mitigation measures for reducing emissions from transportation.

1.11.2 Healthcare service

Sri Lanka is covered by a network of public healthcare facilities that provides free health care to all. In addition, private healthcare services also show a tendency towards growth, especially in urban areas. The countrywide public health service facilities have helped raising the indicators of maternal child health indicators that are in par with higher middle-income or even higher income countries. Sri Lanka has also shown commendable progress in eradicating some communicable diseases such as Malaria and Tuberculosis. The World Health Organization (WHO) certified Sri Lanka as a Malaria free country in 2016. In spite of these achievements, however, rising incidence of other communicable diseases such as Dengue has been reported during the recent years.

The main challenge in health sector in Sri Lanka is posed by non-communicable diseases. In addition, reports indicate that incidence Chronic Kidney Disease (CKD) is spreading rapidly in certain areas of the country. The key factors that contribute to the increasing prevalence of non-communicable disease include ageing population, unhealthy food habits, and the rise of alcohol and tobacco consumption. Growing incidence of CKD is suspected of resulting from exposure to pesticides pollution.

Sri Lanka has experienced rising incidence of outbreak of diseases that are closely connected with environment and weather patterns such as seasonal outbreaks of dengue from the recent past. Moreover, extreme weather events have resulted in increased numbers of fatalities and injuries. Another potential health hazard that needs close attention is spread of vector borne diseases into new areas with changing patterns of local climate. Sri Lanka has an ageing population and gradual rise in temperature and sudden fluctuations in weather patterns can directly affect the living comfort and health of them. Hence, all observations and projections suggest that Sri Lanka's health system has to face increased challenges due to climate change which demand adaptive solutions.

1.11.3 Education

Sri Lanka has reported significant achievements in education system. Literacy rates of both male and female populations exceed 97%. The net primary enrolment rate was 99% in 2015 while the secondary enrolment rate was also high at 85%. These achievements can be considered as a favorable outcome of education policies pursued by successive governments. Country has launched universal free education policy even before gaining the political independence in 1948 and countrywide system of public schools helped to achieve this target. Country adopted compulsory education for children aged 5-14 in 1998. Besides providing free and compulsory education, the government also offer free textbooks, free uniforms, subsidized transport and free school meals for school children.

Not only the school education, the state also provides free tertiary education in 15 government universities and 5 higher education institutes run by the University Grants Commission. These universities and higher education institutes have 556 academic departments that offer courses on different subject areas including environmental science and climate change (more details in section 5.2). In addition to state universities, there is large number of private higher education institutes that offer degree courses of their own or in affiliation with foreign universities.

Climate change has the potential to create harmful impacts on the education system. Recent extreme events dropped school attendance frequently while occasionally forcing the authorities to close down schools temporarily. Floods caused temporary displacement of children of victimized households, often resulting in losses and damages to their school books and other educational materials. Displaced children had to miss their school attendance for several days and in few occasions bar examinations had to be rescheduled for accommodating children faced with disaster events. Even though not systematically investigated, spread of climate sensitive diseases (e.g. dengue) among school children has apparently increased recently.

On the other hand, education is a key factor that determines the adaptive capacity of the country against climate change too. The national education system can contribute to increase the awareness and develop the skills necessary for facing the threat of climate change, i.e. adaptation and mitigation. In addition, school children are being given disaster awareness, including mock drills to increase the preparedness in disaster prone areas. Children educated in causes and impacts of climate change and appropriate climate actions, while strengthening the country's future capacity for implementing mitigation and adaptive actions, can also be considered as an effective channel for communicating knowledge on climate change to other household members too.

1.12 Energy

A major share of Sri Lanka's primary energy still comes from renewable indigenous sources, namely, biomass and hydro. Accordingly, 42% of primary supply comes from biomass sources, whereas hydro and non-conventional renewable energy (NCRE) account for 8% and 3%, respectively (SLSEA, 2015). Fossil fuel sources contribute to 47%. Fuel wood is the major type of biomass widely used in households, especially in rural areas, for domestic cooking, heating of water etc. Besides, a large number of small and medium industries also use biomass for boilers, driers and kilns, etc. Other forms of biomass energy such as coconut shells, bagasse and paddy husk also play a limited role. The data indicate that the composition of the power and energy mix in Sri Lanka is transforming gradually. The share of renewable energy in the primary energy has slowly decreased while the share of petroleum has increased. It has increased the import dependency of energy sector. Coal and NCRE have come as new entries to energy mix.

Demand for electricity has been steadily increasing over the years. The highest demand comes from the domestic sector followed by the industrial and commercial sectors. The demand from household and commercial sectors has been growing faster than the demand from industry. As a result, the share of electricity in industrial sector has been shrinking even though actual consumption has increased. Rapid growth in demand for electricity and susceptibility of hydro power generation to rainfall uncertainties compelled to increase the capacity of thermal power generation from 1990s onwards. As a result, during the last decade, the share of thermal generation has increased up to over 60% of total annual generation and continues to grow even further.

Sri Lanka's growing dependency on fossil fuels has economic, social and environmental impacts. As far as import volume of petroleum is concerned, it has nearly doubled during the period of 2006-2015 indicating growing demand for petroleum. In terms of the composition of imports, locally refined quantity of petroleum has gradually decreased while the share of refined products has increased. Import of coal, a new entry to the energy mix has increased steadily from 2010 onwards after commissioning of first coal power generation plant.

Growing dependency on fossil fuel creates balance of payment pressures on the economy. The burden of fossil fuel imports is a result of both increased volume as well as price hikes. In Sri Lanka, energy sector plays a critical role in mitigation of and adaptation to climate change. Growing dependence on fossil fuel for power generation has made the energy sector a major source of GHG emissions. As a result, Sri Lanka's nationally determined contributions (NDCs) to the Paris Agreement mainly concentrated on the energy sector. On the other hand, power generation in the country is still dependent on hydro power facilities to a significant extent. Changing patterns of rainfall appear to have a direct impact on them. Rising temperature also could affect water availability in reservoirs. Hence, energy is an economic sector that needs careful attention of both mitigation as well as adaptation policies of the country.

1.13 Tourism

Sri Lanka offers a unique tourism destination in the world where multiple attractions are offered within a relatively small area which can be accessed by few hours travel from one attraction to many other. Key attractions include scenic beaches, archaeological sites, nature based, cultural heritage and events. Each of them has the multiple sites of attractions.

In 2016, total earnings from tourism reached 3.52 US$ billion. At this level tourism has become the third highest earner of foreign exchange to the national economy. Its contribution to total foreign earnings reached

14.2%. Total estimated employment in the tourism sector (both direct and indirect) was 335,659 which is 5.1% increase from the previous year.

By its nature, tourism is highly sensitive to disturbing conditions such as natural disasters and adverse weather conditions. Sri Lanka is frequently experienced adverse effects of climate change. Hence, climate change can adversely affect the demand for tourism, creating difficulties for operational activities of tourism. It can also affect the infrastructure facilities and assets of tourism industry making them vulnerable to climate related hazards. This implies that carefully planned adaptation measures are necessary for maintaining the demand for tourism in Sri Lanka while ensuring efficient operation of the industry under rising impacts of climate change.

1.14 Waste management

Waste management is a major challenge in densely populated urban areas where garbage is generated in large quantities. Many local authorities adopted open dumping as the usual method of disposal. This has given rise to problems of environmental and sanitary hazards. Moreover, local authorities found it increasingly difficult to find suitable dumping sites as lands become scarcer. Studies have established that average composition of municipal solid waste (MSW) generated in households contains 60-70% biodegradable organic waste. Organic content mainly comes from kitchen and garden waste. The rest is consisted of plastic, paper, metal, glass and wood which are reusable and recyclable. Further, studies have also shown moisture content of MSW vary from 70-80% with calorific values around 600-1,000 kcal/kg. Limited daily collection and composition of waste restricts the use of certain alternatives of waste management unviable. For instance, high moisture content and low calorific value restrict the use of incineration while limited collection makes sanitary land filling economically non-viable option. The absence of proper waste management has led to health, social and environmental problems from the point of generation to the point of disposal.

The responsibility of MSW management is vested to the local government by the Pradeshiya Sabha Act, the Municipal Council Ordinance and the Urban Council Ordinance. The waste management plans of the country are formulated and executed based on the data records available with the relevant government agencies such as the National Solid Waste Management Support Centre (NSWMSC) operated under the Ministry of Provincial Councils and Local Government, Western Province Waste Management Authority (WPWMA) and Central Environmental Authority (CEA). Certain steps have been taken by the NSWMSC, Ministry of Environment, the CEA and the WPWMA to improve the situation.

1.15 Governance and institutional set up

The government of Sri Lanka have three levels of administrative structures, namely; the central government, Provincial Councils (PCs) and local Authorities (LAs). Each level of the government comprises elected representative bodies.

The Cabinet headed by the Executive President and the Parliament are the elected representatives of the central government. The central government comprises of a hierarchy of organizations, ministries at the top most level to the village officers at the bottom. At the top level, line ministries take policy decisions on broad subject areas of governance. There may be number of line agencies under each ministry to handle specialized areas of the broad subject of the ministry. Two broad categories of line agencies are government departments and state-owned enterprises (SOEs). The SOEs include statutory boards and institutions such as Authorities, Boards, Institutions as well as public enterprises (e.g. State Banks, Corporations, and Government Companies) that have some independence of handling their finances and managerial functions. The budget expenditures of ministries and departments are directly allocated and controlled by the Treasury. At the local level, the central government is represented by regional/local branches of different line agencies and the uniform hierarchy of district administration comprised of District Secretariats, Divisional Secretariats and *Grama Niladari* (Village Officer) Divisions.

Below the level of central government, there are 09 Provincial Councils (PCs) that are comprised of elected members. Provincial governments are nominally headed by a Governor appointed by H.E. the President. The executive powers are vested with the Chief Minister who is an elected member. Administrative structure of the PCs comprises of provincial ministries and provincial line agencies (provincial departments and authorities).

Special arrangements are available for allocating finance to PCs through the Finance Commission and the Ministry in charge of Provincial Councils and Local Government of the central government.

Local Authorities are the grass-root level administrative set up of Sri Lanka. They have three types of elected government bodies, namely; Municipal Councils (MCs), Urban Councils (UCs) and Pradeshiya Sabhas (PSs). Policy decisions taken by the elected representatives are implemented by government civil servants. Functions and responsibilities of LAs include: public health and sanitation (primary health care, solid waste management, maintaining the drainage system, conservancy and scavenging services etc..); public thoroughfares (maintenance and repair, servicing, actions against damages, utilization for special purposes, etc..); community development (pre-schools, libraries, etc..), and; public utility services (water supply, markets and fares, play grounds, public and children's parks, etc..).

Climate change has been identified as a subject relating to environment within the overall mandate of the Ministry of Environment. The national focal point for the UNFCCC is the Ministry of Environment in Sri Lanka. The national policies, programs and institutional arrangements relating to climate change are fast being developed in the country. The subject of climate change has been assigned to the Climate Change Secretariat (CCS) functioning in the Ministry of Environment.

Addressing climate change issues requires a complex institutional mechanism for coordinating actions of several line ministries and agencies. Hence, the CCS is playing a coordination role among several line ministries and agencies. Other key agencies that come under different ministries that deal with areas relating to climate change are the DoM, DMC and NBRO.

Sri Lanka is yet to introduce dedicated legal provisions guaranteed by a parliamentary act to address climate change issues other than general provisions made available in the National Environmental Act and other sectoral legislations. The formulation of National Climate Change Policy (NCCP) of Sri Lanka in 2012 has been a major milestone of the national agenda on climate change.

In addition, National Climate Change Adaptation Strategy for Sri Lanka (2011-2016), Technology Needs Assessments (2014), National Adaptation Plan for Climate Change Impacts (2016-2025) and the Nationally Determined Contributions (NDCs) in 2016 and 2021 are the key climate change related documents that have been prepared by the CCS.

1.16 Preparation of National Communications

Sri Lanka has prepared two national communications and submitted to the UNFCCC in 2000 and 2012. The preparation of Third National Communication (TNC) was coordinated by the CCS and a project management unit (PMU) was established under the CCS to prepare the TNC.

Overall supervision and guidance for the preparation of TNC was made by the Project Executive Board established with the representation of Ministry of Environment, Department of External Resources, Department of National Planning and UNDP Sri Lanka which was chaired by the Secretary, Ministry of Environment. Teams of consultants and individual experts were appointed for particular tasks to be performed. Consequently, three national experts and team of sector experts were appointed for preparation of GHG Inventory, Mitigation Analysis and Options, and Vulnerability and Adaptation Measures (VAM) separately. Four individual consultants were on board for preparation of chapters on National Circumstances; Education, Training, Awareness and Capacity Building; Technology Transfer, Research and Systematic Observations; Gaps, Constraints and Needs. Further, an expert was on board to make socio economic analysis for the VAM chapter. In order to coordinate between PMU and consultants including experts two Technical Coordinators for adaptation and mitigation separately were appointed. During the data collection, analysis and preparation the TNC report by aforesaid consultants and experts to ensure the accuracy and quality of outputs a seven-member Independent Review Panel (IRP) was established comprising well knowledgeable and experienced professionals in this field. Regular progress review meetings were conducted to assess the progress of each consultancy and the IRP participated for those meetings. Series of workshops and stakeholder consultations were held to gather the required information and data for the preparation of TNC report and validate the outputs. In addition to the national expertise and consultancy occupied, an international consultant was hired for sharing international experience on developing national communication.

Necessity of developing a climate change data portal with data sharing and continuous updating facilities has been identified and highlighted by many stakeholders. Not only the preparation GHG inventory, such a data sharing and updating mechanism would help all layers of stakeholders from grass-root level development workers to highest level policy makers in taking decisions on multiple areas of climate action. The CCS is currently planning to launch this initiative based upon the data collected and generated in preparation of the TNC. Accordingly, all information collected by the consultants from different sources and new information generated in the study were uploaded into a database which will provide the basis for continuous updating and sharing of data.

1.17 Multi stakeholder engagement

The CCS has to work in close coordination with multiple national agencies to implement the climate actions. It includes government ministries, departments and constitutional bodies, civil society organizations (CSOs), private sector, academia and media.

Presently, number of CSOs that are dedicated to areas of environment and sustainable development also work in climate change related issues. In spite of that some CSOs currently work in coordination with the CCS and other public agencies in areas relating to climate action.

Even though not specifically identified as climate action, the private sector in Sri Lanka has made some positive steps towards this direction. This is particularly visible in energy sector where, private-public partnerships relating to non-conventional renewable energy (NCRE) have emerged through the facilitation of Sri Lanka Sustainable Energy Authority (SLSEA). The Government has opened some avenues for private sector participation in NCRE through the programmes initiated by SLSEA and the long-term generation expansion plans of the Ceylon Electricity Board (CEB). Net metering for solar energy systems supplied by private sector companies is available for domestic users from the two electricity suppliers in the country namely CEB and Lanka Electricity Company (LECO). Some encouraging private sector involvements are emerging in the area of improving energy efficiency in domestic and industrial sectors too. Energy efficient lighting such as CFL and LED are getting popular and private suppliers are already catering to meet the rising demand. Solar Industries Association (SIA) and Renewable Energy Development Association (REDA) are two business organizations that has been established to promote the common interests of private sector companies working in the area of NCRE.

1.18 Climate financing

Sri Lanka's climate financing has three major sources, namely; public, private and donor funding. Public financing through the government budget is the dominant source of funding for both adaptation and mitigation actions while donor funding has supplemented the government efforts through few major projects and several small projects. Public financing for climate action includes both 'direct' as well as 'indirect' climate finance. Direct climate finance is funding aimed at addressing specifically identified climate change related purposes. For instance, annual budget allocation for renewable energy generation and adaptation related areas such as improving the climate forecasting facilities of the DoM and disaster mitigation measures.

As far as direct public financing for climate related purposes are concerned, two major areas can be mainly identified as financing for climate change mitigation (renewable energy, e-mobility, greening industries) and financing for climate change adaptation (disaster management and resilience building). The government is currently allocating significant resources for improving renewable energy sector and demand side management (DSM) programmes in industrial, commercial and household sectors. Also, significant public funding has been allocated for risk reduction and relief on climate-induced disasters that has mainly been channelled through the Ministry in charge of disaster management and line agencies coming under the same.

However, it appears that government has more indirect financing for adaptation in areas such as irrigation and water management, agriculture, health, coastal zone management, biodiversity and ecosystems conservation which are contributing to build resilience unless specifically identified as climate financing. Even though there are no systematic assessments, it appears that indirect financing for climate change adaptation is higher than direct financing given the indirect funding is being allocated.

As far as private climate financing is concerned, significant investments can be found in areas relating to NCRE such as solar power systems and wind power generation and importation of electric vehicles. These investments have revealed the objective of reducing emissions that can be considered as private sector financing for climate change mitigation. Information on private sector financing for climate change adaptation is slightly available however it is apparent that private sector entities are taking voluntary measures to face climate change impacts such as prolong droughts and floods.

The public and private sectors' efforts for adaptation are further enhanced by donor funding. At present, there are few major projects directly aimed at addressing climate change issues. Two examples are World Bank funded 'Climate Resilience Improvement Project (CRIP) and the Green Climate Fund (GCF) granted 'Climate Resilient Integrated Water Management Project (CRIWMP)' implemented by the Department of Irrigation and the UNDP Sri Lanka. The CRIP is addressing adaptation needs in 10 major river basins in the country. The CRIWMP is focusing on enhancing the adaptive capacity in cascaded tank-village systems in the dry zone.

CHAPTER TWO

National Greenhouse Gas Inventory

CHAPTER TWO

National Greenhouse Gas Inventory

2.0 Introduction

In accordance with the Decision 17/CP.8 (FCCC/CP/2002/7/Add.2), Non-Annex 1 parties are required to estimate anthropogenic emissions by sources and removals by sinks of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) in their national greenhouse gas (GHG) inventories. Countries listed in the Non-Annex 1 parties are also encouraged to provide information on anthropogenic emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) and emissions of ozone precursors such as carbon monoxide (CO), nitrogen oxide (NO_x) and non-methane volatile organic compounds (NMVOCs). In addition, Non-Annex I parties may also report on other gases not controlled by the Montreal Protocol such as sulphur oxides (SO_x).

Sri Lanka, as a Non-Annex 1 party, used the 2006 IPCC-GLs (IPCC, 2006) in the current GHG Inventory, predominantly considering the Tier-1 approach. It includes the emissions from Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land-Use (AFOLU) and Waste sectors. AFOLU emissions and removals are reported under Agriculture, and Land Use, Land Use Change and Forestry (LULUCF) separately.

However, revised 1996 IPCC-GL was used for the calculation of HFC emissions in IPPU sector and the emissions of precursors, CO, NO_x and NMVOC, in the energy and IPPU sectors as these precursor emissions are not given in the 2006 IPCC-GL. The emission factors (EFs) for certain forestry subcategories were extracted from the Good Practice Guidance for Land Use, Land Use Change and Forestry (IPCC, 2003).

The GHG inventory provides emissions by sources and removals by sinks under the above sectors and relevant sub-sectors focusing on the year 2010. In addition, GHG emissions were calculated for the time series 2000-2010. Emissions were calculated in units of mass, and in CO_2 equivalents using the global warming potential (GWP) values given in the IPCC Second Assessment Report (IPCC, 1996).

In the energy sector, emissions from fossil fuel combustion activities and fugitive emissions were estimated. Under the fossil fuel combustion activities, energy industries (including electricity generation and petroleum refining), manufacturing industries and construction, transport and other sectors (i.e. household, commercial and agriculture sectors) were considered. The transportation and storage of CO_2 are not relevant to Sri Lanka and hence not included in the current GHG inventory. Under the IPPU sector, CO_2 emissions from mineral industry and emissions of HFCs were estimated.

The agriculture related emissions include CH_4 from rice cultivation, enteric fermentation and manure management, and N_2O emissions due to soil fertilization and added nitrogen from nitrogen fixing crop residues as well as indirect emissions due to manure management. Carbon dioxide emissions due to liming and urea application, emission estimates of CH_4, N_2O and gaseous emissions such as NO_x and CO due to crop residue burning are also given. The emission estimates associated with LULUCF include the carbon stock change in biomass, dead organic matters, mineral soils and disturbances. Under the waste sector, emissions of CH_4 and N_2O by the disposal of solid waste in sanitary land-fills and open dumping and wastewater treatment facilities were estimated.

2.1 Arrangement for preparation of GHG Inventory

This GHG Inventory was prepared by the Climate Change Secretariat (CCS) of the Ministry of Environment. The Project Management Unit of CCS was primarily responsible for preparation of this inventory, with the support from a Technical Coordinator, National Expert and a Team of Sector Experts.

The followings were considered for the preparation of this GHG Inventory;

1. 2006 IPCC Tier-1 methodology was used. The default emission factors were used due to the concerns on validity and accuracy of certain nationally available EFs.
2. Priority given towards collection and utilization of nationally available activity data.
3. Utilization of pre-determined data templates in line with the worksheets of 2006 IPCC-GL.

4. Maximum use of the nationally available information and capacities through consultation of additional sectoral experts and stakeholders, as needed.

2.2 Overall methodology and summary of sector wise emissions

The GHGs and emissions of precursors were estimated using the IPCC methodology as indicated above and the nationally available activity data.

The methodology from 2006 IPCC-GL based on activity data on carbonate raw material were used to estimate emissions in the sub-categories of IPPU sector, along with default EFs, as national level production data were not available for the final products. For the category of consumption of fluorinated compounds (e.g. HFCs), the Tier-1 methodology of 1996 IPCC-GL was used.

Many of the above industrial processes also emit precursors including NO_x, NMVOC, CO and SO_2. Industries that emit precursors are listed in Table 7.1 (Volume I) of 2006 IPCC-GL. However, EFs for these precursor emissions are not given in the 2006 IPCC-GL and reference has been made to EMEP/CORINAIR Emission Inventory Guidebook (European Environment Agency, 2006) to obtain these EFs.

Most of the data needed for the 2006 IPCC methodology were not properly recorded or available in the country. The Annual Survey of Industries by the Department of Census and Statistics covers all the economic activities including mining, quarrying and manufacturing among others. There was no publication available with the data or information on the actual physical output of the industries or actual energy consumption. Hence, most of the data were collected directly from the relevant industries. Out of the contacted industries, only a few had data collected for prior years to 2010.

The data collected at district level (e.g. for AFOLU sector) or at factory/plant level (e.g. IPPU and waste sectors) were aggregated to derive the final national level estimates. Following the climatic classification in 2006 IPCC-GL, the "Tropical Moist" (covering the conventional dry and intermediate zones) and "Tropical Wet" (covering the conventional wet zone of Sri Lanka) climates were considered under the agriculture and land use-related sub sectors. All the GHG estimates were calculated with units given under 2006 IPCC-GL and the GHG emissions other than CO_2 were converted to CO_2-eq units, considering global warming potential (GWP, 100-year time horizon) of each GHG. Global warming potential of gases were obtained from IPCC Second Assessment Report.

2.3 Quality Assurance / Quality Control (QA/QC)

Greenhouse gas emissions and removals estimated under each sector and specific sub sectors were thoroughly checked periodically at the inventory preparation progressed. The assessment of the accuracy of the estimates were repeatedly checked through the IPCC equations, EFs and the activity data used. The compatibility of the data available from multiple sources and the decision on the final set of activity data to be used were undertaken in consultation with the national and sector experts, Independent Review Panel established by the Project Management Unit (please see section 1.16) and other stakeholders.

The gap filling in the missing data was also achieved through expert and stakeholder consultations. Information on all the data sources, data extraction methods, default emission factors and their sources used, related supportive documents used in the estimation of GHG emissions, etc., were well noted as a quality control measure. In addition, all the worksheets with the data from different sources and the accuracy of the units, etc., were rechecked.

2.4 Uncertainty assessment

Data collected from some sources were not in a regularly collected and updated. The data which were obtained from different sources for a similar parameter had sometimes significant differences. In such cases, the resolution of data differences and the final selection of the data source were determined through sector-specific stakeholder meetings and expert opinion.

In some data of particular sources were not in the format that what the GHG Inventory preparation required. In such cases, back calculation or conversion were made using rates per unit consumed (e.g. electricity bills, total cost of diesel / petrol / kerosene used, etc..).

Uncertainty in the country-specific EFs was primarily due to the availability of multiple values from different studies. Hence, default EFs suggested in the 2006 IPCC-GL which contain improved EFs compared to the 1996 IPCC-GL were considered. In this respect, sector-level uncertainty is detailed in the respective sector.

There is an uncertainty of about 1.25% in converting volumetric data of fossil fuels using density values meant for 15°C when the ambient temperature in the country is around 30°C. There is also uncertainty of about 2-3% in using IPCC values for Net Caloric Value (NCV) when the few measured values exhibit differences compared to those. In the total energy consumption data, the highest contribution was from biomass consumption. However, the consumption data were based on broader assumptions rather than an actual assessment which may cause uncertainties of at least ~10%. Even the NCV of biomass could be different than the values given in 1996 IPCC-GL.

The use of IPCC Tier-1 methodology where a single EF for CH_4 and N_2O was adopted for an entire sub-sector of transport, industries or households, could be a source of error since actual emissions depend on the type of vehicle used or the type of industrial applications.

The major uncertainty associated with the biomass carbon stock change estimation include the use of default wood density and biomass expansion factors that do not reflect the exact country context. Lack of consistency and aggregated nature of the data also creates an uncertainty. Certain activities such as illicit felling carried out in small scale, removal of tree parts for fuel wood and the exact amounts of biomass lost due to data unavailability, and estimation of soil carbon due to lack of information on the land use type before conversion could not be considered.

A common, default EF was used in estimating the CH_4 emissions from flooded land remaining flooded land. However, in order to reduce the uncertainty in the future, country specific EFs should be developed. Further, maintenance of records on the seasonal wetlands including the number of dates inundated and forest fires dates occurred etc. are also recommended.

In the estimation of GHG emissions from Solid Waste Disposal Sites (SWDSs), the use of default Methane Correction Factor (MCF) might lead to a significant uncertainty as the country's existing SWDSs may not exactly match with the standard classification of SWDSs indicated in the 2006 IPCC-GL. Further, the default values of degradable organic carbon (DOC) content in Municipal Solid Waste (MSW) might also lead to uncertainty as the composition of MSW varies with the consumption patterns due to income levels of the country's population.

Also, estimation of GHGs from open burning of MSW due to the use of default values for the fractions of carbon and dry matter content in the burnt waste, combustion efficiency and fraction of carbon oxidized, etc., as those are directly related with the estimation of CO_2. The conversion of waste from its wet weight to dry weight adds an additional uncertainty and this uncertainty varies substantially depending on the accuracy of the weight fractions used.

Further, in the estimation of GHG emissions associated with MSW composting, the use of default emission factors for CH_4 and N_2O might lead to a significant uncertainty, as the ambient temperature is directly related to the rate of composting of waste material in a specific region.

Similarly, in the estimation of CH_4 and N_2O emissions associated with the discharge of domestic wastewater including sewage, a high-level uncertainty can occur due to the utilization of default values that had been developed for Indian region for the degree of urbanization and the degree of treatment utilization by different income groups, etc.

In addition, in the estimation of N_2O emissions from industry wastewater treatment, assumption of a single value for total nitrogen content in the waste water for a given treatment system for the period of 2000-2010 (in the absence of time-specific total nitrogen data) could lead to some uncertainty as well.

2.5 Summary of emissions and emission trends

The sector-wise overall emissions for the country in 2010 are in Table 2.1. The total GHG emission and removals in 2010 are 43,554.75 Gg CO_2-eq and -39,826.30 Gg CO_2- eq respectively. Accordingly, the net GHG emission in 2010 is 3,718.45 Gg CO_2-eq and per capita GHG emission (excluding LULUCF) is 1.07 tonne with midyear population of 20,653,000 in 2010. However, the per capita net GHG emission is 0.18 tonne in 2010.

In 2010, GHG emission profile of Sri Lanka comprises as 64.1% from energy sector including transport, 29.5% from agriculture sector, 2% from IPPU sector and 4.4% from waste sector.

Table 2.1 Summary of GHG emissions and removals in 2010 in Gg CO_2-eq

Sector	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs	Total
Energy	12,810.00		950.46	393.70		**14,154.16**
IPPU	435.59				12.98	**448.57**
Agriculture	340.45		2,860.62	3,304.60		**6,505.67**
Waste	122.78		527.94	325.50		**976.22**
Total excluding LULUCF	**13,708.82**		**4,339.02**	**4,023.80**	**12.98**	**22,084.62**
LULUCF-emissions	21,342.40		112.77	4.96		**21,460.13**
LULUCF-removals		-39,826.30				**-39,826.30**
Net Total	**35,051.22**	**-39.826.3**	**4,451.79**	**4,028.76**	**12.98**	**3,718.45**

GHG emission estimates for the period of 2000-2010 excluding LULUCF are shown in Figure 2.1 and including LULUCF in Figure 2.2. It is revealed that the carbon sequestration is higher than the GHG emission up to 2004 in the country and it is reversed onward 2005 (Figure 2.2).

The total GHG emission in 2010 excluding LULUCF was 22,084.62 Gg CO_2-eq and it was a 25% increase compared to 2000. The highest emissions during the time series were observed after 2006 with slight year-to-year variability.

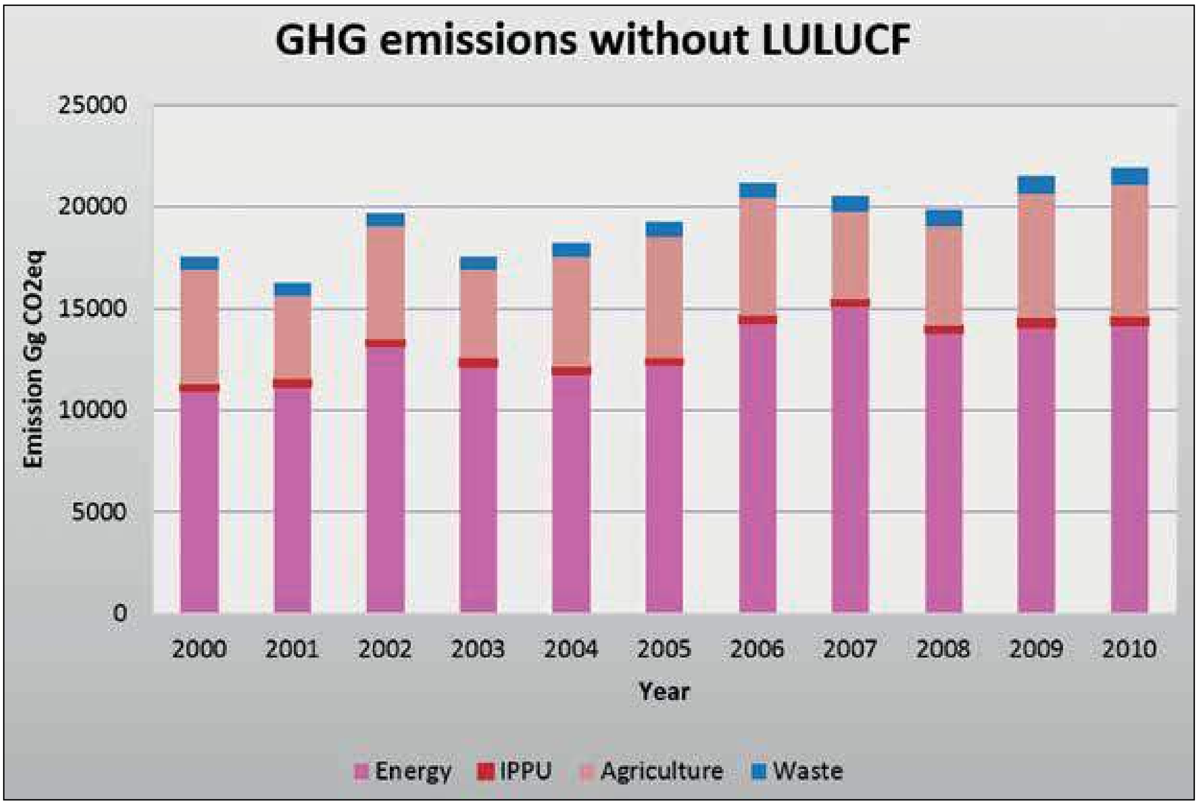


Figure 2.1 GHG emissions by sectors excluding LULUCF from 2000-2010

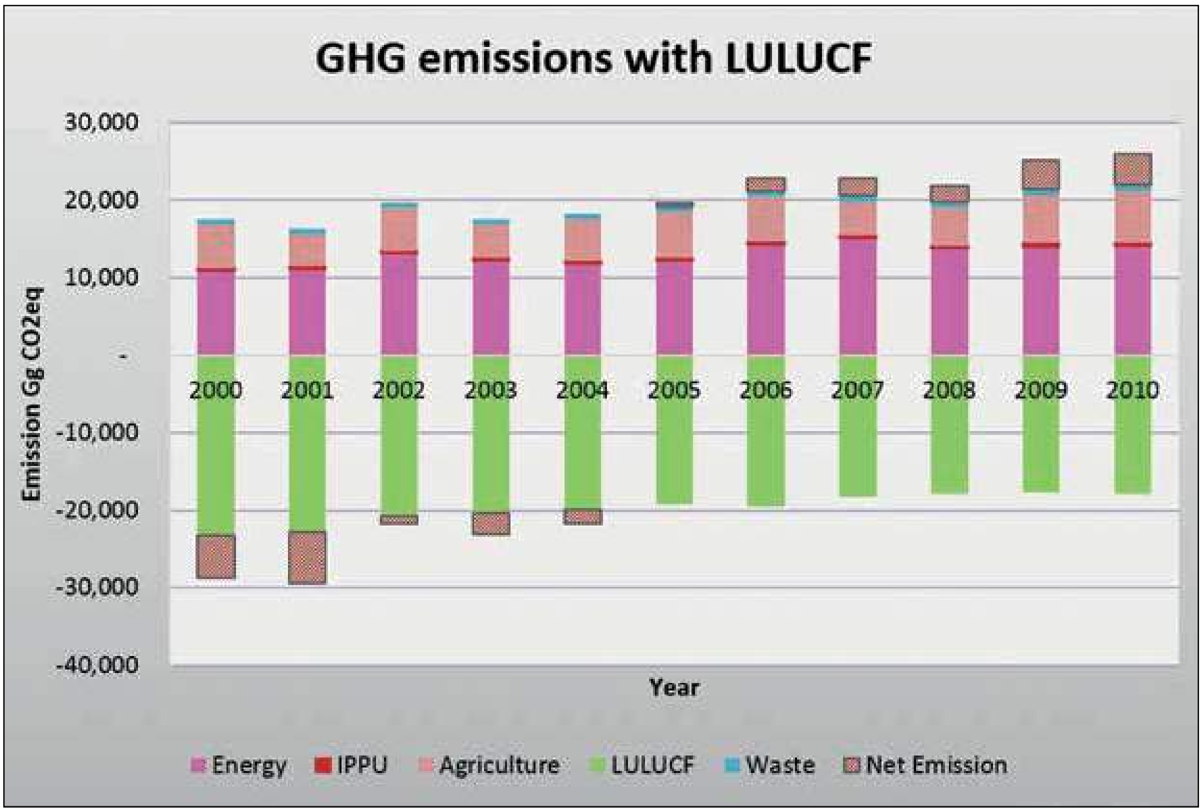


Figure 2.2 GHG emissions by sectors including LULUCF from 2000-2010

The contribution from CO_2 emissions varied between 59% - 66% of the emissions and the contribution from CH_4 emissions was 19% - 21% and that from N_2O ranged between 17% - 20%. The contributions from CO_2, CH_4 and N_2O emissions to the national GHG Inventory in 2010 excluding LULUCF were 62%, 20%, and 18% respectively; 0.0005% of HFC emissions (e.g.12.38 Gg CO_2-eq) was negligible (Figure 2.3).

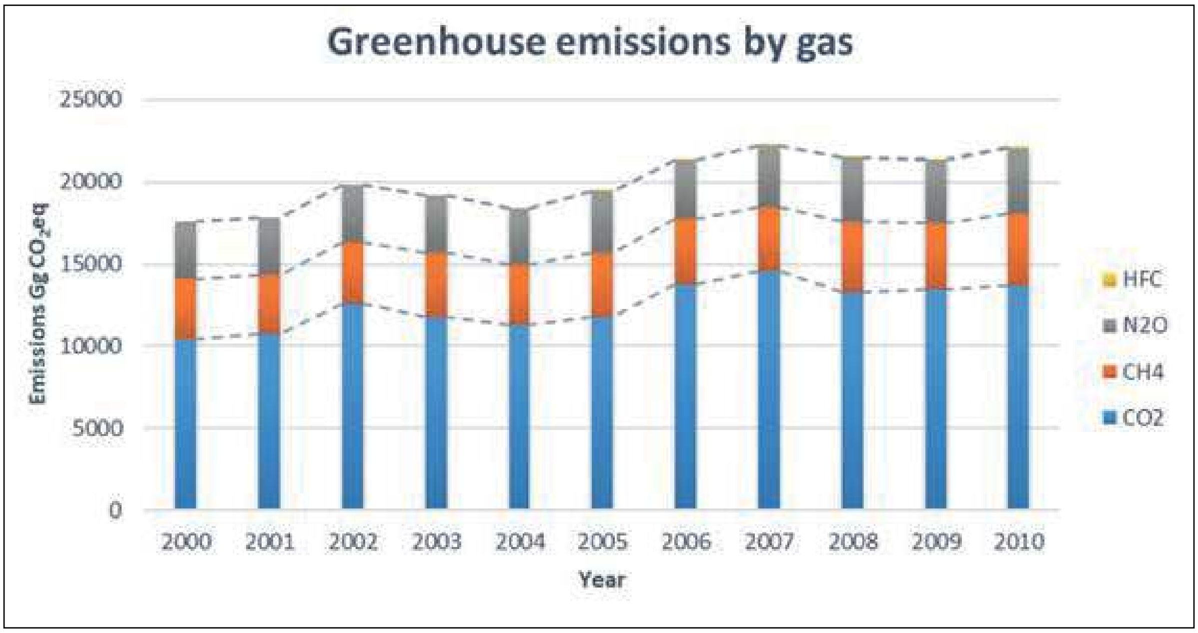


Figure 2.3 GHG emissions by gas (excluding LULUCF) from 2000-2010

2.6 Energy sector

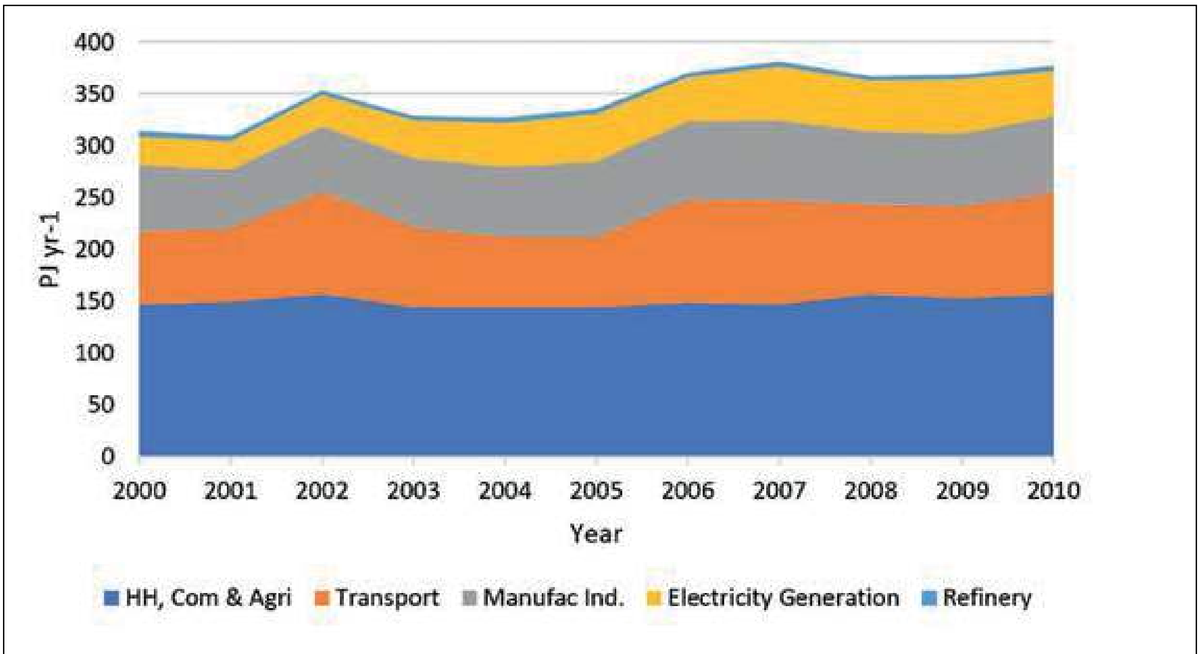
The emissions from sub sectors of energy sector were calculated using the IPCC 1997a, 1997b, 1997c and 2006 Guidelines and the default EFs. The energy sector activity data (i.e energy generation and fuel consumption data) were obtained from the national energy balance statements published by the Sri Lanka Sustainable Energy Authority (SLSEA, 2000-2010). The data included fuel consumption data in electricity generation and other energy needs in industries, transport, household, commercial and agricultural sectors.

The fuel properties published by the Ceylon Petroleum Corporation (CPC) were also considered. Default EFs under the IPCC Tier-1 methodology as well as Net Calorific Values (NCV) for fuels given in the 2006 IPCC-GL were used. Since the carbon content in fuels is given in terms of the energy content of the fuel, it was necessary to convert the amount of fuel burnt expressed in tonnes (t) into Giga-Joules (GJ) using the NCVs.

The EFs corresponding to NO_x, CO and NMVOC emissions from different fuels and sub-sectors were extracted from the 2006 IPCC-GL. The amount of CO_2 emissions is totally dependent on the fuel properties, whereas the emissions of CH_4 and N_2O are dependent on the fuel properties and the combustion burner properties.

2.6.1 Emissions from fuel combustion activities

The energy use in different sub sectors from 2000 to 2010 (Figure 2.4 and Table 2.2) exhibits a growth of 20% in the energy use with the highest growth in electricity generation (60%), followed by Transport (39%), Manufacturing Industries and Construction (16%), and Household, Commercial and Agriculture (7%). However, sub sector contribution in 2010 is shown in the Figure 4.4.



(HH, Com & Agri - Household, Commercial and Agriculture; Manufac Ind.– Manufacturing Industries and Construction; Refinery-Petroleum refining)

Figure 2.4 Growth of sectoral energy use from 2000 - 2010

Table 2.2 Energy use in PJ/yr during 2000 - 2010

Sector	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
HH, Com & Agri	146.8	149.1	156.8	144.2	144.1	144.1	148.2	146.7	156.7	152.4	156.8
Transport	70.43	71.15	98.02	77.00	67.87	67.87	98.79	100.99	86.67	88.64	98.02
Manufac Ind.	63.69	56.37	63.27	66.52	67.34	72.57	76.90	76.37	69.74	70.38	73.87
Electricity Generation	27.13	27.81	30.54	36.41	42.15	46.19	42.21	52.25	49.67	52.41	43.39
Refinery	5.86	4.88	4.25	4.14	5.49	4.33	3.92	4.43	3.92	4.67	4.37
Total	**313.9**	**309.3**	**352.9**	**328.3**	**327**	**335.1**	**370**	**380.7**	**366.7**	**368.5**	**376.4**

(HH, Com & Agri- Household, Commercial and Agriculture; Manufac Ind.– Manufacturing Industries and Construction; Refinery-Petroleum refining)

The energy use in transport in 2000 and 2003 was reduced owing to increased price of diesel and gasoline.

The three main GHGs; CO_2, CH_4 and N_2O, and the three precursors; CO, NO_x and NMVOC, and the emissions of SO_2; an aerosol precursor, were estimated (Table 2.3).

The EFs to compute the emissions of CO, NO_x, NMVOC were taken from 1996 IPCC-GL. The emissions of SO_2 were based on the Sulphur content of the fuel as given by the CPC. Emissions of CO_2 from biomass burning in industries and households were added as a memo item, as those emissions are considered to be offset by the CO_2 emissions absorbed during vegetation growth. However, CH_4 and N_2O emissions from biomass burning were reported. Under 2006 IPCC-GL, CO_2 emissions from biomass burnt for energy generation to be reflected as emissions from changes to biomass stocks under LULUCF sector. Following the 2006 IPCC-GL, the emission from international bunkering was also reported as a memo item (Table 2.3).

The energy sector reports an aggregated CO_2 emission of 14,151.45 Gg CO_2-eq (excluding fugitive emission) in Table 2.3 for 2010. The main contributors were Transport (51%), electricity generation (23.6%) and Household Commercial and Agriculture (15%) sub sectors. The sector emissions for the year 2010 were composed of 90% CO_2 (the highest share), 7% CH_4 and 3% N_2O.

Table 2.3 GHG emissions in 2010 and aggregated emissions in CO_2-eq

Sector	Gaseous emission Gg/yr for 2010							CO_2-eq
	CO_2	CH_4	N_2O	CO	NO_x	NMVOC	SO_2	
Energy (Total)	**12,810.11**	**45.24**	**1.27**	**1,037.33**	**102.76**	**142.71**	**95.74**	**14,152.94**
Electricity Generation	3,323.63	0.13	0.03	0.66	8.56	0.22	65.44	3,334.43
Petroleum Refining	320.63	0.04	0.00	NE	NE	NE	17.53	322.36
Manuf. Ind. & Construction	989.01	1.89	0.25	245.47	8.90	3.16	10.71	1,107.69
Transport	7,101.33	0.68	0.41	85.80	69.63	53.93	16.96	7,243.92
HH, Com & Agri.	1,075.50	42.42	0.75	705.40	15.68	84.69	2.63	2,143.04
Fugitive Emission	0.01	0.07	NE	NE	NE	0.71	NE	1.49
Memo items								
International bunkers	1,431.07	0.113	0.031	14.543	22.552	3.057	NE	1,443.05
CO_2 emissions from biomass burning	22,653.92							22,653.92

(Manuf. Ind.– Manufacturing Industries; HH, Com & Agri- Household, Commercial and Agriculture; NE – Not Estimated)

Aggregate emission of sub sectors in energy for the period of 2000-2010 were calculated. Over the decade, the energy related emissions showed an upward trend in Table 2.4 from 10,951 Gg CO_2-eq in 2000 to 14,151 Gg CO_2-eq in 2010 with an overall growth of 29.2%.

Table 2.4 Aggregate CO_2-eq emissions in different sub sectors during 2000-2010

Year	Aggregated CO_2-eq emission Gg/yr										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Electricity Generation	2,061	2,122	2,331	2,766	3,199	3,527	3,229	3,984	3,794	4,010	3,334
Refinery	432	360	313	305	405	319	289	326	289	344	322
Manuf. Ind. & Const.	1,091	1,095	1,147	1,248	1,042	1,259	1,258	1,252	1,195	1,143	1,108
Transport	5,237	5,291	7,244	5,720	5,019	5,037	7,324	7,480	6,403	6,558	7,244
HH, Com & Agri.	2,130	2,262	2,143	2,129	2,095	2,095	2,171	2,088	2,139	1,991	2,143
Total	**10,951**	**11,130**	**13,178**	**12,168**	**11,759**	**12,237**	**14,272**	**15,130**	**13,819**	**14,045**	**14,151**

(Manufac Ind. & Const. - Manufacturing Industries and Construction; HH, Com & Agri. - Household, Commercial and Agriculture; Refinery - Petroleum refining)

Though, Manufacturing Industries and Construction, Household, Commercial and Agriculture sub sectors have not shown considerable increased of emissions from 2000-2010, emission from electricity generation sub sector has been increased by 61.8% in 2010 compared to 2000 due to thermal power generation. However, the share of hydro power electricity generation in the energy mix during the period has also been increased (Figure 2.5). Further, it is observed that emissions from transport also have been increased by 38% due to the increase of vehicle population in the road transport sector (Figure 2.6). On the other hand, emissions from refinery have been declined by 25%.

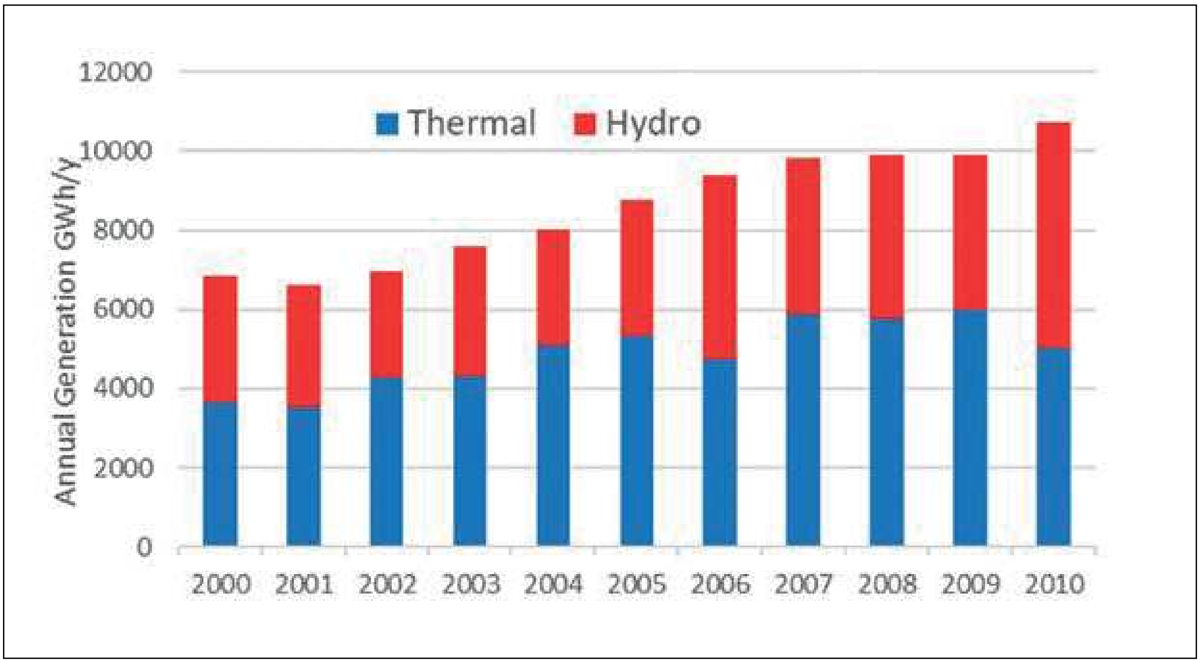


Figure 2.5 Annual electricity generation from thermal and hydro power

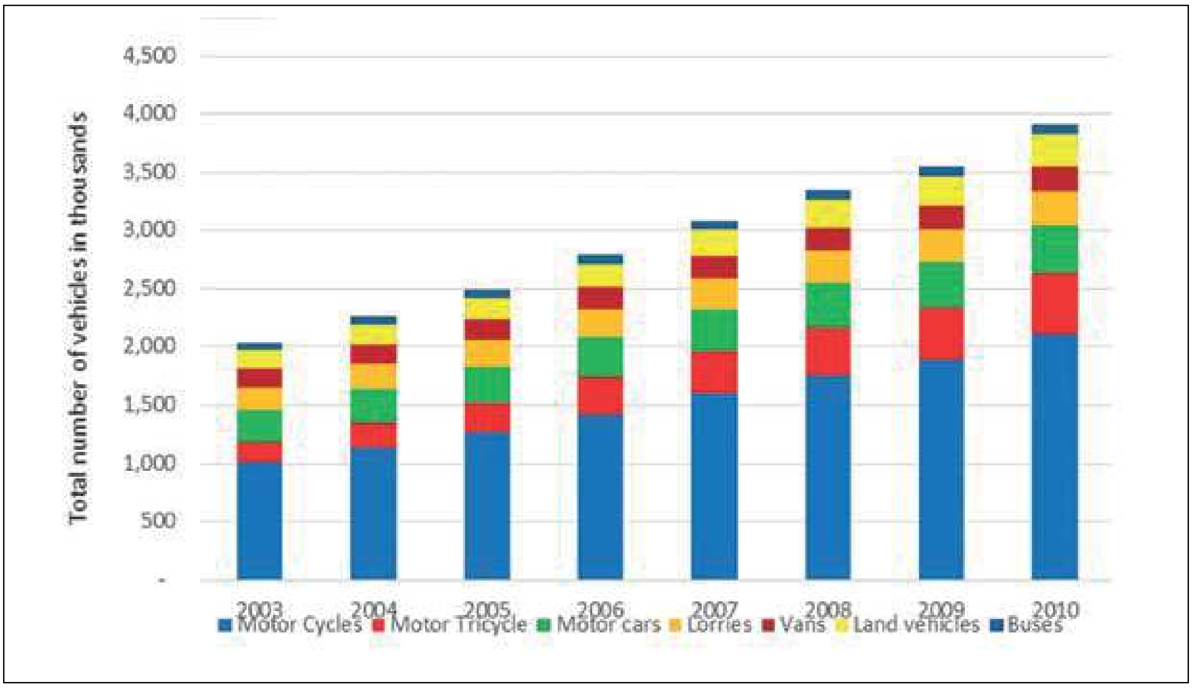


Figure 2.6 Growth of vehicle population from 2003-2010

A breakdown of individual GHGs contribution to the total CO_2-eq emissions from energy sector is shown in Table 2.5. It is clearly shown that the contribution of CO_2 emission is often around 90% of the total GHG emission throughout the time series.

Table 2.5 Total emissions by gas in Gg CO_2-eq from 2000-2010

Year	CO_2	CH_4	N_2O	Total (CO_2-eq)	CO_2 (%)
2000	9,880	868	325	11,072	89
2001	9,943	867	320	11,130	89
2002	11,862	940	375	13,178	90
2003	10,979	852	337	12,168	90
2004	10,574	857	328	11,759	90
2005	11,026	859	333	12,219	90
2006	13,006	886	380	14,272	91
2007	13,863	884	383	15,130	92
2008	12,505	943	371	13,819	90
2009	12,740	930	375	14,045	91
2010	12,810	949	393	14,151	91

2.6.2 Fugitive emissions

Fugitive emissions refer to intentional or unintentional release of GHG during extraction, processing and delivery of fossil fuels to the point of final use. The emissions were computed for transport of oil in pipelines and in bowsers using the emission factors given in 2006 IPCC-GL, it was however found negligible.

2.7 Industrial Processes and Product Use (IPPU) sector

A major source of emissions is the industrial processes that chemically and physically transform materials such as carbonates that release a significant amount of CO_2. During these processes CO_2, CH_4 and N_2O can be produced. In addition, HFCs and PFC soften used in products such as refrigerators, foams or aerosol cans, as alternatives to Ozone Depleting Substances (ODS), have been considered as possible sources of emissions in industrial processes and product use (IPPU) sector.

2.7.1 GHG emissions in sub sectors of IPPU

Under IPPU sector, mainly cement, ceramics, lime, glass, chemicals, metal, solvent application, surface coating, wood preservative application, spirit manufacturing and fluorinate compounds were considered as sub sectors to calculate emissions for 2010. These sub sectors could be further categorized into two as mineral industries and non-mineral industries. The mineral industry category includes cement industry, ceramics industry, lime industry and glass industry. These industries emit CO_2 when the carbonate molecules dissociate on combustion releasing CO_2.

The data on mineral production in the country are given in the Mineral Yearbooks published by the Geological Survey and Mines Bureau (GSMB). Although the annual data on total production of limestone and dolomite used in mineral industries are given in the Mineral Yearbooks, segregated data on quantities consumed in different industries were not available.

In the case of cement, ceramics and glass industries, there are only few factories available in the country and the data on raw material used by them were annually available. The lime industry in Sri Lanka is pursued as a cottage industry and therefore, data on dolomite and limestone consumed in lime industry were not available. Hence, the data for lime industry (Table 2.6) were obtained after deducting the sum of the amounts consumed in the agriculture sector (reported by the National Fertilizer Secretariat) and cement, ceramics and glass industries (reported by individual industries) from the total production given in the GSMB Yearbooks, based on the assumption that what was produced in a year gets consumed during the same year.

2.7.2 Cement industry

The cement industry of Sri Lanka is limited to few factories. Only one factory produces clinker for cement production using locally extracted limestone and dolomite. The others import clinker to manufacture cement. Data were obtained directly from the clinker manufacturer on the consumption of raw material as well as production quantities during the period of 2000-2010. The total amount of cement produced by each manufacturer was available, however disaggregated data by different categories were not available to apply the IPCC Tier-1 Methodology. As recommended in the Tier-2 Methodology, manufacturer's data on clinker production was used in calculating CO_2 generated, which was taken as 0.52 times the clinker produced as given in Equation. 2.4 of Mineral Industry Emissions Chapter of 2006 IPCC-GL. Since, this Emission Factor takes into account the liming added, no contribution from dolomite combustion was considered. To manufacture cement, clinker is burnt in kilns. The manufacturer who uses local raw material to produce clinker and contributes to CO_2 generation is presented in Table 2.7 using EF as 0.52 tCO_2/t Clinker.

Table 2.6 Consumption/Production of dolomite in different industries (tonne)

Year	Consumption/ Production in tonne						
	Fertilizer Usage	Cement Industry	Ceramic Industry	Glass Industry	Consumption Sub total	Total Production	Estimate for Lime Industry
2000	31,940	23,593	1,326	3,359	60,218	75,272	15,054
2001	39,143	25,834	1,342	3,573	69,892	94,169	24,277
2002	35,192	22,316	1,541	3,234	62,283	64,584	2,301
2003	36,631	25,708	1,502	3,818	67,660	82,950	15,290
2004	16,100	42,341	1,579	4,152	64,172	88,434	24,262
2005	35,161	56,305	1,293	4,381	97,140	137,187	40,047
2006	68,032	67,635	1,652	4,329	141,649	180,225	38,576
2007	71,722	75,238	2,124	1,555	159,639	190,000	39,361
2008	61,152	85,620	1,707	7,729	156,208	162,000	5,792
2009	103,307	71,516	1,606	8,294	184,723	273,673	88,950
2010	68,586	61,305	1,436	8,709	140,035	181,692	41,657

Source: Fertilizer Secretariat, Cement Industry, Ceramic Industry, Glass Industry, GSMB

Table 2.7 Emissions of CO_2 from cement production

Year	Manufacturer - Quantity (Tonne)			CO_2 (Gg)
	Cement Production	Clinker Production	Clinker Imported	
2000	531,625	378,286	119,634	196.71
2001	509,168	447,904	23,460	232.91
2002	866,176	469,081	304,033	243.92
2003	849,641	524,238	228,052	272.60
2004	961,732	507,787	322,338	264.05
2005	1,037,056	494,330	371,874	257.05
2006	1,122,465	481,827	417,538	250.55
2007	1,247,491	528,064	437,876	274.59
2008	1,190,800	520,605	410,126	270.71
2009	1,032,905	620,981	230,765	322.91
2010	1,304,213	637,157	443,356	331.32

Source: Direct data collection from the manufacturer

2.7.3 Lime industry

Burning limestone or dolomite to manufacture lime releases CO_2. As indicated in the above Table 2.6, the amount of dolomite used in the lime production was obtained after deducting the quantities consumed in other industries including fertilizer, cement, ceramics and glass from the total production of dolomite. In addition, to the calcium carbonate ($CaCO_3$) obtained from inland corals for the period of 2000-2007 and sea shells for the period of 2000-2009 and emissions from the lime industry are given in Table 2.8.

2.7.4 Glass industry

Sri Lanka has only one major glass manufacturing factory, which produces glass out of mineral raw material including soda ash (Sodium bicarbonate $NaHCO_3$) and dolomite. The consumption data of soda ash, dolomite and calcite were provided by the factory. The emission estimates are given in Table 2.9. Emission factors for soda ash, dolomite and calcite were used as 0.415, 0.477 and 0.44 tCO_2/t respectively.

Table 2.8 Production of lime and CO_2 emissions

Year	Limestone Production (kt)				Dolomite (kt)	EF tCO_2/t		CO_2 (Gg)
	Limestone	Inland	Sea Shells	Total	(Estimated)	Limestone	Dolomite	
	A	B	C	D	E	F	G	H=D*F+E*G
2000	256.6	5.0	3.0	264.6	15.05	0.44	0.477	123.60
2001	411.2	1.0	4.0	416.2	24.28	0.44	0.477	194.69
2002	155.2	3.0	2.0	160.2	2.3	0.44	0.477	71.57
2003	311	1.6	1.7	314.3	15.29	0.44	0.477	145.59
2004	224.1	2.4	1.1	227.6	24.26	0.44	0.477	111.73
2005	141.6	2.2	1.9	145.7	40.05	0.44	0.477	83.23
2006	196.9	5.3	1.2	203.4	38.58	0.44	0.477	107.90
2007	96.9	1.3	10.0	108.2	39.36	0.44	0.477	66.39
2008	138.6	-	1.0	139.6	5.79	0.44	0.477	64.17
2009	318.3	-	1.0	319.3	88.95	0.44	0.477	182.91
2010	148.3	-	-	148.3	41.66	0.44	0.477	85.10

Source: Mineral Year Books 2000 & 2004, GSMB

Table 2.9 Consumption and CO_2 emission of soda ash, dolomite and calcite in glass industry

Year	Consumption in tonne			Emission of CO_2 Gg			Total Emission of CO_2 Gg
	Soda ash	Dolomite	Calcite	Soda ash	Dolomite	Calcite	
2000	4,393	3,359	2,326	1.82	1.60	1.02	4.45
2001	4,672	3,573	2,474	1.94	1.70	1.09	4.73
2002	4,229	3,234	2,239	1.76	1.54	0.99	4.28
2003	4,993	3,818	2,643	2.07	1.82	1.16	5.06
2004	5,730	4,381	2,874	2.25	1.98	1.26	5.50
2005	5,730	4,381	3,033	2.38	2.09	1.33	5.80
2006	5.661	4,329	2,997	2.35	2.07	1.32	5.73
2007	2,026	1,555	2,456	0.84	0.74	1.08	2.66
2008	10,068	7,729	5,330	4.18	3.69	2.35	10.21
2009	10,804	8,294	5,720	4.48	3.96	2.52	10.96
2010	11,345	8,709	6,006	4.71	4.15	2.64	11.50

Source: Primal Glass Company

2.7.5 Ceramics industry

Calcite and dolomite, which are carbonate are the raw materials used in the ceramic industry. When burnt, they emit CO_2. The data on calcite consumed in the manufacture of ceramics products are available in GSMB Year Books. The data on dolomite consumption, however, were obtained directly from the ceramics industry which comprises few companies. The CO_2 emissions released during the combustion of both calcite and dolomite are shown in Table 2.10.

2.7.6 Chemical industry

The Chapter 3 of 2006 IPCC-GL Volume III lists several chemical industries that could produce GHG emissions. However, only a limited number of those industries operate in the country and no reliable data were available. Hence, emissions from this category were considered as not occurring.

2.7.7 Metal industry

Sri Lanka has several metal rolling industries operating with imported raw material, but the data are available in respect of only one industry which produces about 50,000 tonnes of rolled products annually. However, NMVOC released from these industries are below 0.01 Gg and hence not reported.

Table 2.10 CO_2 emissions of calcite and dolomite combustion

Year	Calcite consumption Tonne	Dolomite consumption Tonne	EF for Calcite Consumption	EF for Dolomite Consumption	Emission of CO_2 t	Emission of CO_2 Gg
			(t CO_2/ t calcite)	(t CO_2/ t dolomite)		
	A	B	C	D	E=(A*C+B*D)	F=E/1000
2000	4,320	1,326	0.44	0.477	2,533.1	2.53
2001	3,510	1,342	0.44	0.477	2,184.3	2.18
2002	4,700	1,541	0.44	0.477	2,803	2.8
2003	5,510	1,502	0.44	0.477	3,141	3.14
2004	4,830	1,579	0.44	0.477	2,878.4	2.88
2005	4,340	1,293	0.44	0.477	2,526.4	2.53
2006	5,160	1,652	0.44	0.477	3,058.6	3.06
2007	10,070	2,124	0.44	0.477	5,444.1	5.44

Year	Calcite consumption Tonne	Dolomite consumption Tonne	EF for Calcite Consumption (t CO_2/ t calcite)	EF for Dolomite Consumption (t CO_2/ t dolomite)	Emission of CO_2 t	Emission of CO_2 Gg
	A	B	C	D	E=(A*C+B*D)	F=E/1000
2008	6,310	1,707	0.44	0.477	3,590.8	3.59
2009	13,100	1,651	0.44	0.477	6,551.4	6.55
2010	15,870	1,436	0.44	0.477	7,667.7	7.67

Source: Industry Data of Mineral Year Book 2000 and 2004, GSMB

2.7.8 Solvent application

Solvents are used for a variety of purposes including their use as a cleaning agent and in manufacturing surface coatings. Data for import of dry-cleaning agent tetrachloroethylene (C_2Cl_4) were sourced from the internet (https://www.indexmundi.com/trade/imports) while data for other general purposes solvents were obtained from the database of SLSEA. Their emission factors were obtained from EMEP CORINAIR documents B622 and B621 respectively. The emissions of NMVOC generated from solvent application are given in Table 2.11.

2.7.9 Surface coating applications

Surface coatings are a significant source of NMVOCs, particularly from solvent-based coatings and thinners used to thin surface coatings. In recent years, the technology for manufacturing surface coatings has changed from solvent-based coatings to water-based coatings which do not emit NMVOCs. Hence, there has been a gradual decline in the manufacture of the solvent-based coatings. There are several industries formulating surface coatings in the country. However, data for the period 2000-2010 could be obtained only from a relatively small segment of factories that produce surface coatings. A value of 2 ml was assumed for each of solvent-based paints and thinners and NMVOC emissions were calculated using emission factors given in EMEP CORINAIR document B610. An average value 0.88 kg/l was assumed for density. The results are shown in Table 2.12.

Table 2.11 Emissions of NMVOC from solvent applications

Year	Consumption of DC agent kg	Emission Factor	Emission NMVOC Gg	Consumption of solvents Kt	Emission Factor	Emissions NMVOC Gg	Total Emissions CO_2 Gg
2000	NA	-	-	69.83	1.0	69.83	69.83
2001	NA	-	-	53.90	1.0	53.9	53.90
2002	NA	-	-	37.84	1.0	37.84	37.84
2003	NA	-	-	2.74	1.0	2.74	2.74
2004	NA	-	-	0.02	1.0	0.02	0.02
2005	44,012	0.8	0.035	0.02	1.0	0.02	0.06
2006	46,938	0.8	0.038	0.02	1.0	0.02	0.06
2007	79,192	0.8	0.063	4.40	1.0	4.4	4.46
2008	97,961	0.8	0.078	2.67	1.0	2.67	2.75
2009	98,483	0.8	0.079	0.92	1.0	0.92	1.00
2010	53,921	0.8	0.043	2.69	1.0	2.69	2.73

(DC - Dry Cleaning, NA- Not Available)

Source: CORINAIR B622, CORINAIR B621, SLSEA

Table 2.12 Emission of NMVOC in 2010 from surface coatings in 2010

Year	Consumption (ml)		Density (kg/l)	Consumption (Gg)		Total (Gg)	Emission Factor NMVOC/kg	Emission CO_2-Gg
	Solvents based paints	Thinners		Solvents based paints	Thinners			
2010	2.0	2.0	0.88	1.76	1.76	3.52	700	2.46

Sources: EST, CORINAIR B610

2.7.10 Wood preservative applications

Wood preservatives are widely used to protect wood from insect attacks. Once applied, about 90% of the quantity will be evaporated over time. Based on the data available for the period after 2010, a value of 1 Mega Litre (Ml) consumption was assumed for 2010 to make the inventory complete. The Emission Factor given in EMEP CORINAIR document B646 was used and the resulting estimates are given in Table 2.13.

Table 2.13 Emission of NMVOC from wood preservative application

Year	Consumption	Density	Consumption	Emission Factor	Emission
	Ml	kg/l	Gg	NMVOC g/kg	Gg
2010	1.0	0.88	0.88	900	0.79

Source: CORINAIR B646

2.7.11 Food and Beverage Industry

2.7.11.1 Bakery industry

Non-Methane Volatile Organic Compounds (NMVOCs) are released during the production of bakery products. The annual production of bread was estimated on the basis of per household consumption of bread amounting to 5.1kg per household per annum as given in the Household Income and Expenditure Survey, 2009-2010 published by the Department of Census and Statistics. The emission factor was taken as 4.5kg NMVOC per tonne of bread (EMEP CORINAIR B465). The estimated emissions are given in Table 2.14.

2.7.11.2 Spirit manufacturing industry

NMVOCs are released during the production of spirits as well as during production of liquor from coconut, palmyrah toddy and sugar cane molasses. Data on the production of spirits were obtained from the Excise Department of Sri Lanka. The emission estimates are given in Table 2.15.

Table 2.14 Production of bread and emission of NMVOCs during bread production

Year	Population ('000)	Number of Household	Bread (kt/y)	Emission Factor (kg/t) (bread)	NMVOCs emission CO_2-Gg
2000	19,102	4,776	292.26	4.5	1.32
2001	18,797	4,699	287.59	4.5	1.29
2002	18,921	4,730	289.49	4.5	1.30
2003	19,173	4,793	293.35	4.5	1.32
2004	19,435	4,859	297.36	4.5	1.34
2005	19,644	4,911	300.55	4.5	1.35
2006	19,858	4,965	303.83	4.5	1.37
2007	20,039	5,010	306.60	4.5	1.38
2008	20,217	5,054	309.32	4.5	1.39
2009	20,450	5,113	312.89	4.5	1.41
2010	20,653	5,163	315.99	4.5	1.42

Source: Department of Census and Statistics

Table 2.15 Production of spirits and emission of NMVOCs

Source	Unit	2008	2009	2010
Coconut	Ml	4.46	2.29	2.51
Palmyrah	Ml	0.13	0.07	0.04
Sugar cane	Ml	7.87	9.36	7.15
Spirits total	Ml	12.46	12.43	9.70
NMVOCs	Gg	1.87	1.86	1.45

Source: Annual reports, 2008, 2009 and 2010, Excise Department of Sri Lanka

2.7.12 Consumption of fluorinated compounds

Among the fluorinated compounds are HFC compounds which are used as substitutes in the refrigeration and air-conditioning industry, foam blowing industry, aerosol manufacture and as a suppressant. Hydrofluorocarbon compounds are imported into Sri Lanka through refrigerators and air-conditioners, and in the form of cylinders to service and replenish HFCs in refrigerators and air-conditioners, particularly in motor vehicle air-conditioners. Hence, the imported amounts are assumed to be the emitted amounts for the same year as recommended in 1996 IPCC-GL. HFCs are imported into Sri Lanka since 2005 mainly by three importers. Some of the HFC products come as blends of several HFC components. The Global Warming Potential (GWP) of Second Assessment Report of IPCC values for the blends were obtained by apportioning the GWP values of each constituent HFC according to their composition. Accordingly, HFC 134a, 407A, 40C, and 410A had GWP values of 1,300, 3,260, 1,525.5 and 1,725 respectively. The resulting emission estimates expressed as CO_2 equivalent values are shown in Table 2.16.

Table 2.16 Emissions associated with the consumption of Hydrofluorocarbons and their blends

Year	HFC Consumption (Kg)				Emission (tCO_2-eq)				Total tCO_2-eq
	134a	404A	407C	410A	134a	404A	407C	410A	
2005	4,860	327	-	-	6,318	1,066	-	-	7,384
2006	26,646	-	-	-	34,639	-	-	-	34,639
2007	7,084	-	226	-	9,209	-	344	-	9,553
2008	23,006	436	-	-	29,908	1,421	-	-	31,329
2009	31,020	872	-	226	40,326	2,843	-	390	43,559
2010	9,520	-	-	-	12,376	-	-	-	12,376

Source: HFC importer's data, 2000-2010

Among the other fluorinated substances, only SF_6 was imported to use in power transformers as a dielectric. However, their imported quantities were not available.

2.7.13 Consolidated inventory of the IPPU sector

The consolidated GHG inventory for the IPPU sector for 2010 is given in Table 2.17. It comprises CO_2 emissions from cement industry, lime industry, glass industry, ceramics industry and NMVOCs emissions from several other industries manufacturing surface coatings, solvents, bread production, sugar production and liquor industry producing spirits. The consumption of HFCs and their blends also contribute significant amounts of HFCs and these are shown in terms of their CO_2-eq values as recommended in 2006 IPCC-GL.

Table 2.17 Consolidated emissions from the IPPU sector in 2010

Code	GHG Category	Annual emissions (Gg)		
		CO_2	HFC (CO_2-eq)	NMVOC
2	**IPPU Sector**	**435.59**	**12.38**	**9.16**
2A	Minerals Industry	435.59		
2A1	Cement Production	331.32		
2A2	Lime Production	85.10		
2A3	Glass Production	11.50		
2A4	Ceramics Production	7.67		
2D	Other production			5.98
2D3	Solvents			2.73
2D4	Surface coatings			3.25
2F	Consumption of halocarbons and SF_6		12.38	
2G	Other manufacturing industries			3.18
	Bread			1.42
	Sugar			0.31
	Spirits			1.45

2.8 Agriculture, Forestry and Other Land Use (AFOLU) sector

GHG emissions and removals were estimated for the above sector by considering Agriculture, and Land Use, Land Use Change and Forestry (LULUCF) separately.

2.8.1 Agriculture

GHG emissions in agriculture mainly consists of enteric fermentation, manure management, rice cultivation and burning of crop residues, liming and urea application in managed soils.

2.8.1.1 Methane emissions from enteric fermentation

In Sri Lanka, livestock comprises mostly cattle and buffaloes. goats, swine and sheep constitute only a small part of the country's livestock. About 85% of the cattle and buffalo population is indigenous and the rest of the population is improved breeds. The indigenous population feed on grasses, while improved breeds are supplemented with higher quality feeds. The improved (European and Indian) breeds possess higher digestive efficiencies with reduced CH_4 emissions (Lokupitiya, 2016). Low quality feeds cause higher amounts methane emissions during the digestive process in ruminant livestock (cattle, sheep and goats). The amount of methane emitted through digestive processes of livestock depend on the animal's body size, metabolism, activity levels and quality of the feed (IPCC, 2006).

Final methane emissions were estimated for the two main IPCC categories: dairy (i.e. mature cows that are producing milk in commercial quantities for human consumption) and other cattle (i.e. cows not currently lactating, bulls and calves). It was assumed that the emissions from calves younger than three months were negligible and excluded in the calculations. Their population was assumed to be 20% of the total calf population. Sheep and goat were considered as one category for the purpose of estimating methane emissions.

Parameters such as livestock categories, size of their population and EFs used for the estimation of emission from enteric fermentation and manure management are given in Table 2.18.

Table 2.18 Emission estimate for enteric fermentation and manure management in 2010

Species/Livestock Category	Number of animals	EF for Enteric Fermentation	CH_4 emissions from Enteric Fermentation	EF for Manure Management	CH_4 emissions from Manure Management
		(kg/head/yr)	(Gg CH_4/yr)	(kg/head/yr)	(Gg/CH_4/yr)
1. Cattle					
1.1 Cattle (Improved)					
1.1.1 Milking cows	78,653	58	4.56	6	0.47
1.1.2 Non-milking	30,939	27	0.84	2	0.06
1.1.3 Calves	17,054	27	0.46	1	0.02
1.1.4 Mature Bulls	39,212	27	1.06	2	0.08
1.2. Cattle (Local)					
1.2.1 Milking cows	445,698	58	25.85	6	2.67
1.2.2 Non-milking	175,321	27	4.73	2	0.35
1.2.3 Calves	96,642	27	2.61	1	0.10
1.2.4 Mature bulls	222,199	27	6	2	0.44
2. Buffaloes					
2.1 Buffaloes (Improved)					
2.1.1 Milking	15,312	55	0.84	5	0.08
2.1.2 Non-milking	6,061	55	0.33	5	0.03
2.1.3 Calves	6,011	55	0.33	1	0.01
2.1.4 Mature Bulls	7,273	55	0.40	5	0.04
2.2. Buffaloes (Local)					
2.2.1. Milking	154,818	55	8.52	5	0.77
2.2.2 Non-milking	61,279	55	3.37	5	0.31
2.2.3. Calves	60,786	55	3.34	1	0.06
2.2.4 Bulls	73,537	55	4.04	5	0.37
3. Sheep	7,910	5	0.04	0.22	
4. Goats					
4.1 Improved breeds	373,465	5	1.87	0.22	0.08
5. Swine	83,785	1	0.08	6	0.50
6. Poultry					
6.1 Chicken	14,018,320			0.025	0.35
6.2 Ducks	13,485			0.03	
Total			**69.28**		**6.79**

2.8.1.2 Methane emission from manure management

Methane emission from manure management is relatively low in the country, as manure is mostly deposited by the animals on grazing land. The manure is not managed or treated in any way that results in anaerobic methane emission. There is a dearth of data on the amount of manure used in biogas production. Since, emissions due to manure management is very low, IPCC Tier -I method and default emission factor given in the Table 10.4 of 2006 IPCC-GL for Indian sub-continent were used. The emission estimated for the sub-categories of manure, amount of methane emitted from manure management was lower than that from enteric fermentation. Quantities of methane emitted from enteric fermentation and manure management during 2000-2010, calculated using the livestock data reported by the Department of Census and Statistics, are given in Table 2.19.

Table 2.19 Methane emission consolidated from enteric fermentation and manure management

Year	Annual methane emission from livestock sector ($GgCH_4$)										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Enteric Fermentation	68.49	68.62	69.48	69.55	69.79	70.30	70.58	72.11	71.87	72.97	76.07
Manure Management	6.15	6.20	6.26	6.30	6.28	6.34	6.43	6.59	6.57	6.46	6.79
Total	**116.47**	**111.33**	**115.75**	**123.51**	**111.89**	**121.23**	**121.51**	**117.85**	**131.12**	**125.97**	**134.56**

During the period of 2000 - 2010, methane emission from livestock farming has increased by 11% and 10.4% from enteric fermentation and manure management respectively.

2.8.1.3 Rice cultivation

The total paddy land extent in Sri Lanka is approximately 0.8 million ha. The paddy cultivated area spread over dry, intermediate and wet zones of the country and these lands fall under both rain-fed and irrigated farming. Crop duration for all the rice varieties was taken as 100 days. In the calculation of methane emissions for this inventory, the default emission factor of 1.3kg CH_4 $ha^{-1}day^{-1}$ given in 2006 IPCC-GL was used. For different water regimes, scaling factor of 0.52kg CH_4 $ha^{-1}day^{-1}$ was used for irrigated rice with intermittent flood with multiple aeration; factors of 0.28kg $CH_4 ha^{-1}$ day-1and 0.25kg CH_4 ha^{-1}day-1were used for normal rain-fed farming and drought prone rain-fed areas predominantly in the dry and intermediate zones respectively.

Methane emissions from paddy fields in different climatic zones under irrigated and rain-fed farming calculated for the period 2000-2010 are shown in Table 2.20. The large share of emissions was from the dry zone (DZ) and intermediate zone (IZ) where the country's highest rice production is recorded.

Table 2.20 Methane emissions from rice cultivation in different climatic zones

Year	Annual methane emission from rice fields in different climatic zones (Gg/yr)						
	Area (ha)-Irrigated DZ & IZ	**Methane Emission-Irrigated DZ & IZ**	Area (ha)-Rain fed DZ & IZ	**Methane Emission-Rain fed DZ & IZ**	Area (ha) - Wet Zone	**Methane Emission-Wet Zone**	**Total**
2000	617,751	41.76	85,138	1.88	175,107	4.34	**47.98**
2001	543,608	36.75	81,236	1.80	168,304	4.17	**42.72**
2002	592,575	40.06	82,440	1.82	177,551	4.39	**46.27**
2003	698,464	47.22	106,037	2.34	177,712	4.40	**53.96**
2004	537,412	36.33	81,813	1.81	160,296	3.97	**42.11**
2005	668,527	45.19	100,526	2.06	168,122	3.68	**50.93**
2006	668,490	45.19	93,212	2.06	148,788	3.68	**50.93**
2007	600,580	40.60	77,087	1.70	139,046	3.44	**45.74**
2008	780,138	52.74	91,809	2.03	181,045	4.48	**59.25**
2009	678,993	45.90	110,404	2.44	188,164	4.66	**53.00**
2010	756,887	51.17	119,773	2.65	188,621	4.67	**58.49**

2.8.1.4 Emissions from burning of crop residues

Carbon monoxide (CO) is the biggest GHG emission generated from burning rice residues, followed by methane (Table 2.21). Although there was significant biomass burning (~40-50% of rice straw) before 2000, mostly in certain parts of the dry zone, the practice was considerably reduced due to promotional campaigns and outreach/extension programs by the Ministry of Agriculture on the use of rice straw as mulch in paddy soils. The burning of rice straw has reduced to 6.7% in the wet zone, 16 % in the dry and intermediate zones (Somaratne and Lokupitiya, 2018); hence, these values were used to estimate the amount of rice straw burnt in the calculation of non-CO_2 GHG emissions. The emission factors used as CH_4 : 2.7g, CO : 92g, N_2O : 0.07g, NO_x

: 2.5g (kg dm burnt)$^{-1}$ according to the 2006 IPCC-GL. Emissions of CO_2 from biomass burning is not counted. The emissions of other GHGs and precursors are shown in Table 2.21.

2.8.1.5 CO_2 emissions from Liming and Urea application on managed soils

Lime and urea applied on soils release CO_2 due to dissolution and breakdown processes within soil. Limestone application in soils is practiced in up-country vegetable cultivations to improve the soil fertility. Dolomite is used in perennial crops mostly in tea plantations in the wet zone. The data recorded by GSMB and emission factors of Limestone: 0.12, Dolomite: 0.13 given in 2006 IPCC-GL were used to calculate the emissions in Table 2.22.

Urea is the main nitrogenous synthetic fertilizer used in the agriculture sector of the country. The IPCC default value of 0.2 tonnes of carbon per tonne of urea was used in the calculations. Table 2.23 shows the growth of CO_2 emission from urea application in rice fields, tea plantations and other crops. The highest share (72%) in 2010 came from rice fields, 21% from tea plantations and the remaining 7% was applied on other crops. Emissions from the urea application in rice and tea cultivation showed a growth of 69% while application in other crops showed 46% decrease and the total emission showed 57% growth from 2000 to 2010 (Table 2.23).

Table 2.21 Emissions of non-CO_2 GHGs and precursors from field biomass burning

Year	Area Burnt (ha)	Emission Gg/yr				
		CH_4	N_2O	CO	NO_x	CO_2-eq
2000	624,096	1.35	0.04	45.93	1.25	39.33
2001	557,840	1.21	0.03	41.06	1.12	35.08
2002	601,604	1.3	0.03	44.28	1.27	37.68
2003	648,864	1.4	0.04	47.76	1.3	40.75
2004	551,261	1.19	0.03	40.57	1.1	34.77
2005	677,201	1.46	0.04	49.84	1.36	42.65
2006	666,465	1.44	0.04	49.05	1.33	41.86
2007	594,542	1.28	0.03	43.76	1.18	37.36
2008	765,504	1.66	0.04	56.34	1.53	48.18
2009	698,865	1.51	0.04	51.44	1.4	44.15
2010	771,228	1.67	0.04	56.76	1.54	48.37

Table 2.22 CO_2 emission from limestone and dolomite applications in cropland

Year	Quantities of applied limestone (tonnes)	Emissions from the application of limestone (Gg CO_2)	Quantities of applied Dolomite (tonnes)	Emissions from the application of Dolomite (Gg CO_2)	Total (Gg CO_2)
2000	10000	4.4	31,940	15.22	19.62
2001	10000	4.4	39,143	18.66	23.06
2002	10000	4.4	35,192	16.77	21.17
2003	10000	4.4	36,631	17.46	21.86
2004	10000	4.4	16,100	7.67	12.07
2005	10000	4.4	35,161	16.76	21.16
2006	10000	4.4	68,032	32.43	36.83
2007	10000	4.4	71,722	34.19	38.59
2008	10000	4.4	61,152	29.15	33.55
2009	10000	4.4	103,307	49.24	53.64
2010	10000	4.4	68,586	32.69	37.09

Table 2.23 CO_2 emission from Urea application in rice, tea and other crops

Year	Urea applied to rice fields (tonnes)	Emission from rice fields (Gg CO_2)	Urea applied to tea lands (tonnes)	Emission from tea lands (Gg CO_2)	Urea applied other croplands (tonnes)	Emission from other croplands (Gg CO_2)	Total Emission (Gg CO_2)
2000	177,729	130.33	58,000	42.53	27,800	20.39	193.25
2001	192,718	141.33	59,000	43.27	31,600	23.17	207.77
2002	233,739	171.41	61,000	44.73	31,100	22.81	238.95
2003	202,000	148.13	59,000	43.27	27,000	19.80	211.20
2004	222,000	162.80	71,000	52.07	30,000	22.00	237.87
2005	266,000	195.07	76,000	55.73	29,000	21.27	272.07
2006	265,000	194.33	56,000	41.07	24,000	17.60	253.00
2007	244,000	178.93	58,000	42.53	18,000	13.20	234.66
2008	359,000	263.27	65,000	47.67	15,000	11.00	322.94
2009	251,000	184.07	112,000	82.13	14,000	10.27	276.47
2010	300,251	220.18	98,000	71.87	15,000	11.00	303.05

2.8.1.6 Nitrous Oxide emissions from managed soils

Nitrous Oxide emissions from managed soils comprised both direct and indirect emissions. The direct emissions include those from nitrogen (N) inputs (i.e. synthetic fertilizers and organic N additions, including the annual input of manure N, N inputs from N-fixing and non-N fixing crop residues, N in mineralized soil organic matter causing an annual carbon loss), managed organic soils and direct emissions from urine and dung inputs from grazing animals. Indirect emissions include the N_2O emissions from atmospheric deposition of N volatized from the N inputs added on managed soils and emissions due to any N leached/runoff from managed soils.

Tier-I methodology of 2006 IPCC-GL and default emission factors were used in estimating direct and indirect emissions. Direct emissions from N inputs were estimated separately for flooded rice and other croplands, and then added together. Direct emissions from managed organic soils, the urine and dung deposited on pasture, range, and paddock and indirect emissions from N inputs were estimated according to 2006 IPCC-GL. Managed soils in the country included both mineral soils and organic soils. Since it is difficult to obtain the amounts of applied quantities of organic manure to managed soils, several assumptions were made. The amounts of dung/droppings per head per day from each category of animals were assumed (i.e. poultry 0.05 kg, cattle and buffalo 25 kg, swine 7 kg and goat 3 kg) and converted to respective dry weight. The corresponding values of total N applied were calculated based on N content and total number of animals. The direct application of N consists of chemical fertilizer and manure from chicken, ducks and swine were assumed. Also, N from paddy straw and leguminous crops was used to calculate the N application from crop residues, and the value of 20 kg N ha^{-1} was used in calculating total N application from legume crops.

The highest direct N_2O emission was estimated as 2,049 Gg CO_2-eq/yr in 2010 and the lowest was estimated for 2004 (1,813 Gg CO_2-eq/yr). Indirect N_2O was lower than that of direct emission and the highest estimated emission was 1,234 Gg CO_2-eq/yr (2010) while the lowest was 934 Gg CO_2-eq/yr 2001.

Urine and dung inputs from livestock (cattle, buffalo, goat and sheep) on grazed soils were considered in calculating the direct N_2O emissions, whereas manure from poultry and piggery were considered for direct emissions from manure application (Table 2.24).

Table 2.24 Direct and indirect N_2O emissions from managed soils and manure in Gg N_2O/yr

Category	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Direct-soil	6.33	6.32	5.88	5.98	5.85	6.16	6.02	6.48	6.37	6.29	6.61
Indirect-soil	3.08	3.01	3.2	3.3	3.11	3.62	3.36	3.21	3.99	3.7	3.98
Manure	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03
Total	**9.43**	**9.35**	**9.1**	**9.3**	**8.98**	**9.8**	**9.41**	**9.72**	**10.39**	**10.02**	**10.62**

2.8.1.7 Consolidated emissions for the agriculture sector

The consolidated inventory estimates for the year 2010 is provided in Table 2.25. The largest share of CH_4 emissions came from enteric fermentation.

Table 2.25 Consolidated emissions from agriculture sector in 2010

GHGs Sources Categories			CO_2 Gg	CH_4 Gg	N_2O Gg	CO Gg	NO_x Gg
3	**Agriculture**		**340.14**	**136.23**	**10.66**	**56.76**	**1.54**
	3A1	Enteric fermentation		69.28			
	3A2	Manure management		6.79			
	3C1	Field biomass burning		1.67	0.04	56.76	1.54
	3C2	Liming	37.09				
	3C3	Urea application	303.05				
	3C4	Direct N_2O emission from managed soil			6.61		
	3C5	Indirect N_2O emissions from managed soil			3.98		
	3C6	Indirect N_2O from manure management			0.03		
	3C7	CH_4 emissions from rice cultivation		58.49			

2.8.2 Land Use, Land Use Change and Forestry (LULUCF)

This section mainly consists of the change in carbon stocks in living biomass in forests (gain and loss of biomass), dead organic matter, forest soils, harvested wood products, forest fires and carbon stock change in croplands. Under the other land use related emissions, CO_2 emissions relevant to biomass, crop lands, grasslands, wetlands, settlements and other lands etc.

Carbon dioxide emissions relevant to biomass, dead organic matters and soil carbon stock changes in forest and croplands, and CO_2 and non-CO_2 emissions from other land uses due to human influence were estimated under the land use related emissions. In addition, emission estimates of methane, N_2O and other emissions such as nitrogen oxide and carbon monoxide due to forest fires are provided.

GHG emission for different sub categories under LULUCF were estimated following the 2006 IPCC-GL and IPCC GPG-LULUCF (IPCC, 2003). Required data for emission calculation were mainly obtained from the national reports (annual, periodic and non-periodic) of relevant ministries, the Department of Census and Statistics, Central Bank of Sri Lanka, Forest Conservation Department, State Timber Corporation, Land Use Policy Planning Department, Research Institutions and universities. Further, required data were collected at districts level and aggregated appropriately to derive the final estimates.

Forest plantations less than 20 years old were taken as land converted to forestlands. Existing natural forest areas and the plantation areas established 20 years prior to the inventory year (2010) were considered as forestland remaining forestland. It was assumed that there is no carbon stock change in the undisturbed natural forest areas and the inventory estimations were made only for forest plantations and the restored degraded forest areas. The extent and quantities of the above categories and related GHG emission are comprehensively described in following sections.

2.8.2.1 Change in carbon stocks in living biomass in forests

Carbon stock changes in living biomass include the annual biomass gain in forests due to growth (both above-ground and below-ground) and any losses due to timber and fuelwood harvesting and disturbances. Overall, there was a net carbon sink of 2,706 Gg CO_2 in the living forest biomass in 2010 in Table 2.26.

a. Gain in carbon stocks in living biomass due to growth

In estimating the carbon gain in biomass, the values for annual net increment in volume and basic wood density were extracted from the GPG-LULUCF (IPCC, 2003). For the species that did not have default values indicated in the 2003 IPCC-GL, average values for the relevant genus was considered. IPCC default values for tropical forests was considered for the Biomass Expansion Factor (BEF_1) and below-ground biomass to above-ground biomass Ratios (R). The fraction of carbon in biomass was assumed to be 0.47 based on the 2006 IPCC-GL.

When there were no data on the age of forests, it was assumed that such land belonged to the category of Forest Land Remaining Forest Land. Based on the 2006 IPCC classification, forest lands located in the dry and intermediate zones in Sri Lanka were considered as Tropical Moist Climate; the forest land located in the wet zone were considered as Tropical Wet Climate.

b. Losses in biomass carbon stocks

Carbon losses due to wood removal, fuelwood removal and disturbances were calculated using 2006 IPCC-GLs and GPG-LULUCF (IPCC, 2003). Due to a moratorium imposed on logging inside natural forests since 1990 (Bandaratilake, 2001), the contribution of natural forests toward meeting the country's timber demand has been negligible. Hence, no estimates of timber removal were made under the natural forest category. Although the projected timber volumes for the inventory period are available in the Forestry Sector Master Plan (Ministry of Agriculture, Lands and Forestry, 1995), the present timber supply from forest plantations is much lower than the projected figures in the Forestry Sector Master Plan (Ruwanpathirana, 2011). In estimating the carbon loss in wood removals, Equation 2.12 in 2006 IPCC-GL was used with harvested wood volumes by species; the Biomass Conversion and Expansion Factor for Removals ($BCEF_R$; 2006 IPCC-GL), was replaced with the default values for Biomass Expansion Factor (for removals; BEF_2) and the density given in the GPG-LULUCF (IPCC, 2003). The R (Root to Shoot Ratio) values were extracted from GPG-LULUCF (IPCC, 2003) as well. For the recorded volumes without species, an average wood density of 0.55 tonnes dry matter (dm) m^{-3} was assumed.

Losses of biomass carbon in forest fires were considered under the losses due to disturbances. Although there are no significant threats to natural vegetation from forest fires. Forest fires are significant in forest plantations, especially in Pine and Eucalyptus plantations (Ariyadasa, 2002). Since, these fires are almost short-term surface fires, no impact on the below-ground biomass was assumed from fire, thus making R (Equation 2.14; 2006 IPCC-GL) equal to zero. The fraction of biomass left to decay was taken as 0.5 (2006 IPCC-GL).

Carbon stock change resulting from annual biomass gain and removals in living biomass (considering both the above-ground and below-ground biomass) for forestland during the period of 2000-2010 are given in Table 2.26. The estimates for the period of 2000-2010 showed that forest biomass has been acting as a net carbon sink (Table 2.26). However, a clear trend of declining the CO_2 sink over time was evident, as well as a similar gradual decline in the CO_2 gain by the forest biomass was also evident in Figure 2.7, indicating the need for further restoration of forests and reforestation.

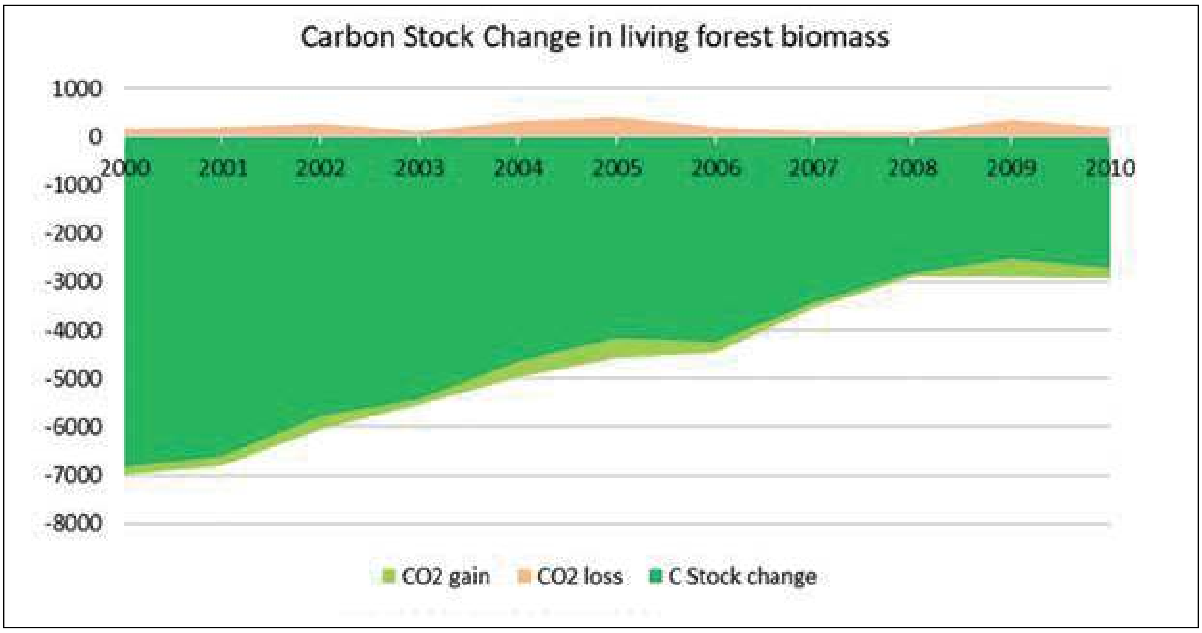


Figure 2.7 Carbon gain and net carbon stock change in living forest biomass (Gg CO_2), 2000-2010

2.8.2.2 Carbon stock change in dead organic matter and soil carbon in forest land

a. Carbon stock change in Dead Organic Matter (DOM)

Dead Organic Matter (DOM) and soil carbon in forest land comprises of dead wood and forest litter. Annual carbon stock change in dead wood pool depends on the carbon inputs from any biomass left from the removed harvests, natural mortality and biomass killed by fire or other disturbances, and carbon release from decay process. Annual changes in the litter stocks in forest floor also contribute to the overall stock change in the forest DOM.

According to the Tier-1 methodology under 2006 IPCC-GL, it is assumed that the DOM carbon stock in Forestland Remaining Forestland (i.e. remaining as forestland for over 20 years) is in equilibrium with no change over time. Therefore, only DOM in land converted to forest lands (i.e. forest plantations younger than 20 years) was estimated. The Tier-1 method assumes that all carbon contained in biomass is emitted directly to the atmosphere during a land-use conversion event and none is added to dead wood and litter pools. Therefore, carbon addition was not considered for the dead and litter pool from a disturbance. Based on the Tier-1 methodology and emission factors given in Table 2.2 of 2006 IPCC-GL, estimates were made for the litter pool excluding fine woody debris with <10 cm diameter; litter carbon stock/s relevant to tropical broadleaf forests (i.e. 2.1 tonnes C ha^{-1}; 2006 IPCC-GL) were used. The net carbon stock change in DOM in forestland is given in Table 2.27.

Table 2.26 Annual carbon stock change in living forest biomass in Gg CO_2

Carbon exchange in Gg CO_2	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Carbon gain in forest biomass											
Land converted to forestland in DZ & IZ	-2453.59	-2084.43	-1795.62	-1387.19	-1087.99	-789.07	-630.09	-325.25	-636.71	-304.14	-262.61
Forestland remaining forestland in DZ & IZ	-893.17	-1367.72	-1067.59	-1151.9	-1181.7	-1234.62	-1268.9	-1295	-334.86	-637.35	-648.61
Enrichment planting in DZ & IZ	-	-	-	-	-	-	-	-	-	-	-5.8
Land converted to forestland in WZ	-2634.91	-2270.22	-2026.87	-1743.37	-1341.64	-1105.88	-1090.76	-373.26	-1623.24	-245.29	-219.65
Forestland remaining forestland in WZ	-1002.11	-1074.1	-1154.44	-1234.93	-1329.88	-1392.2	-1452.8	-1554.98	-305.96	-1694.73	-1721.16
Enrichment planting in WZ	-0.36	-0.726	-5.14	-6.87	-25.41	-37.25	-	-	-	-	-54.33
Total CO_2 gain	**-6984.1**	**-6797.2**	**-6049.7**	**-5524.3**	**-4966.6**	**-4559**	**-4442.6**	**-3548.5**	**-2900.8**	**-2881.5**	**-2912.2**
Carbon loss in wood removal											
Plantations < 20yrs	46.24	40.02	62.81	14.74	59.45	38.16	56.99	44.44	33.02	13.67	5.76
Plantations >20 yrs	45.41	24.32	33.55	2.98	29	23.72	25.24	19.18	19.18	145.82	18.27
Carbon loss in fuel wood removal											
Plantations < 20 yrs	14.84	30.78	20	23.18	29.36	15.32	19.93	14.83	11.27	23.48	29.15
Plantations > 20 yrs	46.06	26.88	20.66	23.95	27.31	22.57	18.53	9.99	9.99	21.84	25.83
Carbon loss in disturbances (i.e. forest fires)											
Plantations < 20 yrs	5.58	80.14	139.45	44.98	177.85	304.69	71.65	27.47	12.07	163.68	127.2
Total CO_2 loss	**158.13**	**202.14**	**276.47**	**109.83**	**322.97**	**404.46**	**192.34**	**115.92**	**85.53**	**368.49**	**206.21**
Carbon stock change ($GgCO_2$)	**-6826**	**-6595.1**	**-5773.2**	**-5414.4**	**-4643.6**	**-4154.6**	**-4250.2**	**-3432.6**	**-2815.2**	**-2513**	**-2706**

*'-'Indicates uptake/removals, and '+' (denoted with no sign) indicates emission to the atmosphere; DZ=Dry Zone; IZ=Intermediate Zone;
WZ= Wet Zone

b. Carbon stock change in forest soils

Carbon stock changes in mineral soils were estimated under this category. As mentioned above, it was assumed that the soil carbon in Forestland Remaining Forestland (i.e older than 20 years) is in equilibrium. Therefore, the soil carbon exchange was calculated only for the land converted to forestland. Since there are hardly any managed organic soils (12-20% or more organic matter by mass; IPCC, 2006) in forests, soil carbon stock changes were estimated only for the mineral soils in Land Converted to Forestland. The land use prior to conversion was considered as degraded/abandoned cropland that had low input and intensive management. Considering the existing soil conditions in the country, a default reference carbon stock of 47 tonnes C ha^{-1} (in a depth of 0-30 cm; IPCC, 2006) for tropical moist Low Activity Clay (LAC) soils were considered for all three climatic zones in Sri Lanka. Net carbon change in soil carbon in forestland is depicted in Table 2.27. The DOM and soil carbon in forestland were a net sink over the period of 2000-2010.

c. Carbon stock changes in harvested wood products

Harvested Wood Products (HWP) include all wood materials (including bark) that remain in harvested sites (IPCC, 2006). The methodology includes the HWP inputs from what is produced within the country, imports/ exports and any loss of carbon due to decay of the existing HWP, taking the production information from several decades ago (extrapolated to the beginning of the last century). Emissions from harvested wood products were not estimated due to lack of data.

2.8.2.3 Non-CO_2 emissions due to forest fires

Non-CO_2 emissions due to forest fires were estimated for this inventory. Overall emissions from forest fires include CO_2 and other GHG emissions resulting from incomplete combustion of forest materials. Out of these non-CO_2 GHG emissions, methane, carbon monoxide, nitrous oxide and nitrogen oxide were estimated using 2006 IPCC methodology. Default values given for secondary tropical forests: mass of fuel available for combustion ($M_B = 180$), combustion factor ($C_f = 0.55$) and emission factors (CO-104, CH_4-6.8, N_2O-0.2 and NO_x-1.6) were considered. The non-CO_2 emissions from forest fires were relatively low. Carbon monoxide was the highest emission. Then non-CO_2 emissions for 2000-2010 are given in Table 2.2

Table 2.27 Carbon stock change in DOM and mineral soil in Gg CO_2

Type	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total land area converted to forestland (ha)	134,436.8	116,251.2	103,381.3	84,025.9	65,295.9	49,913.3	46,846.68	35,325	31,779.2	26,969.82	24,198.71
Carbon stock change in Dead Organic Matter	**-51.75**	**-44.76**	**-39.8**	**-32.35**	**-25.14**	**-19.22**	**-18.03**	**-13.6**	**-12.23**	**-10.38**	**-9.32**
Area converted to forestland in DZ and IZ (ha)	62,867.7	52,942.7	45,906.8	36,283.4	28,983.4	21,603	18,199.88	16,705.15	15,326.05	14,912.86	13,429.65
Carbon stock change in Soil carbon- DZ and IZ	**-302.49**	**-254.74**	**-220.88**	**-174.58**	**-139.45**	**-103.94**	**-87.57**	**-80.38**	**-79.16**	**-71.75**	**-64.62**
Area converted to forestland in Wet Zone (ha)	71,569.1	63,308.5	57,474.5	47,742.5	36,312.5	28,310.3	28,646.8	18,619.85	16,453.15	12,056.96	10,769.06
Carbon stock change in Soil carbon -WZ	**-344.36**	**-304.61**	**-276.54**	**-229.72**	**-174.72**	**-136.22**	**-137.84**	**-89.59**	**-73.74**	**-58.01**	**-51.82**
Total stock change	**-698.6**	**-604.11**	**-537.22**	**-436.65**	**-339.31**	**-259.38**	**-243.44**	**-183.57**	**-165.13**	**-140.14**	**-125.76**

Table 2.28 Non-CO_2 emissions from forest fires

GHG and precursors from forest fires	Emissions in Gg										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Area Burnt (ha)	36	516.7	899.1	290	1146.7	1964.5	461.9	177.1	77.8	1055.3	820.1
CO	0.37	5.32	9.26	2.99	11.81	20.23	4.76	1.82	0.80	10.86	8.52
CH_4	0.02	0.35	0.61	0.19	0.77	1.32	0.31	0.12	0.05	0.71	0.55
N_2O	0.00	0.01	0.02	0.01	0.02	0.04	0.01	0.00	0.00	0.02	0.02
NO_x	0.01	0.08	0.14	0.05	0.18	0.31	0.07	0.03	0.01	0.17	0.13

2.8.2.4 Carbon stock change in croplands

a. Crop lands remaining crop land

Only perennial crops were considered for calculation of annual change of carbon stocks in the crop lands. Emissions from the main perennial crops such as tea, rubber, coconut were estimated. The emissions from other perennial export crops were estimated as a separate category (Table 2.29). Although there is a significant land area reported for other horticultural crops, they were not considered due to unavailability of exact areas and data on biomass removal from these land uses category.

Land extent under tea was grouped into low-, mid-, and up-country tea. The land extents for tea in 2010 was 101,225 ha, 65,458 ha and 37,916 ha respectively. In Sri Lanka, all the tea growing regions are considered under the tropical wet climate. Net carbon stock changes for tea and rubber were estimated using respective default emission factor given under 2006 IPCC-GL for Tier-1 methodology (Table 2.29). Rubber are replanted once in 30 years and a considerable amount of biomass is removed when the entire rubber plantation is uprooted and removed. Since these are mature trees, a default sequestration factor of 50kg C ha^{-1} (IPCC, 2006) was used in calculation of the carbon removed by the uprooting for replanting. In calculating carbon assimilation, the default value for tropical wet condition (i.e. 10 tonnes C ha^{-1}/yr) was used (IPCC, 2006).

As per the Agriculture Census in 2002 and 2013, the extent of coconut cultivation shows 394,836 ha and 440,451 ha respectively. A consolidated average extent over a 5 year period (i.e. 20,734 ha) was used throughout the reporting period as the area under young coconut (< 5 years).

However, there is no data available on biomass removal from mature coconut plantations (total trunk removal). Due to lack of data, area under the mature coconut plantation was not considered for calculation of change in biomass carbon stocks. In calculating the carbon assimilation, the default value for tropical wet condition was used (IPCC, 2006).

b. Home gardens as Cropland Remaining Cropland

Home gardens are a mixed perennial cropping system that provide food, fruits, timber, spices and medicinal herbs. According to the estimates of the Forestry Sector Master Plan- FSMP (MALF, 1995), home gardens covered about 858,000 ha in 1992 and the extent has been increased by 1% annually. Since there is no proper data available for the inventory period, the above assumption based on the FSMP was used to derive the area under home gardens for the period considered in this report.

According to the FSMP estimates, home gardens provide about 0.95 m^3 of sawn logs and 0.5 m^3 of poles per ha per year, or about 41% of national saw logs and 26% of the biofuel demand (MALF, 1995).

The Tier-1 emission factor in 2006 IPCC-GL was used for calculating the biomass gain. In estimating the biomass removal, a wood density of 0.54 g/cm^3 and biomass expansion factor of 3.4 was considered along with relevant data for fuel wood and timber removals, as given in the FSMP. A 10% increase in carbon gain and a 6.3% increase in carbon loss was observed for the country giving a net increase in the carbon gain from 1,245.71 to 2,029.12 Gg from 2000 to 2010 (Table 2.30).

Table 2.29 Net carbon stock change (CO_2 Gg /yr) in cropland remaining cropland and land converted to cropland

Cropping system	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Tea	-5586.3	-5576.30	-5538.32	-5460.64	-5505.45	-6385.87	-6515.52	-6321.06	-6380.81	-6328.58	-6175.69
Rubber	-4805.90	-4822.01	-3699.03	-4018.69	-3849.98	-3601.00	-3752.02	-3434.50	-3364.47	-3394.38	-3520.81
Coconut (< 5 years)	-760.94	-760.94	-760.94	-760.94	-760.94	-760.94	-760.94	-760.94	-760.94	-760.94	-760.94
Other perennial crops	-3366.25	-3361.11	-3214.45	-3065.96	-3057.84	-2884.97	-2914.26	-3062.89	-3391.95	-3463.96	-3551.61
Home gardens	-1245.71	-1316.15	-1388.15	-1461.19	-1534.83	-1610.05	-1691.39	-1774.34	-1857.93	-1942.69	-2029.12
Total	**-15765.1**	**-15836.5**	**-14600.9**	**-14767.4**	**-14709**	**-15242.8**	**-15634.1**	**-15353.7**	**-15756.1**	**-15890.6**	**-16038.2**
Biomass	73.00	72.01	103.10	135.09	74.76	140.82	247.06	295.84	413.87	250.48	375.99
Soil Carbon	1.96	1.96	2.71	2.71	2.01	3.79	6.67	7.98	11.18	6.75	10.14
Total	**74.96**	**73.97**	**105.81**	**137.8**	**76.77**	**144.61**	**253.73**	**303.82**	**425.05**	**257.23**	**386.13**

Table 2.30 Annual carbon stock change in home gardens in CO_2 Gg/yr

Carbon gain and loss	CO_2 Gg/yr	
	2000	2010
Home gardens in dry & intermediate zone	- 4,604.68	-5,086.44
Home gardens in wet zone	- 14,490.26	-16,006.27
Total CO_2 gain	**- 19,094.94**	**-21,092.71**
Carbon loss from timber logs and poles	3,626.14	4,005.52
Carbon loss due to fuelwood	14,223.09	15,058.07
Total CO_2 loss	**17,849.23**	**19,063.59**
Carbon stock change	-1,245.71	- 2,029.12

There is no significant change in the area under annual crops in the recent past. In addition, there is no significant change in soil carbon content in the croplands that have remained as croplands for over 20 years. Therefore, no change in soil carbon stocks for cropland remaining cropland was observed.

c. Land Converted to Cropland

No significant conversion of other land uses to agriculture lands was observed during the reporting period. However, new planting areas of tea, rubber and cinnamon were reported. During the inventory preparation, these new planting areas were considered as cleared shrub lands. Therefore, considering the above assumption, carbon stock changes of biomass and soil were calculated using emission factors of 2006 IPCC-GL (Table 2.30). The proportion of carbon stock change associated with this conversion of the shrub land to new planting areas was found to be very insignificant.

2.8.2.5 Grasslands

There is no specific information on the extent of the land converted to grassland. 33,306.56 ha of grasslands were considered as grasslands remaining grassland and assumed to be at steady state with no net charge in biomass carbon stocks where carbon accumulation through plant growth balances the losses through grazing, decomposition and fire. Following the Tier-1 methodology of 2006 IPCC-GL for carbon stock changes in biomass and DOM were not estimated, assuming they are at equilibrium (IPCC, 2006). Emissions from burning of grasslands/savannas were not estimated here separately as both forests and grasslands were considered under forest fires.

2.8.2.6 Wetlands

According to the Ramsar definition, the wetlands in Sri Lanka can be categorized as inland natural freshwater, marine & salt water and man-made wetlands. In this section, only the emissions from managed and man-made wetlands that are relevant to anthropogenic activities were considered. Of the total peatland area of 2,500 ha in the country, a large extent remains permanently flooded. Only a few higher dry ground areas are developed for cultivation. The use of peat in horticulture or any other purpose is not a common practice in Sri Lanka. Thus, on-site CO_2 and non-CO_2 emissions from managed peatlands due to peat extraction were not estimated.

The statistics of the Survey Department indicate that the wetland extent of the country's tanks and reservoirs in 2010 was 139,033.5 ha. This was considered as the flooded land remaining flooded land, in the emission calculation. In estimating the CH_4 emissions from flooded land remaining flooded land, Tier-I method of 2006 IPCC-GL was used, with an emission factor of 0.095kg CH_4 ha^{-1}day^{-1} (i.e. the estimated mean value for the tropical climates). The total CH_4 emissions from flooded land remaining flooded (i.e. major reservoirs) was estimated at 4.82 Gg CH_4 /yr. Emissions from land converted to wetlands (such as seasonal tanks) were not estimated as there were no clear records available for the period of 2000 to 2010.

2.8.2.7 Settlements and other lands

The carbon stock changes in biomass, DOM and soil in the land remaining in settlements and other lands (i.e. lands with bare soil, rock etc.,) or the land converted to those land use categories were not estimated due to lack of relevant data availability.

2.8.2.8 Consolidated emissions and removals for LULUCF

The consolidated emissions and removals for the forestry and other land use sector for 2010 is presented in Table 2.31.

Table 2.31 Consolidated emissions and removals of forestry and other land use sector, 2010

GHGs Sources and Sink Categories			CO_2 emissions* (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_x (Gg)
3	**Forestry and Other Land Use Sector**		**21,342.4**	**- 39,826.3**	**5.37**	**0.02**	**8.44**	**0.13**
	3B1a	Forestland remaining Forestland	44.1	- 2,429.9				
	3B1b	Land converted to Forestland	162.11	- 608.22				
	3B2a	Cropland remaining cropland	20,750.06	- 36,788.21				
	3B2b	Land converted to cropland	386.13					
	3B4a	Wetland remaining wetland			4.82			
	3C1a	Biomass burning in forest land			0.55	0.02	8.44	0.13

* Total CO_2 emissions are lower than the emissions from biomass burnt, reported under the energy sector where the total emissions are derived from sustainable and unsustainable (i.e. illegal felling) biomass sources with no proper source categorization and it is a high uncertainty.

2.9 Waste sector

The waste sector releases CO_2, CH_4 and N_2O gases from solid waste disposal, biological treatment of solid waste, incineration, open burning of waste and wastewater treatment and discharge (IPCC, 2006). Solid waste disposal is commonly carried out through land filling, composting, incineration and conversion of waste to energy. The most common GHG produced from Municipal Solid Waste (MSW) disposal in Solid Waste Dumping Sites (SWDSs) is methane. In addition, CO_2 and NMVOCs as well as small amounts of N_2O produce in the disposal sites. The primary source of CO_2 from waste is the decomposition of organic matter derived from biomass sources. Based on 2006 IPCC-GL, CO_2 emission from biogenic waste was not considered under the waste sector.

The solid waste generated in the country usually includes MSW, industrial, commercial, health care and other waste such as sludge and e-waste. MSW generally refers to the waste collected by municipalities or other local authorities. The sludge refers to the waste generated from various wastewater treatment processes and it mainly includes biological and chemical sludge. Most of the chemical sludge generated from industrial wastewater treatment and biological sludge generated from health care wastewater treatment fall under hazardous waste category, as per Sri Lanka's regulations on waste management.

The most common form of MSW disposal taken place in the country during the period of 2000-2010 is the open dumping on uncontrolled SWDSs and in low lying areas and informal burning in the absence of sanitary landfills or fully engineered landfills in the country. In the areas where there were no SWDSs managed by the local authorities, waste disposal was carried out mainly on open lands, low lying areas and through open burning. Only a small portion of waste was composted and used for biogas generation. In addition, disposal of hazardous waste generated from different activities such as healthcare, wastewater treatment and other industrial activities has taken place through incineration in some establishments (using incinerators dedicated for waste destruction) and co-processing in the cement kiln at Puttlam Cement Works (PCW) at a limited level.

2.9.1 Emissions from solid waste disposal

During the period of 2000-2010 waste management was not appropriately organized due to lack of suitable waste disposal facilities in the country whereas six uncontrolled SWDSs were in operation. The prevalent method of waste disposal in Sri Lanka is open dumping accounting for more than 85% (AIT, 2014). Thus, the recorded data on waste disposal were also available only for few years, and not for all the years from 2000-2010.

The MSW database (MENR, 2005) indicates that the average MSW collection in 1998 was 2,544 tons and 2004 was 2,838 tons per day. The estimated amount of average MSW collected across the country in the year 2010 (estimated based on the past data available) was about 3,365 tons per day.

The waste generated by 46.9% of the country is burnt openly and the majority of population are not served by waste collection facilities (DCS, 2012). For the purpose of preparation of this inventory, the category of SWDSs available in the country was considered as unmanaged, shallow type SWDSs.

The estimated methane emission in SWDSs during the period of 2000-2010 shows an increase from 6.70 Gg/yr to 11.03 Gg/yr of CH_4 in Table 2.32.

Table 2.32 CH_4 emission in Gg/yr from the disposal of MSW in SWDSs

Year	MSW Disposed to SWDSs (Mil. tonnes/yr)	CH_4 Correction Factor	Fraction of Degradable Organic Content which actually degrades	CH_4 emission from SWDSs	
				CH_4 (Gg/yr)	CO_2-eq (Gg/yr)
2000	0.136	0.6	0.77	6.70	140.70
2001	0.139	0.6	0.77	6.84	143.64
2002	0.142	0.6	0.77	6.97	146.37
2003	0.144	0.6	0.77	7.11	149.31
2004	0.147	0.6	0.77	7.25	152.25
2005	0.207	0.6	0.77	10.20	214.2
2006	0.210	0.6	0.77	10.37	217.77
2007	0.214	0.6	0.77	10.53	221.13
2008	0.217	0.6	0.77	10.70	224.7
2009	0.221	0.6	0.77	10.87	228.27
2010	0.224	0.6	0.77	11.03	231.63

2.9.2 Emissions from biological treatment of solid waste

The most widely practice method of treatment of readily biodegradable organic waste is composting in Sri Lanka. The windrow composting was the most widely used in the processing of MSW and about 5% of the collected MSW are processed in various households and central composting systems (AIT, 2014). Anaerobic digestion was practiced in a few places on an individual basis for biogas generation.

Composting of waste material is an aerobic process and it converts large fraction of Degradable Organic Carbon (DOC) in the material into CO_2. Inside the anaerobic portions of the compost pile CH_4 is formed and released in small quantities. Composting produces N_2O emissions in small amounts depending on the nitrogenous compounds contained in the waste, which has been considered in the emission calculations.

The estimated emission of CH_4 and N_2O from composting of readily biodegradable MSW for the period of 2000-2010 shows an increase from 2.34 Gg/yr to 3.10 Gg/yr of CH_4 and 0.14 Gg/yr to 0.19 Gg/yr of N_2O respectively. The default emission factors used for these estimates are 0.24g N_2O/kg for nitrous oxide and 4g CH_4/kg for methane (Table 2.33).

Table 2.33 CH_4 and N_2O emissions in Gg/yr from composting of MSW

Year	Mass of Organic Waste composted (Kg '000)	Composted			
		CH_4 (Gg)	CO_2 -eq (Gg)	N_2O (Gg)	CO_2-eq (Gg)
2000	584.91	2.34	49.14	0.14	43.40
2001	595.89	2.38	49.98	0.14	43.40
2002	606.87	2.43	51.03	0.15	46.50
2003	617.84	2.47	51.87	0.15	46.50
2004	628.82	2.52	52.92	0.15	46.50
2005	690.24	2.76	57.96	0.17	52.70
2006	711.28	2.85	59.85	0.17	52.70
2007	732.32	2.93	61.53	0.18	55.80
2008	753.37	3.01	63.21	0.18	55.80
2009	774.41	3.10	65.1	0.19	58.90
2010	764.09	3.18	66.78	0.19	58.90

2.9.3 Emissions from incineration and open burning of solid waste

As a result of unavailability of incineration facility for solid waste and hazardous waste including pharmaceutical waste, waste oil and industrial sludge, data for GHG emission calculation were not available for the period of 2000-2010.

Open burning is the most commonly practices method of disposal of MSW in rural areas and sub urban areas where there are no proper waste management facilities available. In addition, open burning of dry waste including yard trimming are practiced in the urban areas too.

The estimated emission of CH_4, N_2O and CO_2 from open burning of MSW during the period of 2000-2010 shows an increasing trend from 0.56 Gg/yr to 0.81 Gg/yr of CH_4, 0.01 Gg/yr to 0.02 Gg/yr of N_2O and 96.39 Gg/yr to 122.78 Gg/yr of fossil CO_2 (Table 2.34). The default emission factors used for estimating methane (6,500 gCH_4/tonne) and nitrous oxide (150 gN_2O/tonne) of waste quantity.

Table 2.34 CH_4, N_2O and CO_2 emissions in Gg/yr from open burning of MSW during 2000-2010

Year	MSW (tonnes/yr)	CH_4	CO_2-eq	N_2O	CO_2-eq	CO_2
2000	86.00×10^3	0.56	11.76	0.01	3.1	96.39
2001	87.03×10^3	0.57	11.97	0.01	3.1	98.16
2002	88.07×10^3	0.57	11.97	0.01	3.1	99.94
2003	89.10×10^3	0.58	12.18	0.01	3.1	101.71
2004	90.13×10^3	0.59	12.39	0.01	3.1	103.49
2005	99.96×10^3	0.65	13.65	0.01	3.1	106.70
2006	104.92×10^3	0.68	14.28	0.02	6.2	109.92
2007	109.88×10^3	0.71	14.91	0.02	6.2	113.14
2008	114.85×10^3	0.75	15.75	0.02	6.2	116.35
2009	119.81×10^3	0.78	16.38	0.02	6.2	119.57
2010	124.77×10^3	0.81	17.01	0.02	6.2	122.78

The summary of the estimated emissions of CH_4, N_2O and CO_2 associated with MSW handling for the year 2010 is given in the Table 2.35.

Table 2.35 The summary of CO_2, CH_4 and N_2O emissions in Gg/yr from MSW handling

Year	Open burnt	Disposal Sites		Composted		Open burnt		Composted		Open burnt	
	CO_2	CH_4	CO_2-eq	CH_4	CO_2-eq	CH_4	CO_2-eq	N_2O	CO_2-eq	N_2O	CO_2 -eq
2000	96.39	6.70	140.70	2.34	49.14	0.56	11.76	0.14	43.40	0.01	3.10
2001	98.16	6.84	143.64	2.38	49.98	0.57	11.97	0.14	43.40	0.01	3.10
2002	99.94	6.97	146.37	2.43	51.03	0.57	11.97	0.15	46.50	0.01	3.10
2003	101.71	7.11	149.31	2.47	51.87	0.58	12.18	0.15	46.50	0.01	3.10
2004	103.49	7.25	152.25	2.52	52.92	0.59	12.39	0.15	46.50	0.01	3.10
2005	106.70	10.20	214.20	2.76	57.96	0.65	13.65	0.17	52.70	0.02	3.10
2006	109.92	10.37	217.77	2.85	59.85	0.68	14.28	0.17	52.70	0.02	6.20
2007	113.14	10.53	221.13	2.93	61.53	0.71	14.91	0.18	55.80	0.02	6.20
2008	116.35	10.70	224.70	3.01	63.21	0.75	15.75	0.18	55.80	0.02	6.20
2009	119.57	10.87	228.27	3.10	65.1	0.78	16.38	0.19	58.90	0.02	6.20
2010	122.78	11.03	231.63	3.18	66.78	0.81	17.01	0.19	58.90	0.02	6.20

2.9.4 Emissions from wastewater treatment and discharge

The sources of the wastewater generated in the country includes domestic, industrial and commercial. In urban areas where treatment plants are available, domestic wastewater including sewage are treated and discharged while pre-treated industrial wastewaters generated from the industries located in the industrial zones established under the Board of Investment of Sri Lanka (BOI) are disposed into the common treatment plants of the respective industrial zones.

In the rest of the urban areas, sewage generated is disposed into onsite septic tanks through water sealed latrines and the majority of domestic wastewater is disposed into soakage pits. Industries located in the non-industrial zones across the country are expected to treat their wastewater to comply with the effluent disposal standards stipulated by the respective regulatory authorities. CH_4 emissions from common treatment facilities were considered negligible as those are of aerobic biological treatments followed by simple chemical treatments.

In order to estimate GHG emissions of wastewater treatment of sugar and brewery were considered. In the estimation of CH_4 emission, the industry-specific activity data together with the respective default vales of maximum CH_4 producing capacity of 0.25kg CH_4/kg, Chemical Oxygen Demand (COD) and CH_4 Correction Factor (MCF) of 0.2 indicated in the 2006 IPCC-GL were used in the calculation of CH_4-EF for the treatment pathway.

The brewery industry considered for the GHG estimation treats its process wastewater using anaerobic digestion, and the emitted biogas is burnt in a flaring mechanism before releasing to the environment. Therefore, GHG emissions from the brewery industry was considered negligible.

The summary of emissions of CH_4 and N_2O associated with the treatment and discharging of wastewater for the period of 2000-2010 is given in the Table 2.36. The estimated emissions of CH_4 and N_2O associated with the treatment and discharge of domestic wastewater reported for the period of 2000-2010 showed an increase from 9.10 Gg/yr to 10.12 Gg/yr for CH_4. However, a decrease of CH_4 from 0.0034 Gg/yr to 0.0014 Gg/yr from industrial wastewater treatment is shown. The emissions of N_2O associated with domestic wastewater has increased from 0.6 Gg/yr to 0.84 Gg/yr. The N_2O emissions associated with industrial wastewater was insignificant.

Table 2.36 CH_4 and N_2O emissions from wastewater discharge in Gg/yr

Year	CH_4 emissions				N_2O emissions			
	Domestic WW Discharge		Industrial WW Treatment (Sugar)		Industrial WW Treatment		Domestic WW Discharge	
	CH_4	CO_2-eq	CH_4	CO_2-eq	N_2O	CO_2-eq	N_2O	CO_2-eq
2000	9.10	191.08	0.0034	0.0714	0.002	0.62	0.60	186.0
2001	9.19	193.08	0.0030	0.0630	0.002	0.62	0.62	192.2
2002	9.29	195.12	0.0017	0.0357	0.002	0.62	0.63	195.3
2003	9.39	197.19	0.0045	0.0945	0.002	0.62	0.65	201.5
2004	9.49	199.28	0.0022	0.0462	0.002	0.62	0.68	210.8
2005	9.59	201.40	0.0008	0.0168	0.002	0.62	0.71	220.1
2006	9.41	197.58	0.0009	0.0189	0.002	0.62	0.70	217.0
2007	9.80	205.75	0.0020	0.0420	0.002	0.62	0.72	223.2
2008	9.90	207.93	0.0024	0.0504	0.002	0.62	0.75	232.5
2009	10.01	210.18	0.0019	0.0399	0.002	0.62	0.76	235.6
2010	10.12	212.43	0.0014	0.0294	0.002	0.62	0.84	260.4

2.9.5 Consolidated emissions of the waste sector

The consolidated emissions for waste sector for 2010 is presented in the Table 2.37.

Table 2.37 Consolidated emissions of the waste sector in 2010

Waste Category No.	Waste Category	Net Annual Emissions (Gg)		
		CH_4	N_2O	Fossil CO_2
4	**Waste**	**25.14**	**1.052**	**122.78**
4A	Solid Waste Disposal on SWDSs	11.03	-	-
4B	Biological treatment of solid waste	3.18	0.19	-
4C	Open burning of Waste	0.81	0.02	122.78
4D	Wastewater treatment and discharge			
	Domestic wastewater discharge	10.12	0.84	-
	Domestic wastewater treatment (STP)	-	4.57×10^{-5}	-
	BOI Industry wastewater treatment	-	0.002	-
	Sugar industry wastewater treatment	1.44×10^{-3}	-	-

CHAPTER THREE

Vulnerability and Adaptation Measures

CHAPTER THREE
Vulnerability and Adaptation Measures

3.0 Introduction

Sri Lanka is in the frontline of climate change, frequently facing repetitive climate induced disasters with multiple impacts on economic development. A multitude of natural hazards such as droughts, floods, landslides, cyclones, storms and sea-level rise threaten the country. According to Desinventar database of Disaster Management Centre, Sri Lanka, around 15 million people have been affected by droughts (8,047,354), floods (7,187,921) and landslides (190,000) from 2008 to 2018 in Figure 3.1.

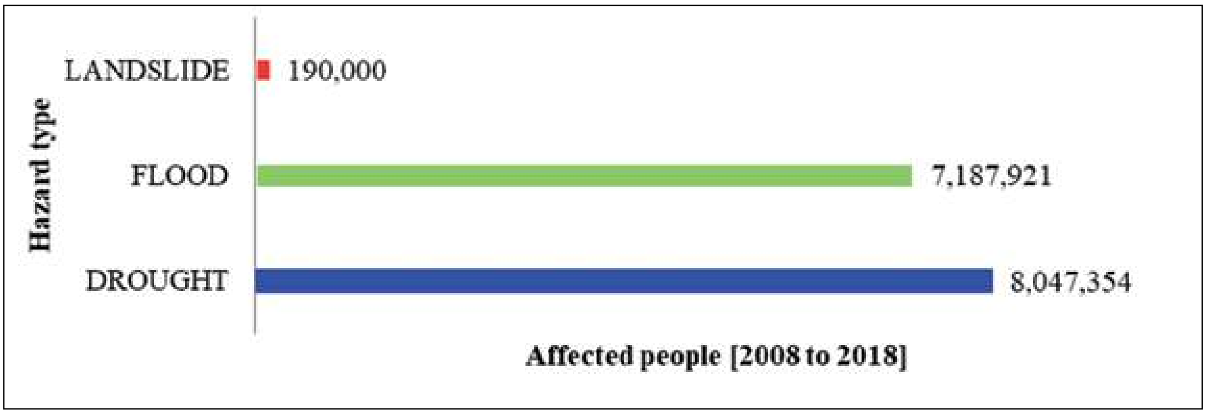


Figure 3.1 Number of affected people by droughts, floods, landslides (2008-2018)

The incidence of disasters caused by climate hazards has increased by 22 folds during the last decade compared to 1973-1983 (UNDRR, 2019). The post disaster needs assessments (PDNAs) in 2016 and 2017 estimated the loss and damage due to floods and landslides as the LKR 175 billion. The Global Climate Risk Index 2019 published by the Germanwatch has ranked Sri Lanka as the second most vulnerable country to extreme climatic events in the world (Eckstein et al., 2019). The World Bank estimates that 7.7% of GDP will need to be spent to manage climate related disasters by 2050 (WB and EU, 2017).

3.1 Scope

This chapter assesses climate change risks (present and predicted) posed by prevalent hazards which include floods, droughts, sea level rise and landslides in vulnerable sectors of agriculture, fisheries, livestock, water resources, health, biodiversity & ecosystems, coastal & marine, human settlements and tourism. These sectors are consistent with the Nationally Determined Contributions (NDCs) and National Adaptation Plan for Climate Change Impacts in Sri Lanka (NAP). A focus on the different climate risks in different administrative boundary levels provides an opportunity to propose appropriate, robust and flexible adaptation measures. Further, it enables an understanding of climate scenarios supporting to assess possible impacts and potential adaptation measures at national and sub-national levels. The methodology used to do so is described in 3.2.

3.2 Methodology

Identifying of risks and adaptation measures was a consultative process with the participation of sector experts and the officials of relevant institutions. The National Expert Committee on Climate Change Adaptation (NECCCA) as well an Independent Review Panel provided guidance during the assessment. The risk assessment was recommended and guided by the NECCCA, based on the methodology proposed by the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). The assessment examined:

1. **Past and future climate analysis:** Past trend analysis was conducted using data of 19 surface weather stations maintained by the DoM in Sri Lanka from 1980 to 2015. Future climate predictions have been investigated using short-, medium- and long- term time horizons; using downscaled (25km grid resolution) RCP 4.5 and RCP 8.5 climate projections as per the section 4.2 of AR5.

2. **Socio-economic analysis:** Socio-economic analysis was based on secondary information obtained through desk review, participatory techniques and consultations. The analysis focused on socio-economic impacts due to climate change as well as impacts due to implemented adaptation measures. Projection-based Futuristic Vision was used to guide the analysis.
3. **Approach used for developing climate change risk maps:** The AR5 Climate Risk Framework has been adopted for this study and the following risk formula given in the GIZ Resource Guide was used for risk calculations (GIZ and EURAC, 2017).

Risk = (Hazard × Weightage of Hazard (wH) + Exposure × wE + Vulnerability x wV) /(wH+wE+wV)

Hazard is the potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury and other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.

Exposure is the presence of people (population), livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

Vulnerability is the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. Population vulnerability is derived from historic death toll whereas economic vulnerability is derived from historic economic losses.

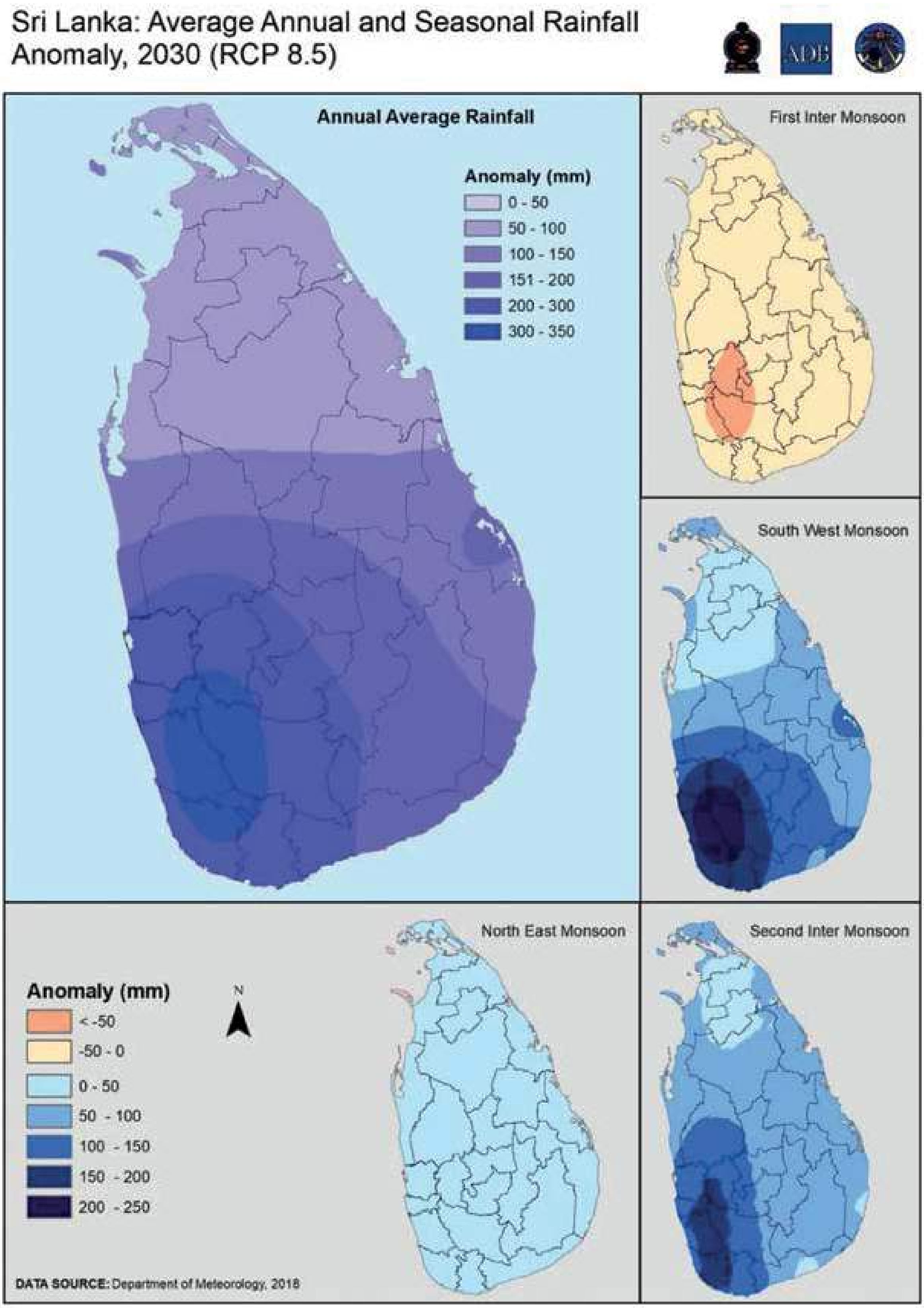
Weightage is the process of attaching a numerical modification (weight) to an indicator to emphasize the importance of this indicator against other indicators. Weighting (eg: adding a multiplier or divisor to the respective factor) is used to enhance or reduce the influence of that factor in its interaction within the composite indicator.

Indicators for each risk component were selected through stakeholder consultations and considering data availability and sub-sectoral impacts. Weightages for selected indicators were assigned through expert opinions. Data required for each indicator were collected in line with mapping boundaries. Proxy data were used where direct data were not available. Data normalization techniques were used for data standardization. The Weighted Arithmetic Aggregation Technique was used for risk calculation and mapping. In mapping, the Equal Interval Technique was used to classify different risk categories: low risk (0-0.33), moderate risk (0.33-0.66) and high risk (0.66-1). Areas with data deficiency, non-applicable and less than the threshold value in appropriate sectors and sub-sectors with specific parameters are indicated in hollow color (white).

In the health sector, the climate change risk of Dengue, Leptospirosis and Leishmaniosis were assessed based on the boundaries of MOH (Medical Officer of Health) divisions. To calculate the Temperature Humidity Index (THI) for cattle in the livestock sector, the formula defined by Mader, et al. (2006) was used. For the biodiversity sector, Maximum Entropy (MaxEnt) modelling version 3.4.1 (Phillips et al., 2004 and 2006; Phillips and Dudick 2008; Elith et al. 2011) was used to predict current and future habitat suitability in line with available species distribution data. High resolution contour mapping was used to assess the risk to sea level rise along the coastal areas and potential one meter inundation areas using LiDAR data. A map of 1:50,000 Landslide risk-prone area prepared by NBRO was used to interpret landslide risk.

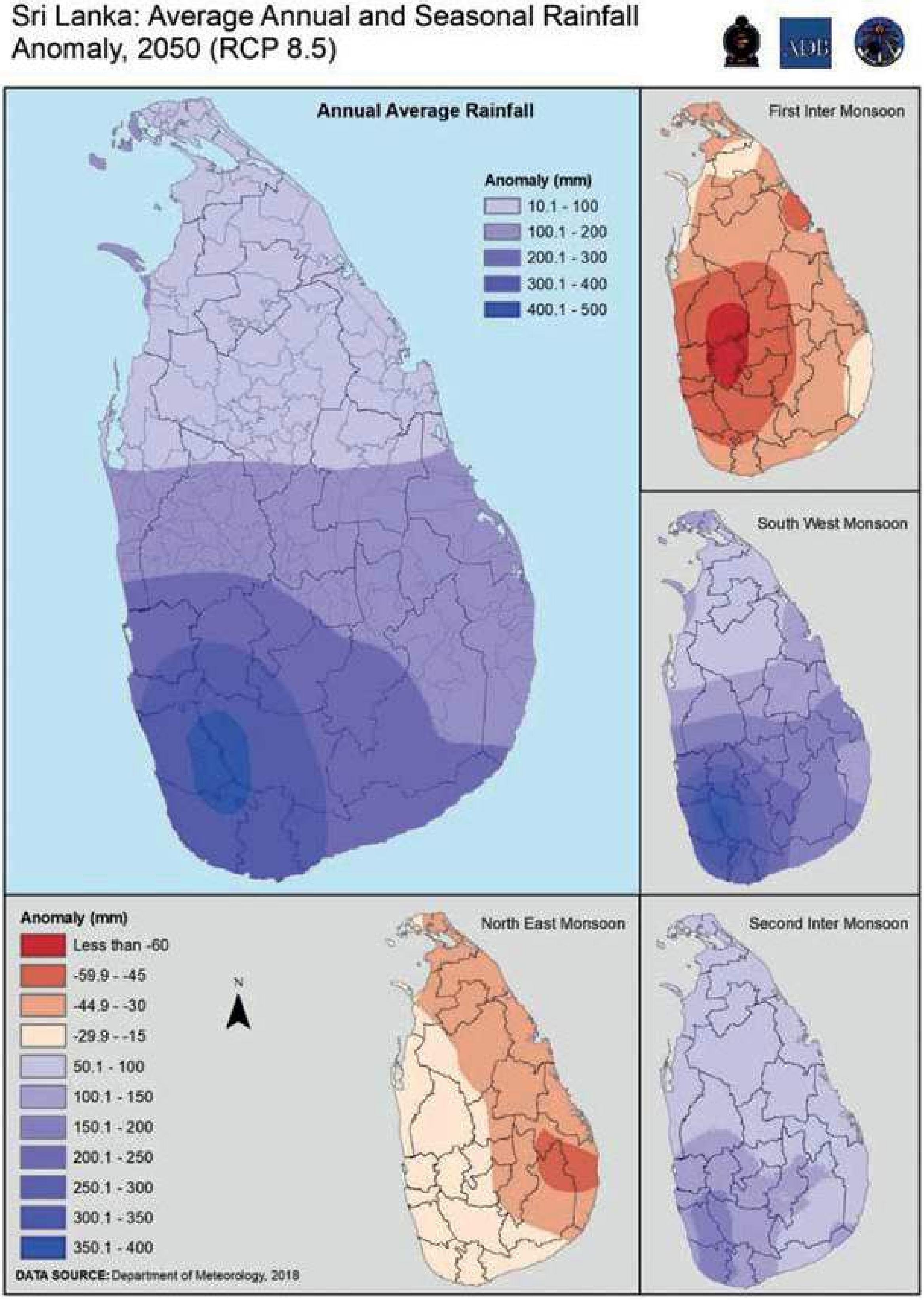
The prepared risk maps reflecting the current status of the sectors was compared with 2030 and 2050 RCP 8.5 rainfall and temperature anomaly maps prepared by the project of Updating Climate Change Vulnerability Assessment and Piloting Mainstreaming Climate Change Adaptation into National Development Activities implemented by the DoM, Sri Lanka (Figure 3.2-3.5).

For each sector, appropriate future anomalies of temperature and rainfall maps for 2030 and 2050 under RCP 8.5 were compared with risk maps prepared by this assessment (Figure 3.2-3.5). Although, the assessment applied all the risks into relevant sectors, only the maps with significant risks are included in this report. Adaptation measures were proposed through a participatory approach, based on risk maps and climate projections. Indicators for women, children and other vulnerable groups including the elderly, differently-abled and pregnant women were also considered in developing the indicator list and proposed appropriate robust and flexible adaptation opportunities.



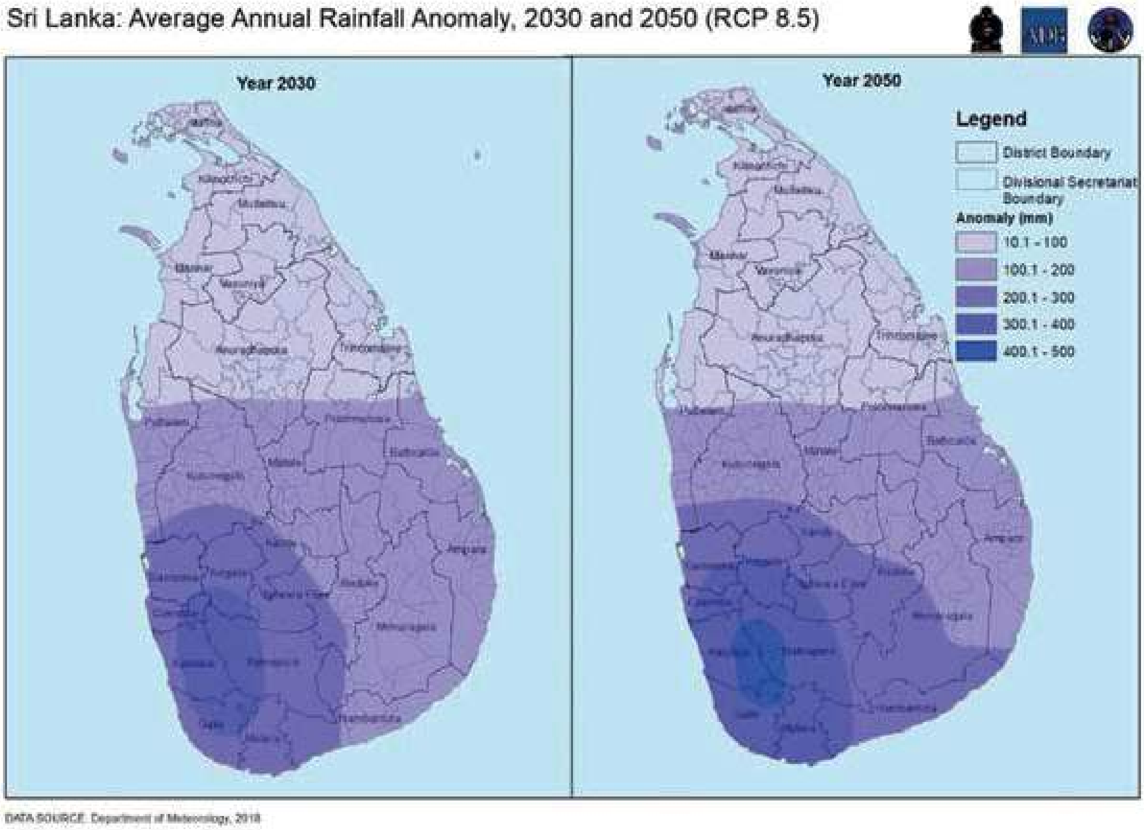
Source: Climate Risk Assessment 2018, ADB (TA-8572 REG)

Figure 3.2 Average annual rainfall anomalies by monsoons, 2030 (RCP 8.5)



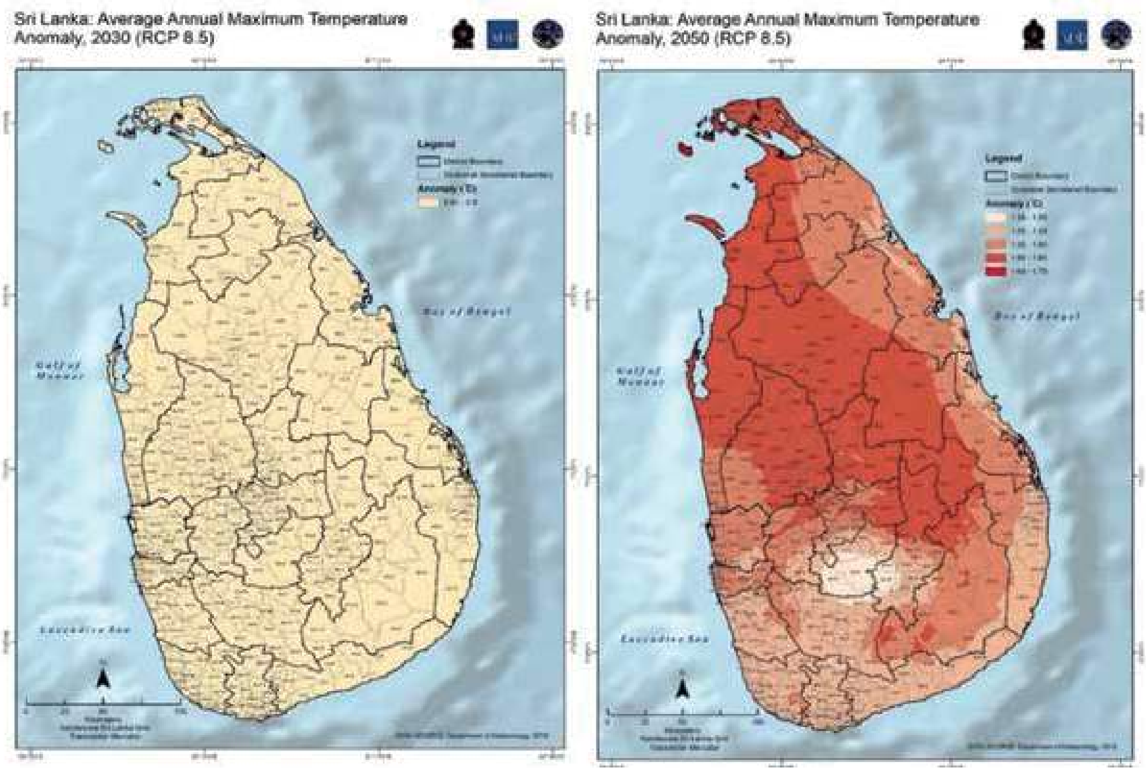
Source: Climate Risk Assessment 2018, ADB (TA-8572 REG)

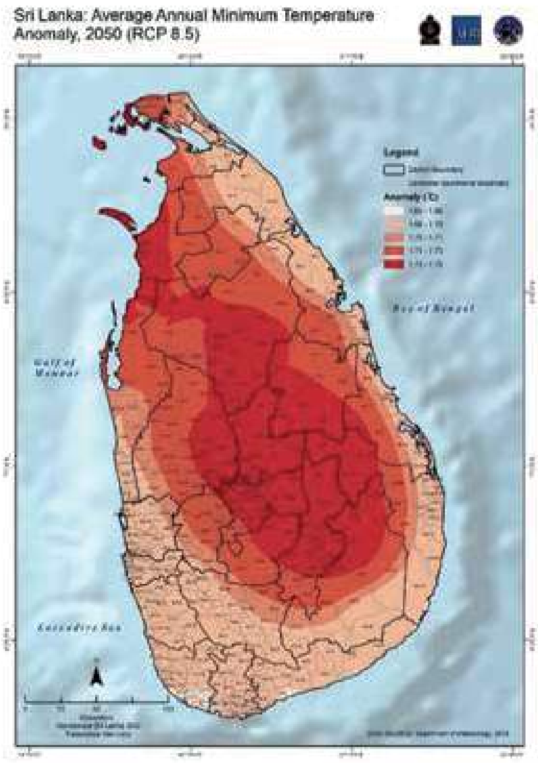
Figure 3.3 Average annual rainfall anomalies by monsoons, 2050 (RCP 8.5)



Source: Climate Risk Assessment 2018, ADB (TA-8572 REG)

Figure 3.4 Average annual rainfall anomalies for 2030 and 2050





Source: Climate Risk Assessment 2018, ADB (TA-8572 REG)

Figure 3.5 Average annual maximum temperature anomaly (up); and average annual minimum temperature anomaly (bottom); 2030 and 2050

3.3 Climate change trends in Sri Lanka

3.3.1 Observed local trends (temperature and precipitation, 1980-2015)

Standardized and homogeneous daily rainfall and maximum and minimum temperature records were obtained from 19 weather stations of DoM for the time period of 1980-2015. These were used for analyses of trends in annual extreme indices of temperature and precipitation in Sri Lanka (Jayawardena et al., 2018). Ten extreme precipitation indices and nine extreme temperature indices were computed for all stations using the RClimDex software developed by the World Meteorological Organization Expert Team on Climate Change Detection and Indices (WMO-ETCCDI) (Easterling et al., 2003; Alexander et al., 2006).

The results of this analysis reveal that warm nights are increasing and cold nights have significantly decreased (Figure 3.6). It is evident that annual average minimum temperatures are increasing significantly across the country. The diurnal temperature range difference between maximum and minimum temperatures is decreasing (Easterling et al., 1997; Jayawardena et al., 2018), indicating that the minimum temperature is increasing faster than the maximum temperature (Figure 3.7). Moreover, significantly decreasing trends were observed for "*Maha*" season than "*Yala*" season.

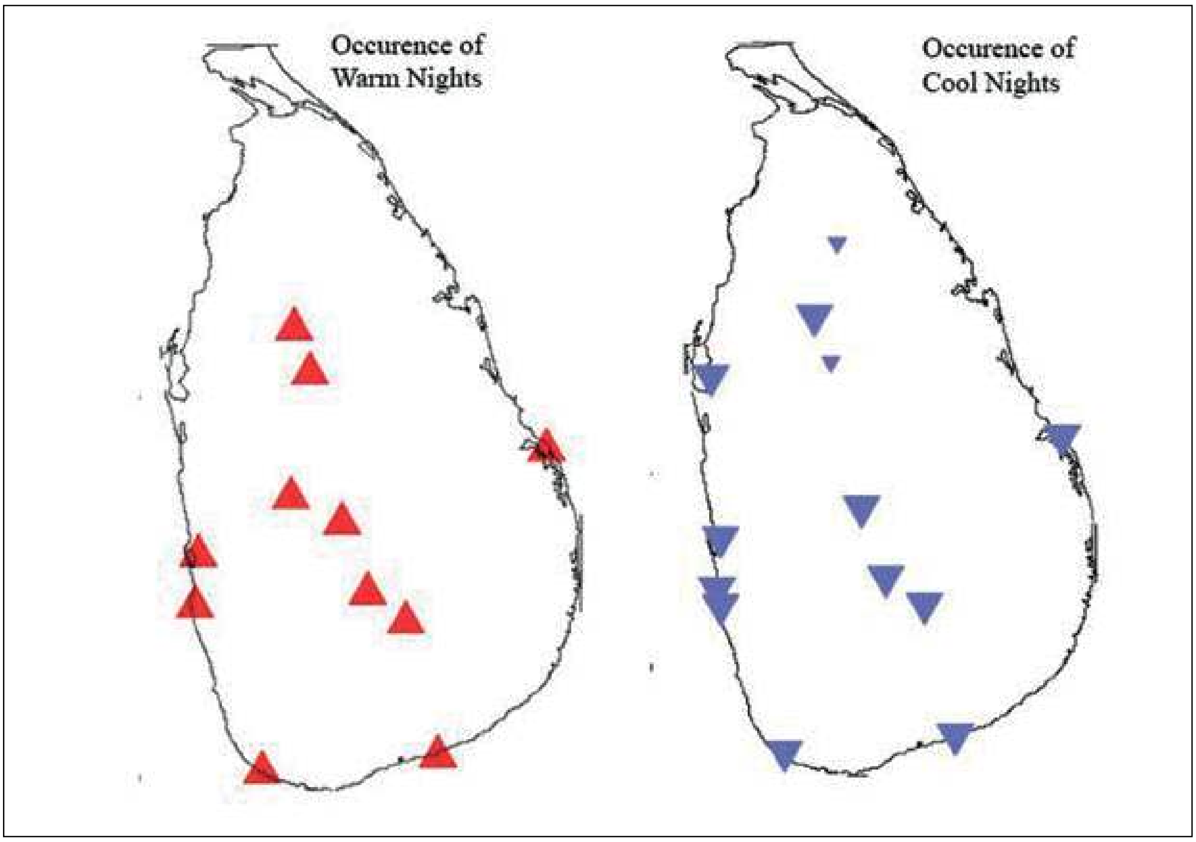


Figure 3.6 Spatial distribution maps of trends in occurrence of warm nights (left) and occurrence of cold nights (right) (see Note 01 for explanation of triangles)

Note 01: Red triangles show an increasing trend; blue triangles indicate a decreasing trend; significant changes at the 5% level are indicated by large triangles and 10% levels are indicated by small triangles (Adopted from Jayawardena et al., 2018).

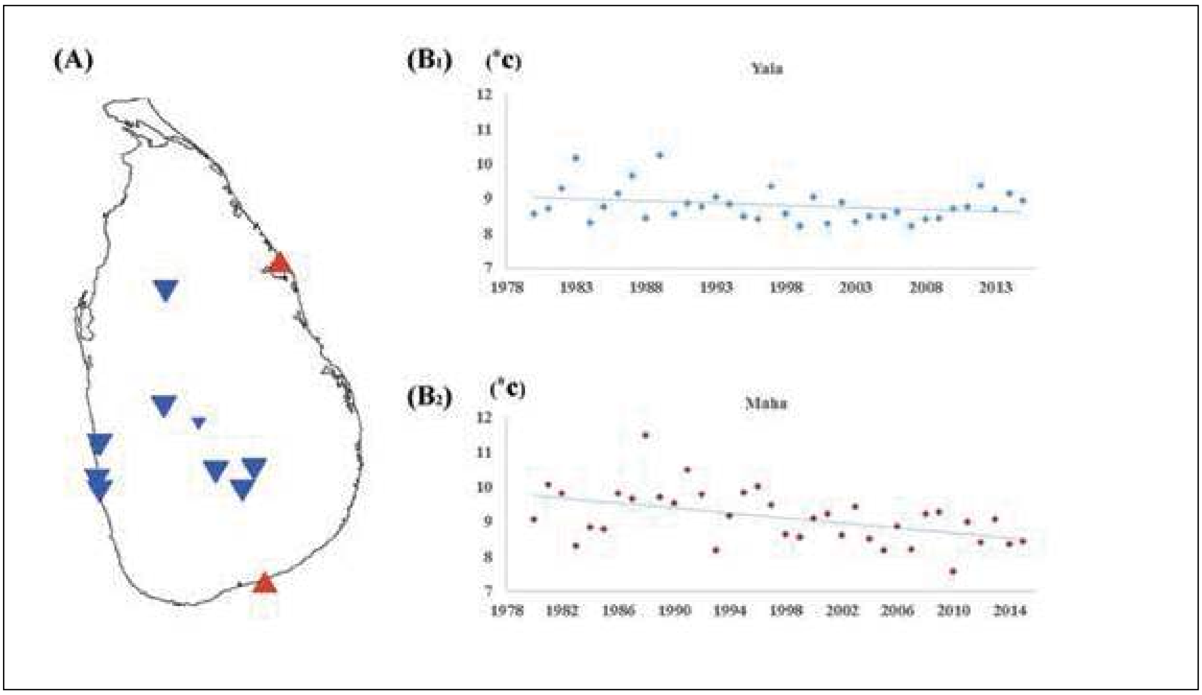
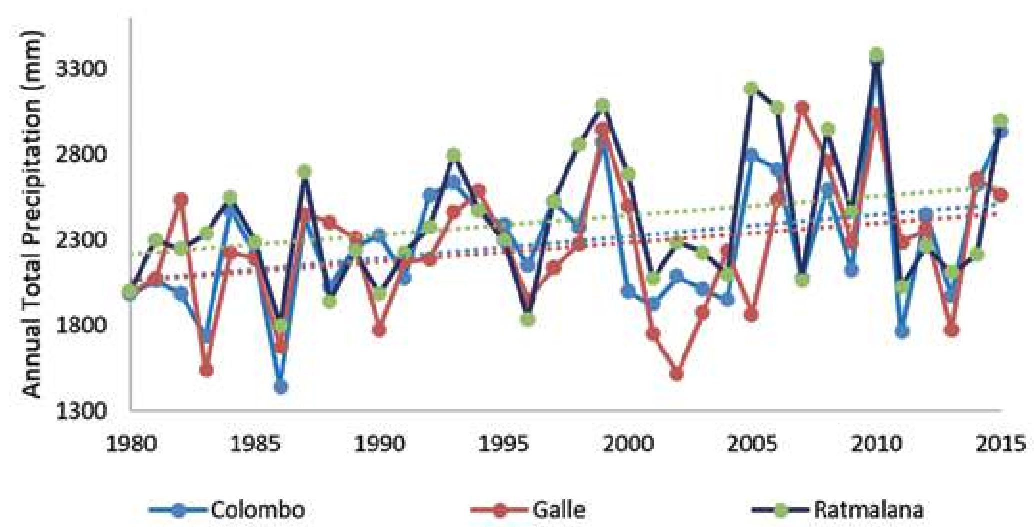


Figure 3.7 Spatial distribution maps of trends in diurnal temperature range and time series for diurnal temperature range for Yala (B1) and Maha (B2) seasons at Anuradhapura (Note 01)

Rainfall: An increasing trend was observed for total annual rainfall in Sri Lanka for the period of 1980-2015 (Figure 3.8). Statistics revealed that 65% of stations have shown significantly increasing trends for annual precipitation at 5% or 10% level (Jayawardena et al., 2018) (Figure 3.9). The maximal one-day and five-day precipitations from 2010-2015 in main three climatic zones when compared with decadal changes, revealed; 60% and 50% increase in maximal one-day and five-day precipitation in Anuradhapura, 110% and 60% increase in Batticaloa (compared to the 30 years average) in Table 3.1. Additionally, 90% of the stations showed non-significant increasing trends in total precipitation on extreme rainfall days. However, 20-25% of the station trends are significant at the 5%-10% levels in Figure 3.9 (Jayawardena et al., 2018).



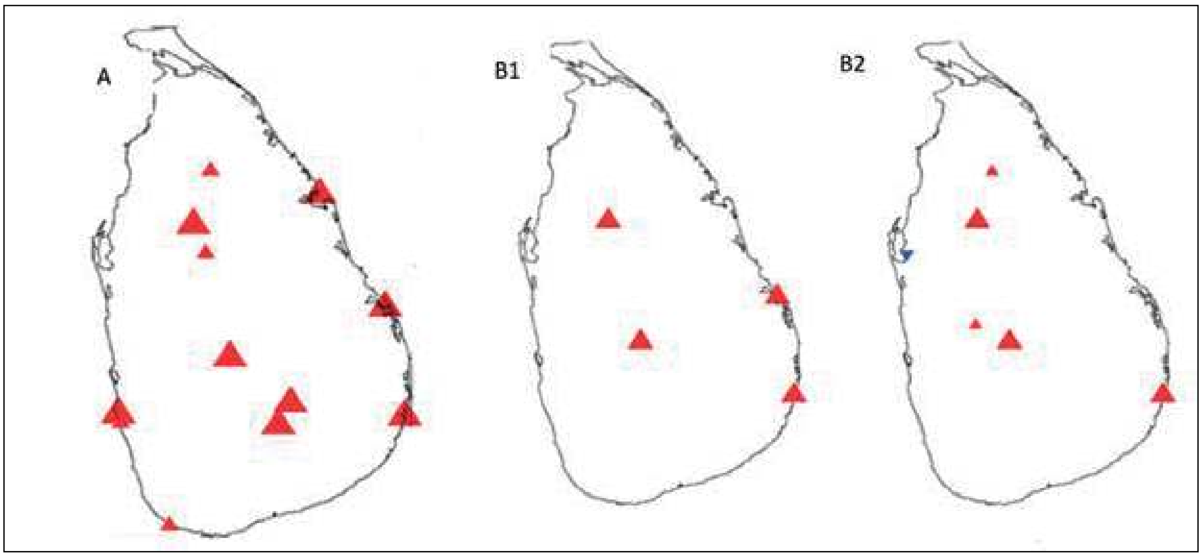
Source : Jayawardena al., 2018

Figure 3.8 Time series for annual total precipitation at few stations located in Colombo, Galle and Ratmalana

Table 3.1 Decadal changes in five-day maximum rainfall and one-day maximum rainfall in selected stations representing the three climatic zones

Period	Dry zone			Intermediate zone			Wet zone		
	Anuradhapura	Puttatum	Batticoloa	Kurunegala	Badulla	Bandarawela	Katunayake	Katugastota	Nuwara Eliya
	Maximum Five-Day Rainfall								
Average 30	175	193	251	221	192	159	142	93	85
Decade 80	166	213	238	229	237	177	123	95	91
Decade 90	176	189	225	214	168	144	162	94	94
Decade 2000	184	180	286	219	171	160	133	90	70
2010-2015	**281**	**159**	**528**	**301**	**257**	**192**	**146**	**127**	**95**
	Maximum One-Day Rainfall								
Average 30	89	113	126	123	95	76	257	177	188
Decade 80	73	133	130	123	110	78	243	178	217
Decade 90	99	114	113	115	94	75	265	179	197
Decade 2000	94	95	135	131	81	75	252	173	150
2010-2015	**135**	**79**	**200**	**172**	**124**	**91**	**263**	**249**	**198**

Source: Jayawardena et al., 2018

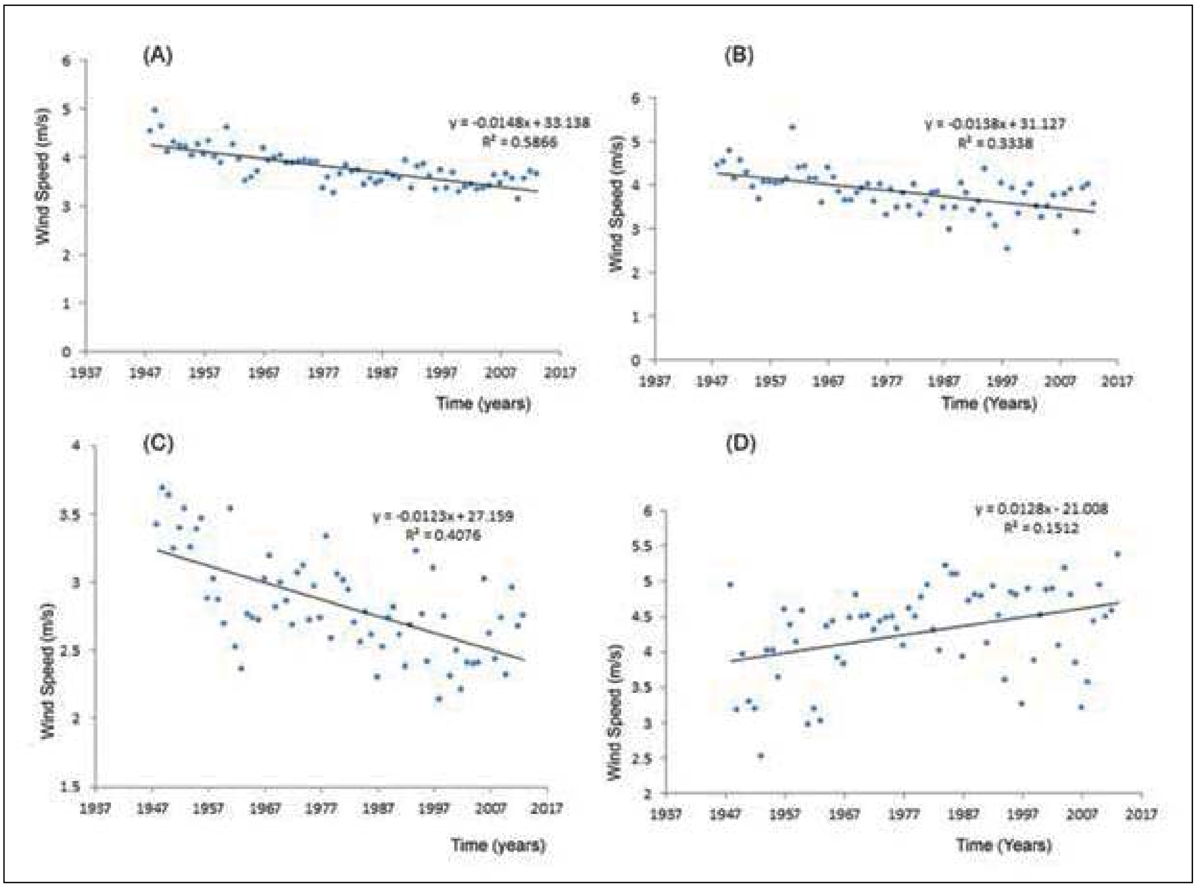


Source: Jayawardena et al., 2018

Figure 3.9 Spatial distribution map of trends for annual total precipitation (A), spatial distribution maps of trends for very wet (B1) and extremely wet (B2) days (Note 01)

Consecutive wet days (CWD) and Consecutive dry days (CDD) have shown mixed trends for all 19 meteorological stations for period of 1980-2015. The station in Katugasthota station showed increasing trends while Nuwara Eliya and Ratnapura stations resulting a decreasing trend in CWD. Meteorological stations such as Colombo, Katunayake, Ratmalana and Puttalam that are located in the west coast showed lesser number of CDD. Increasing trend of high precipitation indicate that occurrence of extreme rainfall events will influence the total annual precipitation in Sri Lanka in Figure 3.9. Therefore, the increases in total rainfall observed in many locations may be due to extreme rainfall events.

Wind: Sri Lanka has two distinct monsoonal wind patterns; southwest and northeast monsoons. The Department of Meteorology has commenced a study to understand the changes in southwest monsoon wind pattern using two major study areas located on Bay of Bengal and the Arabian Sea. The wind speeds in both these locations showed decreasing trends while meridional component showed increasing trends. The meridional wind component will dominate over the Arabian Sea causing a stronger southwest monsoon in Sri Lanka (Figure 3.10).



Source: Premalal, 2018

Figure 3.10 Time series for area average wind speed (ms-1) of zonal wind (A) and meridional wind (B) at Arabian Ocean and zonal wind (C) and meridional wind (D) at Bay of Bengal zone during onset of southwest monsoon from 1937-2017

3.3.2 Climate change projections (Scenarios)

Statistically downscaled (25 km^2 grid resolution) NASA Earth Exchange Global Daily projection data sets were used to analyze through CanESM2, CNRM-CM5, CSIRO-MK3-6-0, GFDL-CM3, MRI-CGCM3 and NCAR-CCSM4 under Coupled Model Inter-comparison Project 5 (CMIP5). The research also investigated future changes of precipitation and temperature for three time periods as 2030s, 2050s and 2080s. The study refers 2020-2040 as a short term, 2040-2060 as medium term and 2070-2090 as long term for the two emission scenarios of RCP 4.5 (moderate emission) and RCP 8.5 (high emission) against climatological means during the historical run period from 1975-2005. Spatial patterns of precipitation for all three futures have been discussed for seasonal and annual patterns in this section.

Temperature: In the ensemble multi model prediction, results increase in minimum and maximum temperatures for all three-time horizons for both RCP 4.5 and RCP 8.5. Further, results of multi model ensemble prediction revealed that minimum and maximum temperature of RCP 4.5 is expected to be increased by 0.7-1.2°C in short term, by 1.0-1.6°C in medium term and 1.5-2.3°C by long term with respect to climate projections. According to the RCP 8.5, temperature increased under the projections in short, medium and long term will be 1.1-1.5°C, 1.6-2.5°C, and 2.4-3.5°C for maximum temperature and 1.0-1.5°C, 1.4.-2.3°C and 2.2-3.2°C for minimum temperature in Figure 3.11.

Rainfall: *South West Monsoon (SWM):* In the short-, medium- and long-term projections, the positive anomaly of rainfall is predicted over most parts of the island by multi-model ensemble prediction under RCP 4.5 and RCP 8.5 scenarios including the wet zone that could result in more intense rainfall with greater aerial extension in the future in Figure 3.12.

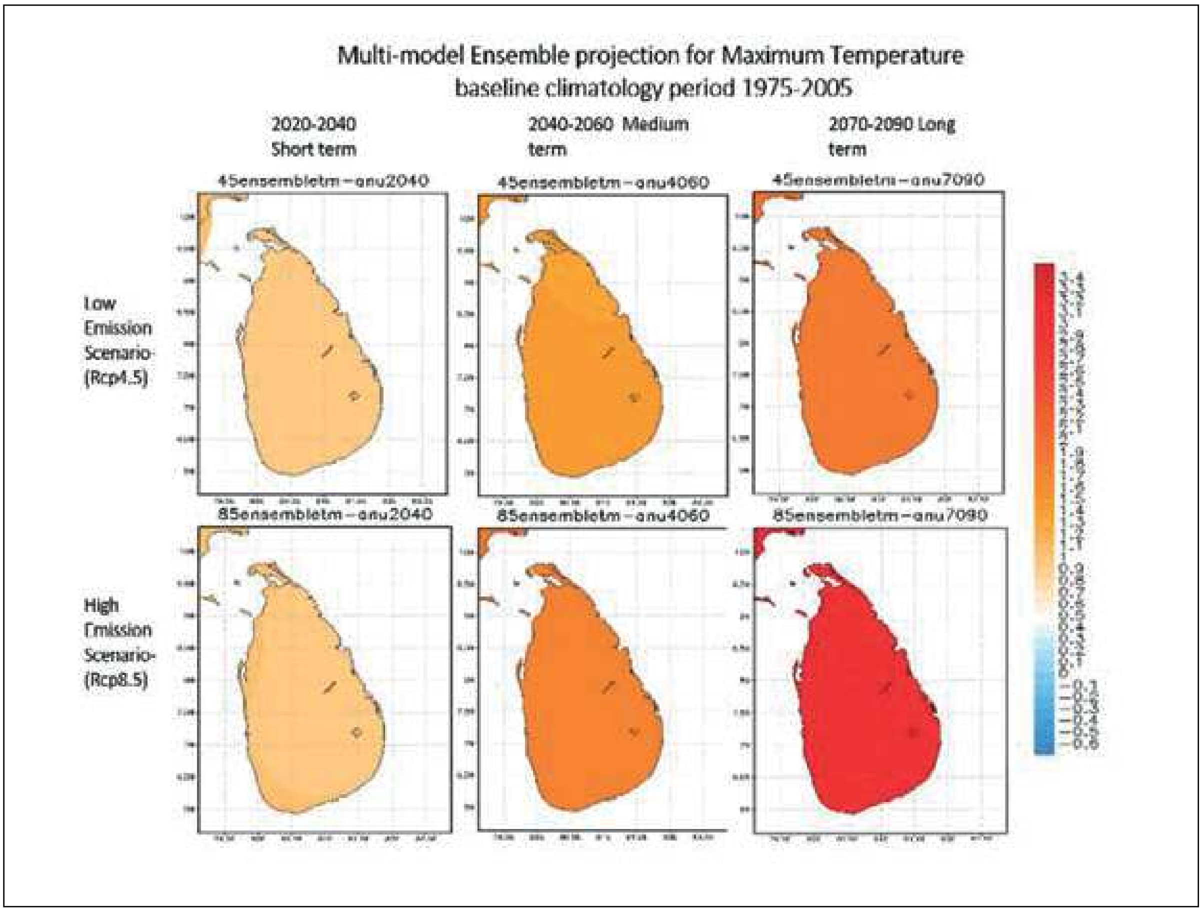
North East Monsoon (NEM): Northeast monsoon rainfall anomaly is negative for short-, medium- and long-term projections with a slightly positive anomaly over most parts of the island under RCP 8.5 for short term projection. During the medium term, projections indicate a negative rainfall anomaly over most parts of Sri

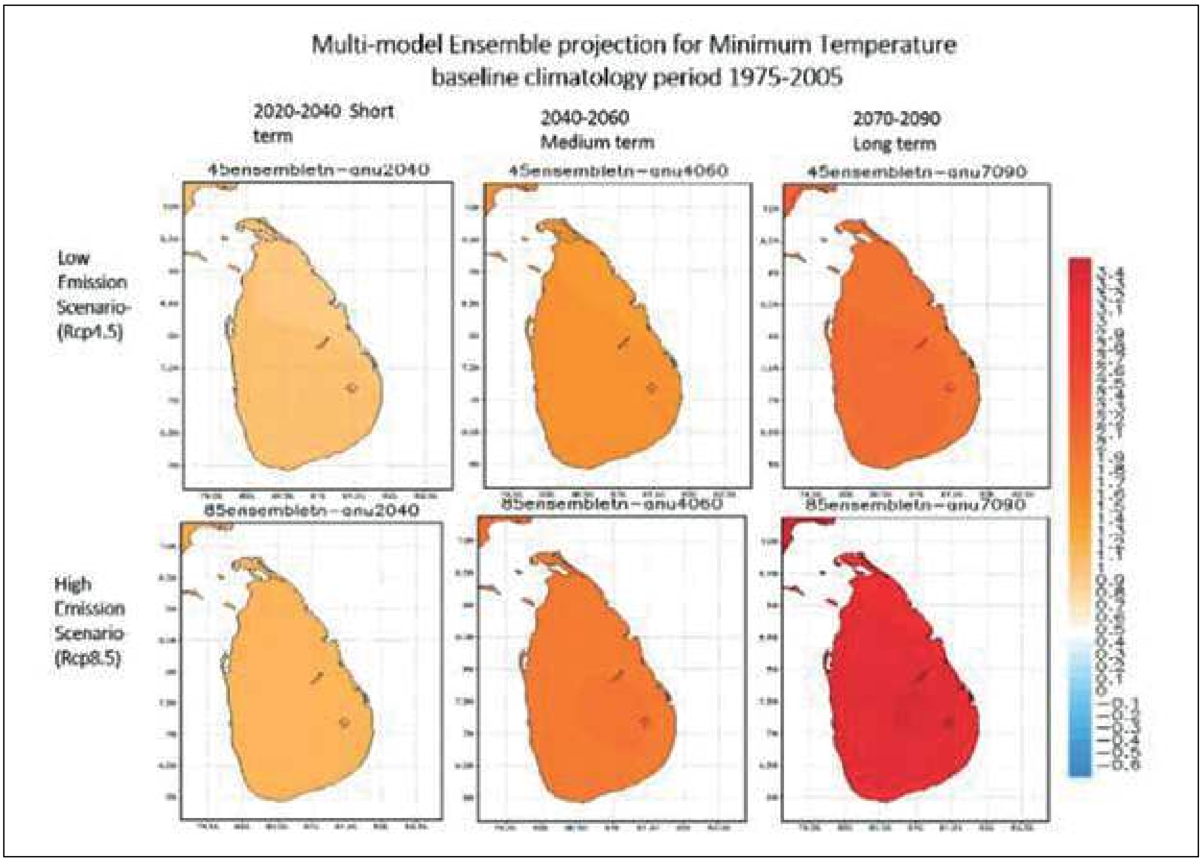
Lanka for both RCP 4.5 and RCP 8.5 scenarios. Negative anomalies of rainfall are predicted in the long term for both emission scenarios with lesser number of rainfalls in the dry zone (Figure 3.13).

First Inter Monsoon (FIM): A negative rainfall anomaly is evident for the short term, slightly negative for the medium term and a positive anomaly for the long term according to the RCP 4.5 scenario. However, RCP 8.5 resulted in negative anomalies for the rainfall for short-, medium- and long-term periods.

Second Inter Monsoon (SIM): The multi-model ensemble predicted a negative anomaly over the north-eastern parts and positive anomalies in the remainder of the country for RCP 4.5 in the short term, while RCP 8.5 projected positive anomalies for the rainfall over most parts of the island in the medium term. The long term scenario for RCP 4.5 and 8.5 indicates a positive rainfall anomaly for entire country.

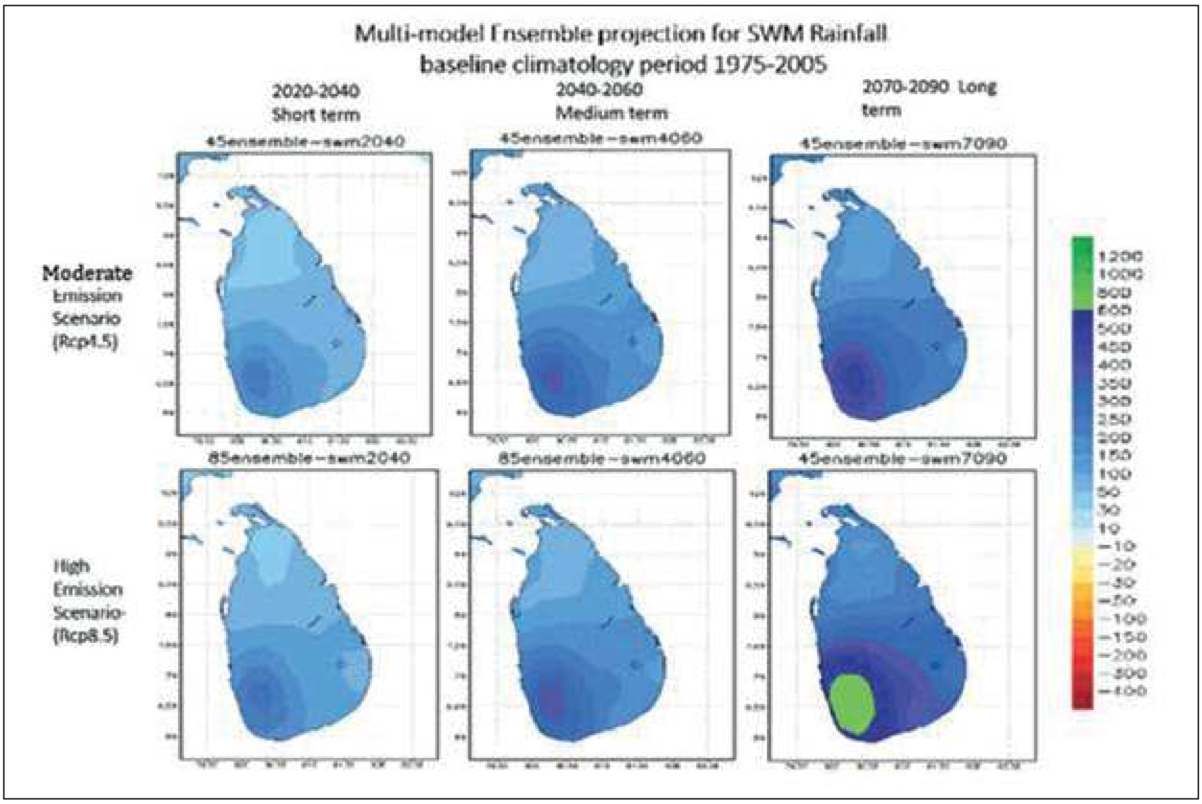
Annual Rainfall: The study using multi-model ensemble projections indicated that the annual rainfall anomaly to be negative in the dry zone, especially in the north-eastern parts, however, positive in southwestern parts in the short term, while the anomaly is positive and increasing under the RCP 4.5 thereafter. The annual rainfall anomaly is positive and increasing under RCP 8.5, where this increment would be significant in the wet zone.





Source: Jayawardena et al., 2018

Figure 3.11 Multi-model ensemble of change in maximum temperature (up) and minimum temperature (bottom), relative to 1975-2005 for moderate emission scenario (top; RCP 4.5) and high emission scenario (bottom; RCP 8.5) for time periods; short (2020-2040), medium (2040-2060), long (2070-2090)

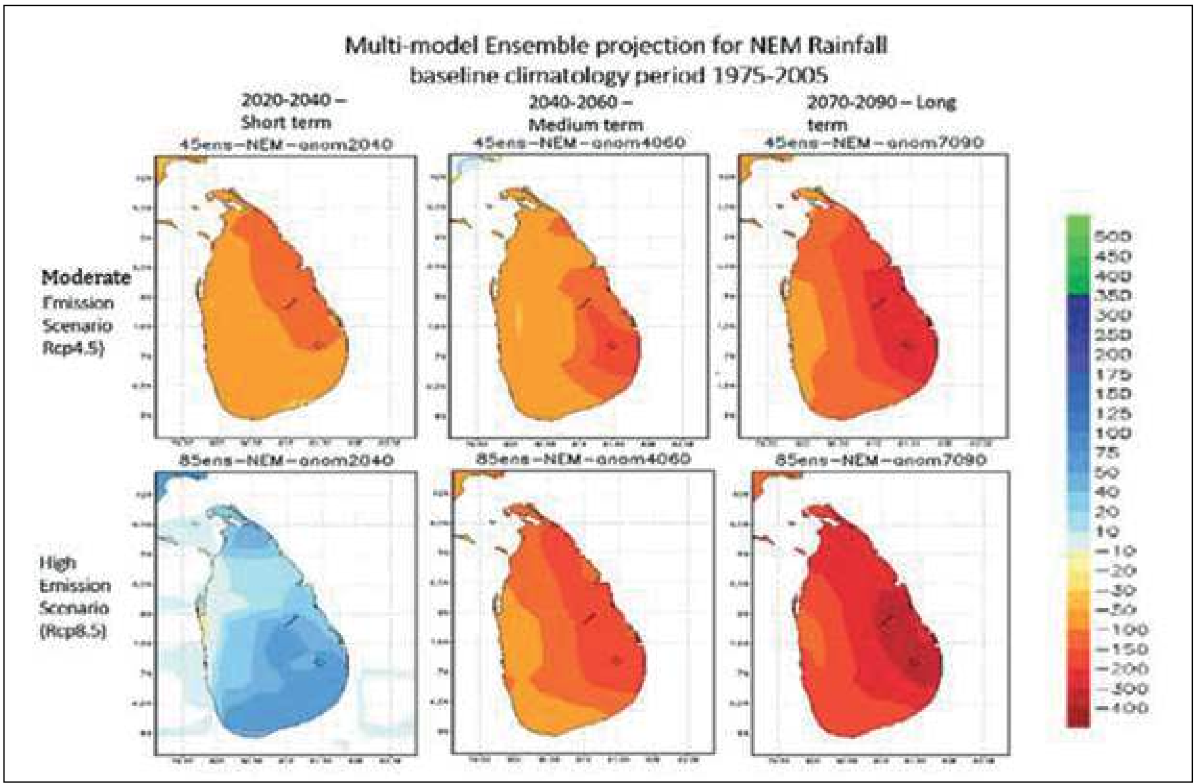


Source: Jayawardena et al., 2018

Figure 3.12 Multi model ensemble of change in Southwest Monsoon (SWM) rainfall, relative to 1975-2005 for RCP 4.5 (up) and RCP 8.5 for time periods (left; 2020-2040), (middle; 2040-2060), (right; 2070-2090)

3.4 Predicated climate change impacts in Sri Lanka

Changes in NEM rainfall compared to the baseline climatology clearly indicate a negative rainfall anomaly, especially in the dry zone under RCP 4.5 and RCP 8.5 scenarios. More frequent droughts are expected in the dry and intermediate zones. Rainfall reduction in the NEM will increase vulnerability of agriculture sector to prolong droughts, as nearly 70% of rice cultivation takes place during the *Maha* season in the dry zone in Sri Lanka. Increases in air temperature observed in the recent past and expected to continue in future projections are likely to have huge impacts on evaporation and evapotranspiration. Projected changes in precipitation patterns, changes in extreme weather events and increasing evaporation could result in reduced water availability and thereby agricultural productivity decreases in the dry zone.



Source: Jayawardena et al., 2018

Figure. 3.13 Multi model ensemble of change in North East Monsoon (NEM) rainfall, relative to 1975-2005 for RCP 4.5 (up) and RCP 8.5 for time periods (left; 2020-2040), (middle; 2040-2060), (right; 2070-2090)

An increase in the frequency and severity of extreme rainfall events has been observed during the recent past. Climate projections indicate notable increases of extreme rainfall events that will influence annual/total precipitation in parts of the country. This pattern would increase climate variability, resulting in more floods, landslides and droughts. Changes in annual as well as southwest monsoon rainfall compared to the baseline climatology indicate a positive rainfall anomaly in the wet zone that could rise over time under RCP 4.5 and RCP 8.5 emission scenarios. This could make the western slopes of the central hills more prone to natural disasters such as landslides, land degradation and soil erosion (Darshika et al., 2018).

3.4.1 Uncertainties in predicted climate change impacts for Sri Lanka

Climate modelling provides the basis for forecasting future climate change. Making decisions based on projections requires a thorough understanding of the sources, their impacts and uncertainty for future planning. Uncertainties are associated with GHG emissions scenarios, unexpected climate induced disasters, demographics, changes in land use, economic development programmes and other variables. Further, uncertainties in climate modelling arise from uncertainties in initial conditions, boundary conditions (e.g. a radiative forcing scenario), observational uncertainties, uncertainties in model parameters, and structural uncertainties resulting from the fact that some processes in the climate system are not fully understood or are impossible to resolve due to computational constraints.

3.5 Governance framework for building resilience in Sri Lanka

This section mainly focuses on how Sri Lanka has been able to integrate climate change adaptation and resilience-building into spheres of life, governance and development using mainstreaming approaches and supportive policies. The CCS established under the Ministry of Environment in 2008, the operational focal point to the UNFCCC, advocates a comprehensive approach to deal with climate change related issues in the country. The Secretariat is supported National Climate Change Policy of Sri Lanka and other sectoral policies and legislations. Further, there are a number of strategies, plans, projects and programmes to strengthen adaptation measures. However, CCS would require legal provisions mandated by a separate Parliamentary Act to build better resilience in coordination with line ministries and institutions that are responsible for climate resilience building.

Sri Lanka, through an Act of Parliament, has established National Sustainable Development Council to steer the Global Agenda for 2030. The CCS is responsible for monitoring and coordinating the Goal 13 "Climate Action". The Disaster Management Act and National Policy on Disaster Management are implemented by the DMC which provides directives for a more resilient and safer country against disaster risks induced by climate change. These policy instruments help to prepare for pre and post disaster damages and relief with substantial support to minimize loss and damages brought by climate risks. Implementation of climate actions proposed in the NAP, NDCs and SDGs should build resilience in an integrated, mainstreamed and synergistic manner to face the adverse effects of climate change in Sri Lanka.

3.6 Sectoral risk assessments and adaptation measures

3.6.1 Agriculture sector and climate change impacts

Sri Lanka is predominantly rural and agriculture-based country. It boasts a world renown hydraulic civilization spanning over two millennia. Approximately 2.6 million ha, equivalent to 42% of the country's total terrain, is in crop production. Much of this land is owned by 1,650,000 smallholder farmers. The agriculture sector, although it employs over 30% of the rural labour force, generates less than 10% of GDP and the contribution has declined annually in recent years to 7.7% in 2015, 7.1% in 2016 and 6.8% in 2017 (CBSL, 2018). Sri Lanka encompasses three major agricultural production systems as food, plantation and minor export crops. The most important food production systems in Sri Lanka are rice (paddy), maize, pulses and vegetables. The main plantation crops in Sri Lanka are tea, rubber and coconut. The minor export crops of Sri Lanka consist of cloves, cinnamon, cardamom, nutmeg, mace and pepper. This sector is governed by several ministries and supported by several departments and institutions.

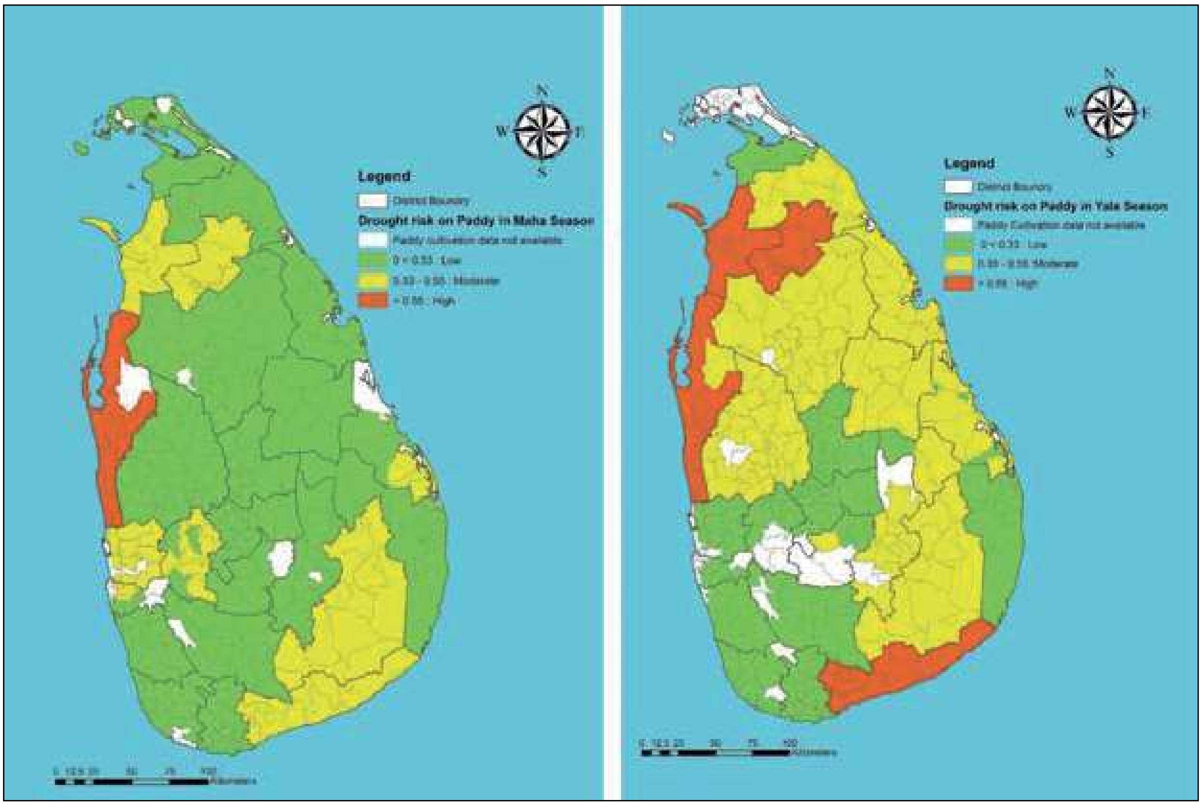
At present, climate change impacts are threatening the entire life cycle of food production and food security in Sri Lanka. A study done by Eriyagama et al., (2010) found that the farming districts of Nuwara Eliya, Badulla, Moneragala, Ratnapura, and Anuradhapura are more sensitive to climate change. Jayatillaka and Droogers (2004) revealed that major climatic parameters such as temperature, CO_2 and precipitation are the most influencing factors for crop growth. A controlled experiment conducted by Vidanage and Abeygunawardane (1994) concluded that an increase in temperature from 0.1°C to 0.5°C could reduce rice yield by approximately 1%-5%. Further, the study revealed that ambient temperature exceeding 35°C even for just 60–90 minutes at the flowering stage of paddy can cause sterile grains, in the Yala season in dry and intermediate zones in Sri Lanka. Moreover, Sri Lankan farming communities have faced frequent and severe droughts since 1974. Statistics show that 283 dry spells have been reported over a period of 30 years since 1974 (Berundharshani and Munasinghe, 2015) and this has negatively impacted on agriculture, livelihoods and the socio-economic condition of farmers. Furthermore, increased temperatures and decreased daytime and night time temperature differences have negatively affected high value crops, especially vegetable and potato cultivation (De Zoysa and Inoue, 2014).

Agriculture in Sri Lanka is considered to be the sector that is the most vulnerable to the adverse impacts of climate change. Moreover, Sri Lanka may experience a severe food insecurity situation in the country with a number of associated issues. In this assessment, the impacts of droughts, floods and landslides were evaluated for six major agricultural crops (paddy, tea, rubber, coconut, minor export crops and sugarcane) at the Divisional Secretariat level.

3.6.1.1 Paddy cultivation

Rice is the staple food in Sri Lanka and is mainly cultivated as a wetland crop. The country has two predominant cultivational seasons linked with the bi-modal monsoon patterns. The primary cropping season for paddy is *Maha* with cultivation of about 6,067 km^2 (606,702 ha) in 2019. Around half of that of area is cultivated in the *Yala* season. Nearly 879,000 farmer families are engaged in paddy cultivation providing livelihoods for up to 32% of the population. Rice cultivation is highly vulnerable to climate shocks such as droughts, dry spells, floods and sea-level rise. Rainfed paddy farmers are highly exposed and sensitive to drought. Consecutive failure of five years' of *Maha* season (2013-2017) in the dry zone reduced resilience of farmers, crops and livelihoods to climate change impacts. As a result of this, the government had to mobilize SLR 9.1 billion in crop insurance to compensate their losses from 2014 to 2018 in the both *Yala* and *Maha* seasons as per a communication of Agriculture and Agrarian Insurance Board in 2019.

Drought risk in *Maha* season: Puttalam district, which depends entirely on NEM rain for *Maha* cultivation is at high risk, while Hambantota, Monaragala, Mannar, Vavuniya and parts of Gampaha, Kegalle and Batticoloa districts face a moderate risk (Figure 3.14-A). According to the RCP 8.5 for 2030, the maximum temperature and rainfall anomalies are increasing (Figure 3.2, 3.4 and 3.5). This can further increase the risk to paddy cultivation in some of areas in the dry zone. The situation will further aggravate in 2050 with higher temperature intensity and lesser rainfall, thus expanding the risk to additional areas in the dry zone in Figure 3.3, 3.4 and 3.5.



Drought risk on paddy-*Maha* season (A)

Drought risk on paddy-*Yala* season (B)

Figure 3.14 Drought risk of paddy in *Maha* and *Yala* seasons

Adaptation measures: Implementation of larger-scale irrigation projects and crop diversification for vulnerable districts are major adaptation measures that have been recommended. Further, rehabilitation of the ancient irrigation system (cascading village reservoirs) is one important adaptation measure for droughts in the dry zone. Research and development of drought-resistant paddy varieties are to be done as an important adaptation measure. Additional adaptation measures could include awareness raising on climate shocks, use of cropping calendars by paddy farmers, enhancement of the infiltration rate, adopting post harvesting techniques, timely transmission of early warning and seasonal forecasts and establishment of two-way climate information dissemination with the DoM.

Drought risk in *Yala* season: Puttalam, Mannar, Vavuniya and Hambantota districts are at high risk for droughts during *Yala* seasons whereas Moneragala, Kurunegala and rest of the dry zone confront a moderate risk (Figure 3.14-B). The Ampara district reveals a low risk due to access to major irrigation schemes. Rainfall and temperature anomaly maps show increasing trends for temperature and reduced trends for rainfall during *Yala* season in the dry zone. This might increase dry spells and create a shortage of water for paddy cultivation by further increasing the risk in the dry zone. Conversely, the wet zone could experience more intense flooding from the southwest monsoon. According to 2050 anomaly maps for temperature and rainfall, the situation in the dry zone will be further aggravated with more dry spells and less rainfall, increasing the risk as per the RCP 8.5 scenario (Figure 3.3, 3.4 and 3.5).

Adaptation measures needed: Implementation of larger-scale irrigation projects and crop diversification for vulnerable districts are major adaptation measures that have been recommended. Research and development of drought resistant varieties and short term paddy varieties are major adaptation measures. Rehabilitation of abandoned cascade tanks/reservoirs (and associated infrastructure) as well as building of new reservoirs would be an attractive and effective adaptation measures. Maintenance of the reservoir system and, collection and conservation of water for irrigation would enhance resilience. Promotion of alternative short-term crops in the fields during low rainfall seasons to ensure sustainable livelihoods is another important adaptation measure.

Additional adaptation measures could include awareness raising on climate shocks, use of cropping calendars by paddy farmers, enhancement of infiltration rate in catchments and watersheds, adopting post harvesting techniques, timely transmission of early warnings and seasonal forecasts and establishment of effective climate information dissemination systems.

Flood risk in *Maha* season: During the *Maha* season, the western and southern coastal areas receive less rainfall while some parts of Jaffna, Eastern and North-Central Provinces are subject to moderate flood risks for paddy cultivation. The rainfall anomaly maps for NEM for 2030 predicts less rain in the dry zone and this further lowers the risk from floods and inundations (Figure 3.2). However, localized flash floods stemming from high intensity rainfall can harm paddy fields unless drainage infrastructure can cope. The risk for wet zone paddy cultivation will remain low in 2030 and 2050 as per the RCP 8.5 scenario (Figure 3.2, 3.3 and 3.4).

Flood risk in the *Yala* season: According to this assessment, Ratnapura, Kalutara, Galle, Matara, Colombo and Gampaha districts possess considerable risk to floods during southwest monsoon. The western, southern and most parts of the Sabaragamuwa provinces and Puttalam district face a moderate risk for flood related damages. During the *Yala* season when southwest monsoon is active, the flood risk is low for paddy cultivation in the dry and intermediate zones. The wet zone will receive more rains with moderate to higher flood risk by 2030 and it will be worsen by 2050. However, the flood risk in the dry zone and the intermediate zone will be reduced in 2030 and 2050 according to the rainfall and temperature anomaly of RCP 8.5 scenario (Figure 3.2, 3.3 and 3.4).

Adaptation measures needed: Research and development of flood resistant and short-term paddy varieties are potential adaptation measures for wet zone paddy farming. Enhancement of river catchment and upper catchment infiltration is important while water capacity of reservoirs is enhanced to prevent flood.

Another major adaptation measure would be the development of management systems and infrastructure to quickly drain excess water out of the flood zones to storage reservoirs or to the sea. Construction of rainwater storage in the flood prone areas and diversion of excess water in the wet zone could be so useful during drought spells in the dry zone. Enhancement of ground water recharge systems is another potential adaptation measure.

3.6.1.2 Tea cultivation

Tea is grown as a rain fed crop in the country. Tea is one of the main sources of foreign exchange for Sri Lanka and contributing over LKR 233.3 billion to the economy as per the Annual Report of Sri Lanka Tea Board in 2017. The majority of tea plantations in Sri Lanka, except those at high elevations (>1200m), are likely to be adversely affected by higher temperatures and drier weather conditions. The reduction of monthly rainfall by 100 mm, reduces the productivity by 30-80 kg of 'made' tea per hectare. However, the increase in ambient

CO_2 concentration from present level (around 370 ppm) to 600 ppm increases tea yield by about 33-37% (Wijeratne et al., 2007).

Landslides risk for Tea cultivation: According to landslide maps, most tea growing areas have a landslide risk. Also, some DSDs in Badulla, Kegalle, Ratnapura, Kandy, Nuwara Eliya, Matara and Galle districts experience a high risk of landslides while associated with floods could be shallow or starting from bedrock. According to the rainfall anomaly maps for 2030 and 2050, higher rainfall is expected in most of the tea growing areas which could further increase landslide risk for the most of tea plantations under RCP 8.5 scenario (Figure 3.2, 3.3 and 3.4).

Drought risk for Tea cultivation: Risk and hazard maps indicate that due to prolonged droughts and increased ambient temperature, low country tea would be affected. Tea plantations in Galle, Matara and Kalutara districts will be heavily affected by drought conditions. Increasing temperatures will significantly impact the yield. Ratnapura and Kegalle districts will face a moderate impact due to drought conditions and occasionally upcountry tea plantations could face severe dry spells.

Adaptation measures needed: Implementation of proper regulations to limit the growing of tea below 3,000 feet, use of soil conservation techniques on landslide prone steep slopes and conservation, catchments and fragile areas are key adaptation measures to ensure safety from landslides. In addition, landslide risk maps prepared by the NBRO should be used as a land use planning basis and for building approvals. Further, use of organic fertilizers for tea estates is recommended to maintain the physical structure of soil. Avoiding extreme slopes for tea cultivation and using recommended drainage facilities are also considered to be effective adaptation measures.

Since most of the low country tea grown by smallholders, proper adaptation measures can save the livelihood of these families. Efficient irrigation when there are prolonged dry spells (especially using solar powered micro pumping systems), development of drought resistant varieties, implementation of community driven irrigation facilities, proper drainage facilities to improve ground water recharge, implementation of micro scale sprinklers, and research on multi cropping of tea plantations to provide an alternative income to smallholder families are key recommended adaptation measures.

3.6.1.3 Coconut Cultivation

The coconut sector of Sri Lanka accounts for 0.7% of the country's GDP (CBSL, 2019) and significantly contributes to foreign exchange earnings. The total land area under cultivation covers more than 440,000 ha, annually producing about 2.5-3.0 billion nuts.

Coconut palms that were frequently exposed to warm/drought seasons have significant failures in fruit formation as reproductive organs of a mature coconut palm (from flowers to mature nut) are more sensitive to water stress and high temperature than the vegetative organs. Coconut palm produces one inflorescence every month and the crown of a healthy palm generally bears 14-16 coconut bunches of different development stages. These stages of inflorescence development such as pollen formation followed by button nut formation will be sensitive to prevailing climatic conditions. Continuous exposure to heat or water stress can prevent the accumulation of starch and sucrose in the developing anthers, which are the main source of energy for pollen germination, resulting in poor pollen quality. Further, high temperatures, low relative humidity and a high vapor pressure deficit at the stage of pollination may cause pollen drying which results in reduced formation of the nut.

In Sri Lanka, floods and landslides are the other conditions that damage coconut farming. Over 14,000 acres of coconut lands are highly vulnerable and another 49,000 acres are moderately vulnerable to flood exposure (MoE, 2011). Occasional flooding does not harm coconut palms, but poorly-drained soils persisting for an extended period may eventually damage the palms.

Drought risk for coconut cultivation: The risk map shows that Puttalam and Mannar districts experience higher drought related risk for coconut plantations while Hambantota and Kurunegala districts and the most of areas in the dry zone reveals a medium risk of drought. During the past few years, coconut cultivations in Puttalam, Mannar and Hambantota districts were severely affected by droughts. The temperature and rainfall anomaly maps for 2050 predict further enhancement of dryness in terms of reduction of rainfall and increase of temperature in the dry and intermediate zones, further intensifying the drought risk (Figure 3.3, 3.4 and 3.5). This will further aggravate the situation in Puttalam, Mannar and Hambantota districts. The wet zone will not have serious impacts but could be affected by seasonal dry spells/longer dry spells.

Adaptation measures needed: Use of varieties with heat and drought tolerant characteristics is one of the major adaptation measures to effects of climate change. The degree of sensitivity to high temperature can vary with the variety, depending on their tolerance to stress. Climate resilient tree-based agroforestry systems have been identified as an adaptation measure for climate change impacts. For instance, coconut based mixed cropping systems or coconut-based agroforestry systems can improve the microclimatic condition by influencing air temperature, soil temperature, vapor pressure deficit, and soil moisture content of plantations.

Additional measures include providing irrigation, introduction of new watering technologies such as underground drip feeding, greater use of organic fertilizers for soil moisture retention, groundwater recharging facilities, introduction of inter cropping in coconut estates, and promotion of micro rainwater ponds/irrigation facilities. Development of heat and drought tolerant seed material in the seed gardens would need to be increased.

3.6.1.4 Rubber cultivation

Rubber is a plantation crop that is totally dependent on rainfall. The accepted norm for rubber growing is warm climatic conditions with around 2,000 mm rainfall evenly spread across the entire year. Rubber plantations resist drought conditions more than any other plantation crop grown in Sri Lanka. Similarly, they are flood-resistant for several days. Although commonly grown in rainy districts such as Kalutara and Ratnapura, the best weather for rubber is in the intermediate zone. Recurrent rainfall and floods lead to lower yields due to frequent interruptions in rubber tapping which impose costs on planters, their labours and smallholders. A short dry spell is advantageous for rubber to avoid leaf diseases caused by fungi during the period of new flush of young leaves (mid-Feb to mid-March). However, rain and drought affect tapping days and disrupts harvesting. Furthermore, climate change may cause new diseases which are detrimental to trees. The existing clones that have tolerance to climate change are limited (Yogaratnam, 2011).

Irregular rainfall and flood risk for rubber cultivation: The hazard and risk maps show that in some areas in Kalutara and Kegalle districts, there is significant risk to rubber. Except in coastal areas in Galle and Matara districts, the other areas in the wet zone indicate a moderate risk of floods. New rubber growing areas such as Moneragala demonstrates a low risk of floods. The RCP 8.5 rainfall anomalies for 2030 and 2050 indicate that most of the rubber growing areas are going to experience higher precipitation, thus posing an increased flood risk (Figure 3.2, 3.3 and 3.4).

Landslide risk for rubber cultivation: According to the risk assessment results, Kegalle and Kalutara districts have a significant risk of landslides. Medagama and Moneragala DSDs indicate a medium risk for landslides. However, rubber is a tree which conserves soil and prevents shallow landslides (Keith and Broadhead, 2011), on the other hand, large rubber trees can add to the weight and increase the intensity of landslides due to bedrock collapse. Galle and Matara districts show a low risk for landslides. The new areas of rubber growing in Moneragala illustrate a medium risk. According to the projections of the rainfall anomaly maps for 2030 and 2050, high rainfalls can be expected in Kegalle and Kalutara districts as well as all other rubber growing areas in the wet zone where a greater risk of landslides would be expected (Figure 3.4).

Adaptation measures needed: An effective rain guard, developed through research conducted by the Rubber Research Institute (RRI), can reduce interruptions to tapping during rainy season. Eventually, moving rubber plantations to other areas where rainfall is 2,000 mm but also has a more even distribution and more sunshine hours per day will reduce the risk to rubber due to climate change impacts. Growing rubber in a mixed plantation with other crops and inter-cropping are other adaptation measures that allow growers to diversify and have alternative incomes when rubber tapping is not possible during rainy seasons.

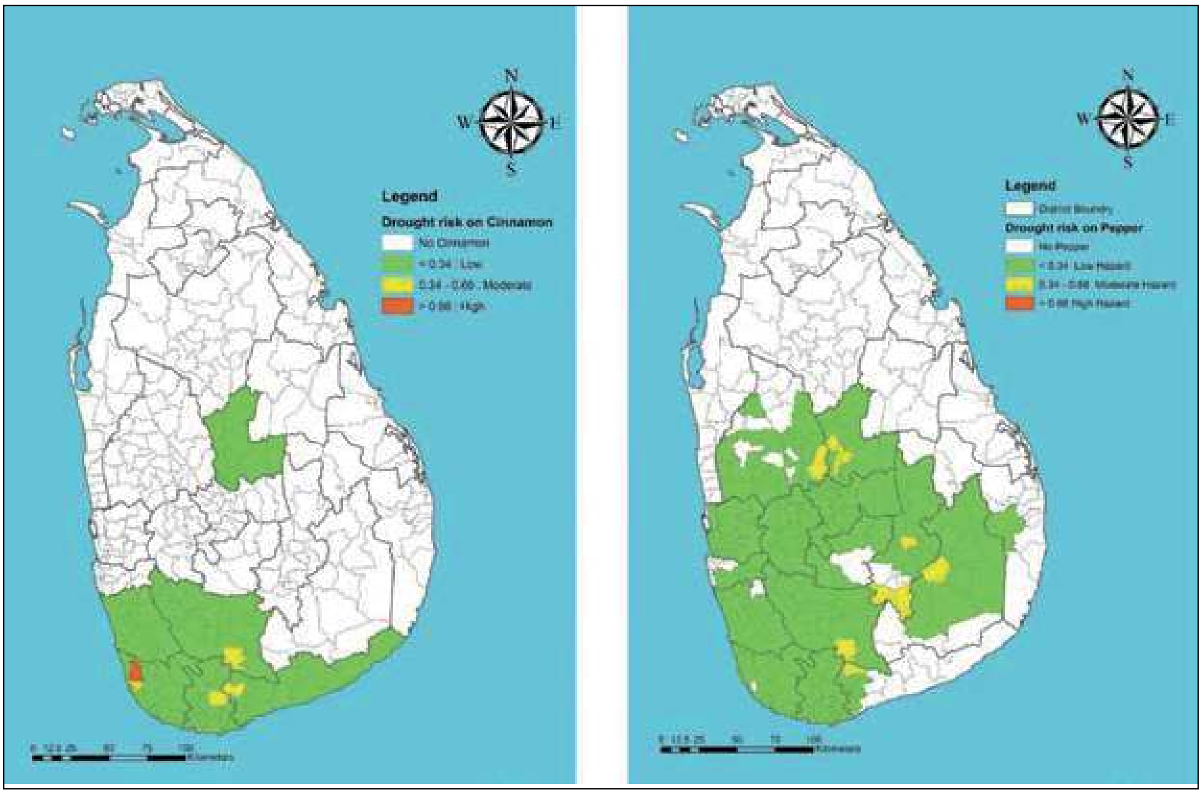
The risk of landslides can be reduced by shifting rubber plantations to intermediate zone where moderate rainfall occurred, protection of higher elevation areas through soil stabilization techniques and development of proper storm water drainage systems are also required.

3.6.1.5 Minor export crops

In Sri Lanka, nearly a quarter of gross export earnings are derived from minor export crops. Minor export crops including clove, cinnamon, cardamom, nutmeg, mace, pepper etc., contributed by 14.5% of export earnings in 2013. Sri Lanka is the world's largest producer and exporter of cinnamon which accounts for approximately 77% of the world exports. The country produces 2% of the world supply of pepper with an export value per year of over 7 US$ billion (Sachitra and Chong, 2015).

A. Cinnamon cultivation: Cinnamon originated in the central hills where seven wild species are found in Kandy, Matale, Belihul Oya, Haputale, Horton Plains, and the Sinharaja forest ranges. Presently, cultivation is concentrated along the coastal belt from Negombo to Matara, and has made inroads in Kalutara and Ratnapura. According to the Department of Export Agriculture, cinnamon can withstand high temperatures up to 32°C if rainfall is over 1,750 mm and tolerate high humidity. Sri Lanka's cinnamon has high concentrations of essential oils and is a highly sought after commodity and, the sector is dominated by smallholder farmers.

Drought risk for cinnamon cultivation: The overall risk of drought is comparatively low as cinnamon grows in the wet zone and a few areas in the intermediate zone. The map indicates a few growing areas such as Karandeniya, Kollonna, Walasmulla and Mulatiyana with moderate risk, while Ambalangoda shows high risk (Figure 3.15-A). According to temperature and rainfall anomaly maps of 2030 and 2050, the wet zone will not see diminished rainfall but variability will increase and the temperature could exceed safe thresholds, thereby elevating the risk from low to moderate levels as per RCP 8.5 scenario (Figure 3.2, 3.3, 3.4 and 3.5).



Drought risk on cinnamon (A) Drought risk on pepper (B)

Figure 3.15 Drought risk maps for cinnamon and pepper

Adaptation measures needed: Conducting further research on growth parameters for cinnamon can be recommended. Field trials to propagate cinnamon to other areas such as Moneragala and Kandy, while developing new varieties to suit to different regions, could help the industry stand for climate change risks and impacts. In addition to that, promotion of alternative livelihood options, promotion of mix culture, implementation of micro watering systems, promotion of community driven irrigation mechanisms are potential adaptation measures that could be applied.

B. Pepper cultivation: Pepper is a rain-fed crop that requires over 2,000 mm of annual rainfall and temperatures higher than 12°C up to a maximum of 35°C. Areas with prolonged drought or dry periods should be avoided for pepper cultivation unless there is supplementary irrigation. A clear dry spell and sufficient rainfall for flower induction and pollination are vital for the production while strong winds are harmful. Growth and yield performances are better in the humid tropics.

Drought risk for pepper cultivation: According to the map, cultivation in the wet and intermediate zones have low risk due to high rainfall expected in the models. Within the pepper growing areas, a few DSDs shows a moderate risk to drought. Rideegama DSD in the Kurunegala district shows a moderate risk of drought. Similarly, Pallepola, Matale and Ambanganga Korale DSDs in the Matale district, Haldummulla and Soranatota DSDs in Badulla district, Walasmulla DSD in Hambantota district and Kollonne DSD in Ratnapura district show moderate drought risk (Figure 3.15B). However, in 2030 and beyond, pepper growing in the intermediate zone could be seriously affected due to less rainfall and increasing temperatures (Figure 3.2, 3.4 and 3.5).

Adaptation measures needed: Development of new pepper varieties resistant to drought will have long term benefits. However, introduction of efficient irrigation schemes, especially community driven water management, would be useful in the short term coupled with improved maintenance of pepper plants to obtain increased yields.

C. Sugarcane cultivation: Sugarcane is a semi-perennial, commercial crop grown in the intermediate and dry zones of Sri Lanka. At present, nearly 15,000 farmer families are directly involved in sugarcane production for vacuum-pan sugar mills, while large number of farmer families produce jaggery and syrup as cottage products (Wijayawardhana and Kumarasinghe, 2011). There is a potential of producing an average yield of 56-112 MT/ha from local sugarcane plantations. Scarcity of water and prolonged drought periods severely affect the sugarcane crop, while unseasonal rainfall and shifts in monsoonal weather patterns are considered more critical climatic factors.

The effects of drought in early and mid-growth stages mainly reduces cane yield and thereby sucrose yield. A shift in temperature will affect diseases, insects and weeds in sugarcane production. The prolific dry weather exacerbates the symptoms of ratoon stunting disease. On the other hand, water logging is a widespread phenomenon that drastically reduces the growth and survival of sugarcane causing 18-64% reduction in cane yield depending on the duration, plant growth stage and cultivars (Zhao and Li., 2015).

Adaptation measures needed: Adaptation for such adverse climatic variations are limited in the present context. Two available adaptation options are to change of the planting and harvesting schedules of sugarcane to minimize the impact of drought conditions and supplementary irrigation. The establishment of small ponds within plantation areas to maintain the ground water level is also a possibility. Farming communities are used to the current cropping cycles and adjusting practices to respond to climate risks could need a government led top-down approach. Promotion of climate smart agriculture techniques and weather-based insurance schemes could also be useful.

3.6.2 Livestock sector and climate change impacts

Livestock is closely integrated with agriculture and a high national priority for meeting protein requirements and ensuring food security in the country. The sector grew by 4% in 2019 (Livestock Statistical Bulletin, 2020) and continues to do so. The sector covers farming of cattle, poultry, buffalos, goats, sheep and swine. The majority of cattle farms are distributed in the dry zone while only about 12% of the total cattle population is found in the wet zone. Swine farming provides employment for over 5,000 families in the coastal belt of the western and north-western provinces. Around 90% of the goat population is found in the dry and intermediate zones.

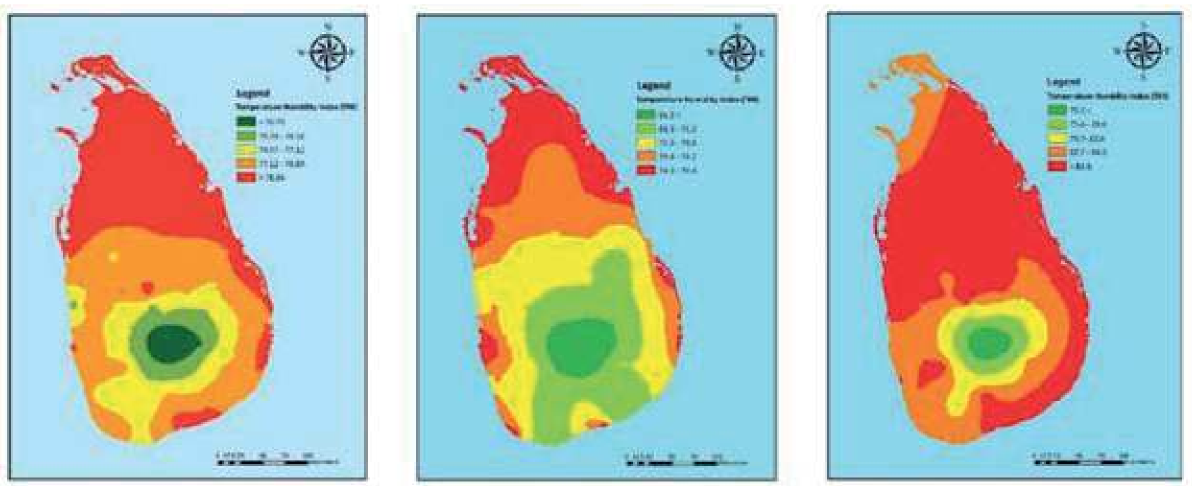
Climate change poses formidable challenges to the livestock sector and its future development. The predicted temperature increased from 2.3°C - 4.8°C and increased precipitation by 2050 will aggravate the stress on dairy animals by adversely affecting productivity and reproductive capacity on high yielding dairy cattle. Given Sri Lanka's vulnerability to extreme weather conditions, the impact of such events on the livestock sector will result in a loss of income for rural households and will indirectly affect livestock production by aggravating feed, fodder and water shortages. The recent droughts during 2016-2017 provided clear evidence for such adverse conditions for livestock sector.

3.6.2.1 Dairy farming and cattle rearing

The Thermal Comfort Zone (TCZ) for temperate dairy breeds is in the range of 5°C - 25°C. Intensification of dairy systems in dry regions using temperate breeds could lead to greater vulnerability to temperature and humidity increases. Temperature Humidity Index (THI) greater than 72 units generates heat stress for dairy cattle.

Temperature anomalies in 2030 and 2050 indicate part of the intermediate and dry zones are at high risk of increasing temperature (Figure 3.13). According to the Temperature Humidity Index (THI) maps in Figure 3.16, the upcountry wet zone is the most suitable area for exotic breed since a favourable climate prevails throughout the year. However, further expansion of the dairy industry in this area is hindered due to restriction of resources such as land and fodder. The THI values in the intermediate and dry zones vary with the day and night time temperature changes. The majority of dairy animals are distributed in the intermediate and dry zones (88%) where land is available however, these zones will face greater challenges from temperature increase, droughts and diseases.

Adaptation measures needed: During prolonged drought periods, it is important to apply better management practices such as shade grazing, and introduce animals (cattle) that having moderate productivity to these areas. Conservation of animal genetic resources through proper breeding strategies to retain economically important characters that resist extreme weather changes would be vital. Development of new feed varieties, promotion of integrated farming techniques with agriculture and fisheries, and introduction of micro cooler areas are other effective adaptation measures to overcome stress level.



(A) Variation of the THI on average temperature and relative humidity

(B) Variation of the THI on maximum temperature and relative humidity

(C) Variation of the THI on maximum temperature and relative humidity

Figure 3.16 Variations of the Temperature Humidity Index (THI)

Drought risk for cattle: As demonstrated in the rainfall anomaly maps above Figure 3.2, 3.3 and 3.4 risk to drought will range from moderate to high in the intermediate and dry zones. This has a negative impact on dairy production due to the unavailability of grazing lands, especially in the intermediate and dry zones. Furthermore, grazing and mixed rain-fed pastures and farm crop residues used as fodder will be affected by prolong drought situation. Water scarcity will be a major problem for dairy animals since their water requirement is extremely high compared to other livestock. The combined effect of water and feed scarcity during droughts adversely affects productivity of the cattle farming and reproductive capacity (Figure 3.17).

Adaptation measures needed: To enhance adaptation, there is a need to increase farmers' awareness and knowledge related to climate change and crop stock mixed farming systems. Climate change related research and development (R&D) and encourage public private partnerships for specific crop stock farming systems. Strengthening adjacent watershed capacities and management of grazing lands to improve resilience coupled with location specific low cost techniques to increase water use efficiency for livestock would be pivotal.

3.6.2.2 Poultry farming

High temperatures, rainfall and relative humidity can have profound impacts on poultry production, especially with regard to meat and egg production, outbreak of diseases, feed intake and immune systems (Adesiji and Baba, 2013).

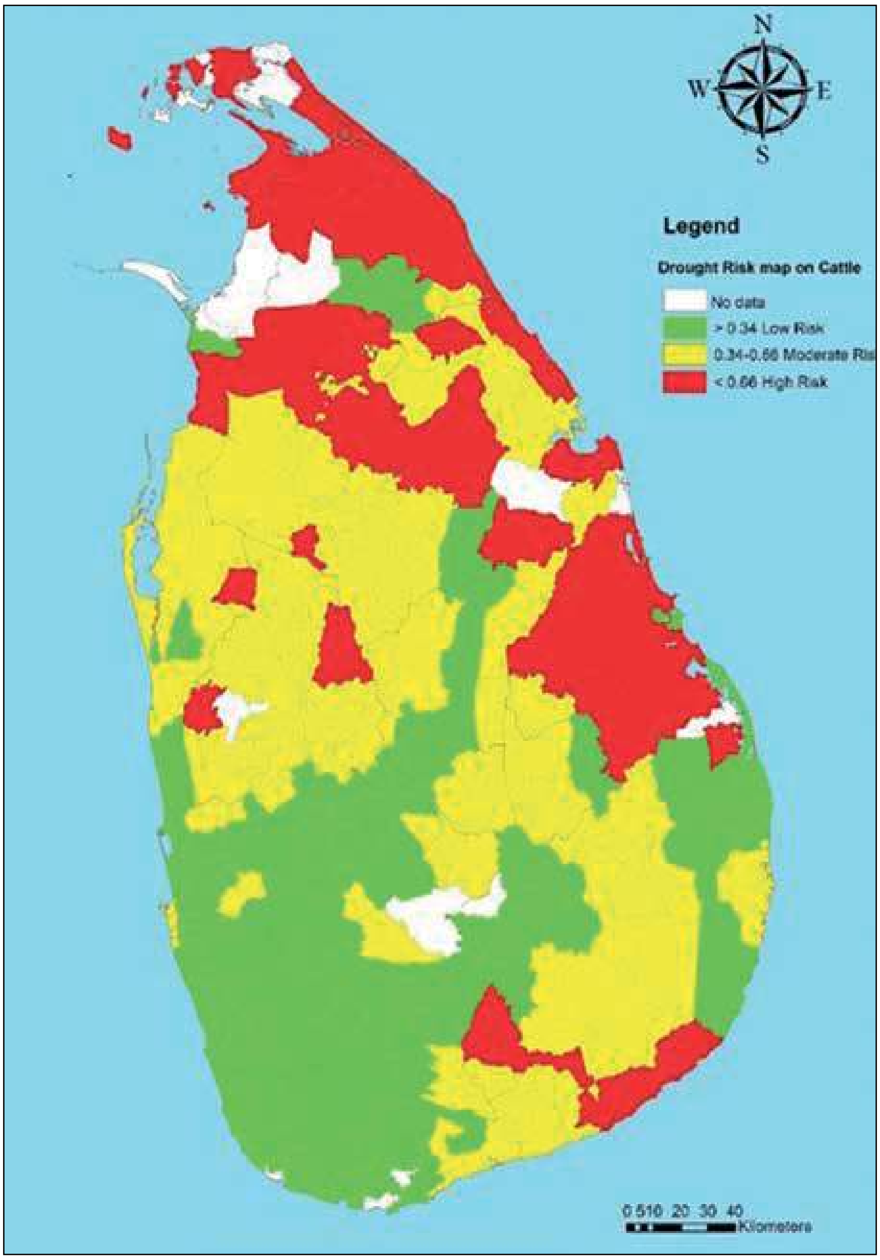


Figure 3.17 Drought risk map for cattle

Most large farms with over 100,000 population are managed under closed house systems where climate within the house environment is completely controlled. These farms are not affected by the outside environment or temperature and such farms account for around 22% of the total poultry population. The small and medium scale farmers mostly manage their poultry in open house systems and they are the most vulnerable to the adverse impacts of climate change.

However, a large number of medium scale farmers use the open house deep litter system to manage their poultry. Such farms are not economically sound and are highly vulnerable to climate change since they are unable to control adverse climatic conditions such as high temperature and humidity. Changing climate conditions directly affect feed intake and productivity. Further, extreme heat and humidity may lead to high mortality. Broilers in final stages of their life are usually more susceptible to high temperatures than the layers (Manisha et al., 2019). Poultry is a self-sustaining industry and government involvement is limited on policy interventions to monitor and control the poultry industry.

Extreme temperature risk for poultry farming: Moderate to high risks exist in the intermediate and dry zones for poultry farming. The maximum temperature anomaly for 2030 shows an increase of temperature uniformly across the country and 2050 shows a very high risk in most parts of the dry and intermediate zones (Figure 3.5). According to the risk maps of extreme temperature, a moderate risk prevails in Kurunegala, Gampaha, some parts of the Puttalam and Rathnapura districts (Figure 3.18). Prolonged drought may have an impact on feed industry, but it will not have a significant influence on poultry industry since feed ingredients are mostly imported. Therefore, risk and hazard on poultry industry due to drought are not discussed.

Adaptation measures needed: Adapting to climate change anomalies, poultry farming should be managed to effectively cope with extreme conditions with enhanced resilience, coupled with good management and modernization of farms. Further, implementation of micro water schemes, use of insulation for poultry farms and the introduction of shady areas to combat heat effect around the poultry farms are other adaptation measures that can be recommended.

3.6.2.3 Swine farming

Swine farming is another important industry to supply animal proteins to local consumers. This industry was popular in the coastal belt of Kalutara to Negombo in the past. However, in recent times, it has spread to the interior where urban markets are being established. About 60% of swine farms are small scale, while 25% are medium sized and the remaining 15% are large scale.

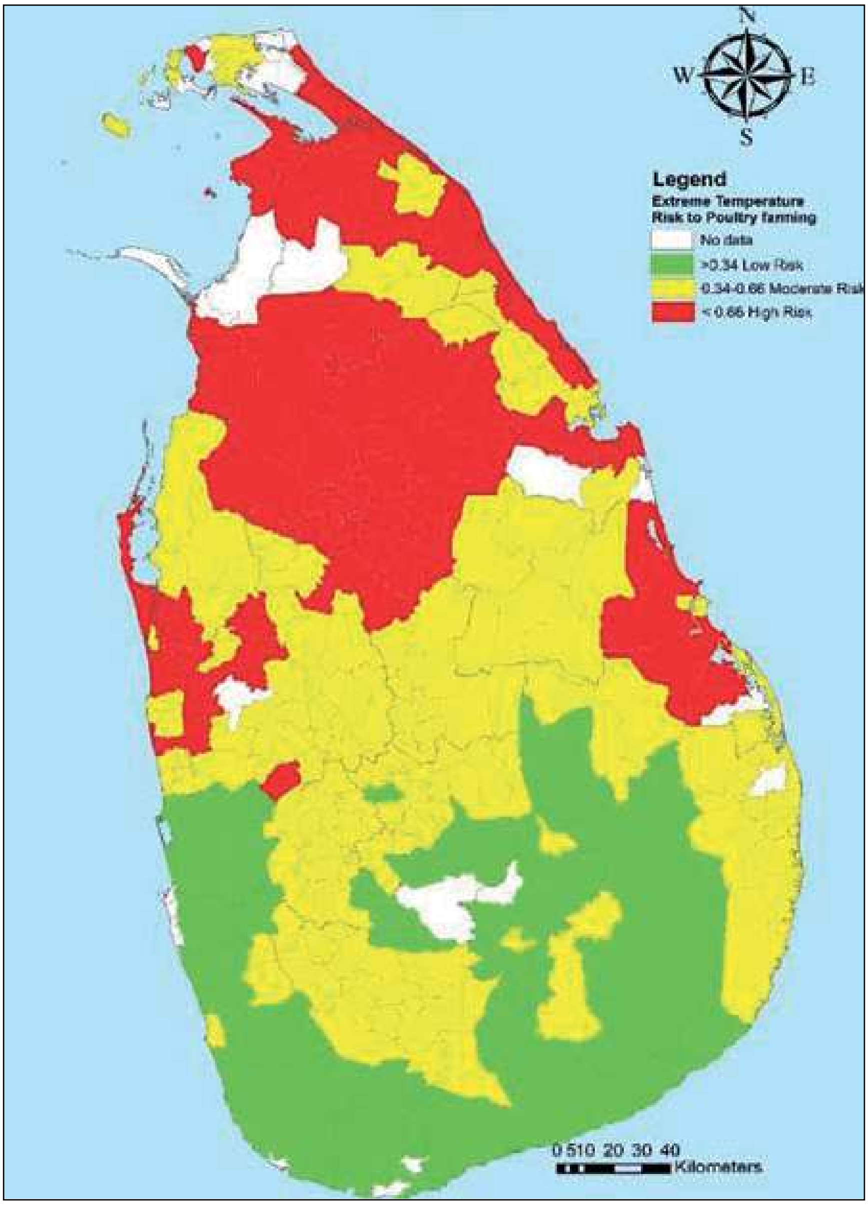


Figure 3.18 Extreme temperature risk to poultry farming

Medium and large scale farms are intensively managed in housing and fed with concentrates throughout their entire production period. Animals in small farms are managed using extensive or semi intensive systems. The swine industry is mainly dependent on exotic breeds such as Landrace and Large White which are highly vulnerable to stress conditions caused by high temperature and humidity. In addition to the exotic breeds, a substantial number of farmers in coastal areas are rearing indigenous pigs which have valuable traits such as adaptability to poor feed quality, resistance to diseases and the ability to survive under a wide range of environments (Silva et.al., 2016). The industry has been stagnating due to various constraints including religious taboos. The total swine population in the country is approximately 75,000-80,000 (DAPH, 2015). However, the industry is very profitable due to the low cost management systems adopted by the farmers.

Extreme temperature risk for swine farming: Swine are highly vulnerable to temperatures above 28°C. The maximum temperature anomaly for 2030 shows an increase of temperature uniformly across the country while 2050 shows a very high risk in the most parts of the dry and intermediate zones, and even in the wet zone (Figure 3.5). Extreme temperature makes the dry and intermediate zones and, occasionally, the wet zone to be unfavourable for swine farming (Figure 3.19).

Adaptation measures needed: To adapt to climate change anomalies, the swine industry can introduce improvements for farm houses to effectively cope with anticipated climate and weather extreme. Improved access to water sources will be an important adaptation measure. Enhancement of shading areas, insulation for swine farms and use of micro water schemes are also a proposed adaptation measures for swine farming resilience.

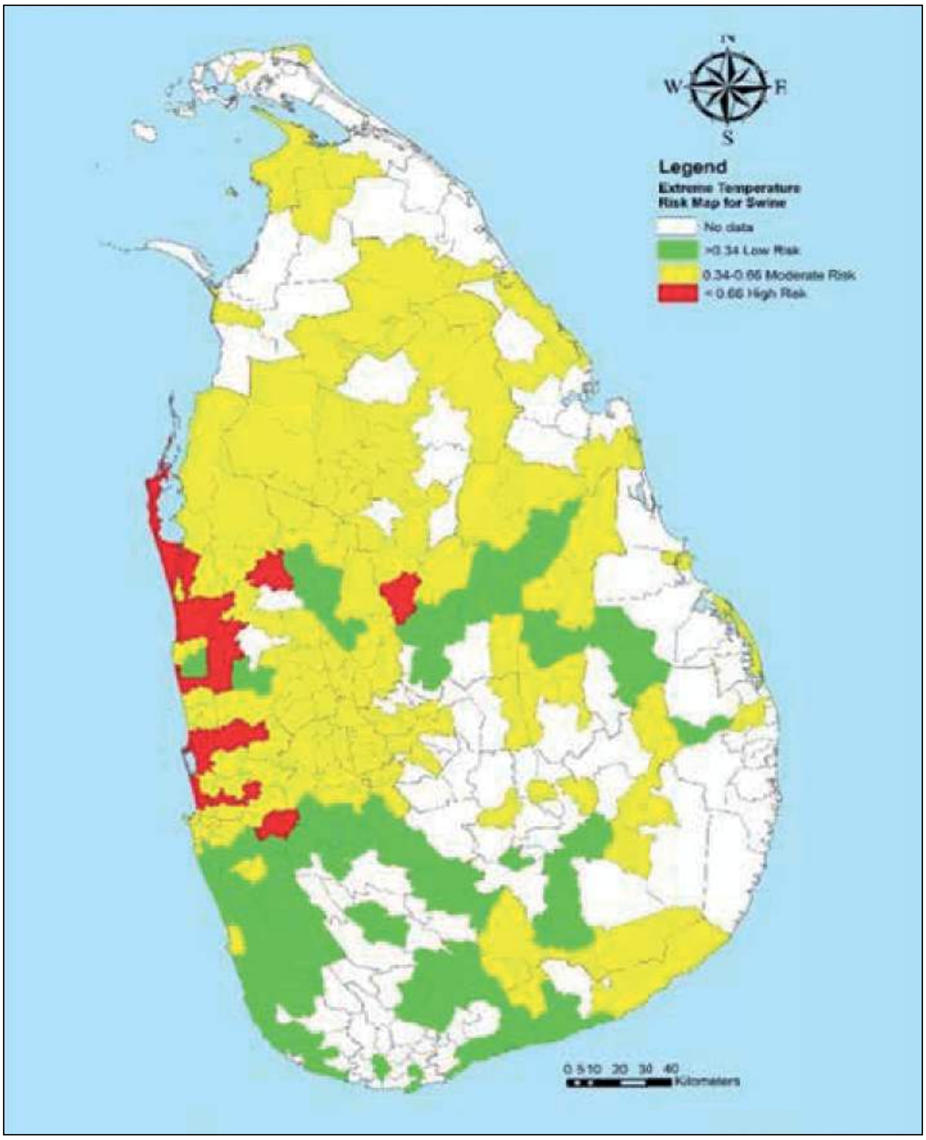


Figure 3.19 Extreme temperature risk map for swine

3.6.3 Fisheries sector and climate change impacts

The fisheries sector of Sri Lanka consists of three main sub sectors namely; offshore, deep sea, and inland and aquaculture. These sub sectors employ around 250,000 active fishers and another 100,000 in support services, where 560,000 people have found direct and indirect employment.

The fishery sector constitutes the major economic activity in the coastal region which is home to 25% of the population in the country. The sector provides about 70% of the animal protein requirement in the country and contributed 1.3% to the GDP in 2016 (NARA, 2016).

The country possesses an Exclusive Economic Zone of 517,000 km^2 as a marine resource. There are 45 major brackish water lagoons and estuaries covering 1,580 km^2 along the coastal belt. An extent of 5,200 km2 of freshwater bodies including irrigation reservoirs, perennial tanks and seasonal tanks, constitute inland fisheries. The total fish production is 530,920 tons in 2016 of which 456,990 tons of fish came from the ocean while the remaining 73,930 tons were harvested from inland and aquaculture sources (NARA, 2016).

There are 59,116 fishing vessels, 24,028 outboard engine fiberglass reinforced boats, 17,813 non-motorized traditional craft and 4,218 inboard multi-day vessels. Along the coast, there are 700 landing sites for minor fish harvesting by traditional crafts and outboard motorboats. The multiday and someday boats use 12 fishery harbours and the country possesses 19 locations for anchorages. The inland fisheries subsector includes capture fisheries in inland waters (perennial reservoirs) and culture-based fisheries (minor perennial reservoirs and seasonal reservoirs). The inland fisheries subsector produced 68,500 tons from capture fisheries and 8,740 tons from culture-based fisheries in 2017 (MFARD, 2018).

Climate change issues for the fisheries sector have received relatively little attention. However, the sea level rise at the rate of 1.5 mm/year to 3 mm/year over the past 100 years (Arulananthan, 2016) and warming of the sea has recently been identified as the most two crucial factors in the fisheries sector. The effects of climate change on aquatic ecosystems can be seen through the sea surface temperature (SST) rise and associated changes in the phenology of the organisms, or indirect through ocean acidification. The increasing frequency and intensity of storms could also increase the sector's vulnerability to climate change (Figure 3.20).

Due to climate change, fisheries sector experience differences in species distribution. Changes in freshwater levels in estuaries would alter the composition of brackish water species. A changing climate would impact seagrass bed ecosystems which in turn, would affect marine production and income of fishery based livelihoods. The property and physical infrastructure of small scale fishers and their communities would also be threatened with rising sea levels. Changes of the SST according to climate change impacts on the distribution, growth and reproduction of fish stocks will lead to significant shifting of potential fishing grounds, causing impact on offshore deep sea fisheries.

Sea level rise will result in loss or change of coastal habitats and species distribution with profound impacts on fisheries. Landward migration of coastal wetlands would result in the loss of established freshwater and brackish water habitats (such as mangroves, salt mashers, coral reefs and seagrass) that are important breeding grounds for coastal and marine fisheries. Loss of wetlands in coastal areas and changes in salinity of lagoons and estuaries affect fish and shellfish. Increasing storm surges and disaster events will damage reefs, leading to reduction in fish breeding and feeding grounds. Also, damage to coral reefs will increase coastal erosion and salinity of inland soil and freshwater sources. Ocean acidification would make it more difficult for shellfish, crabs, lobsters and corals to build calcium carbonate shells, causing stocks to diminish.

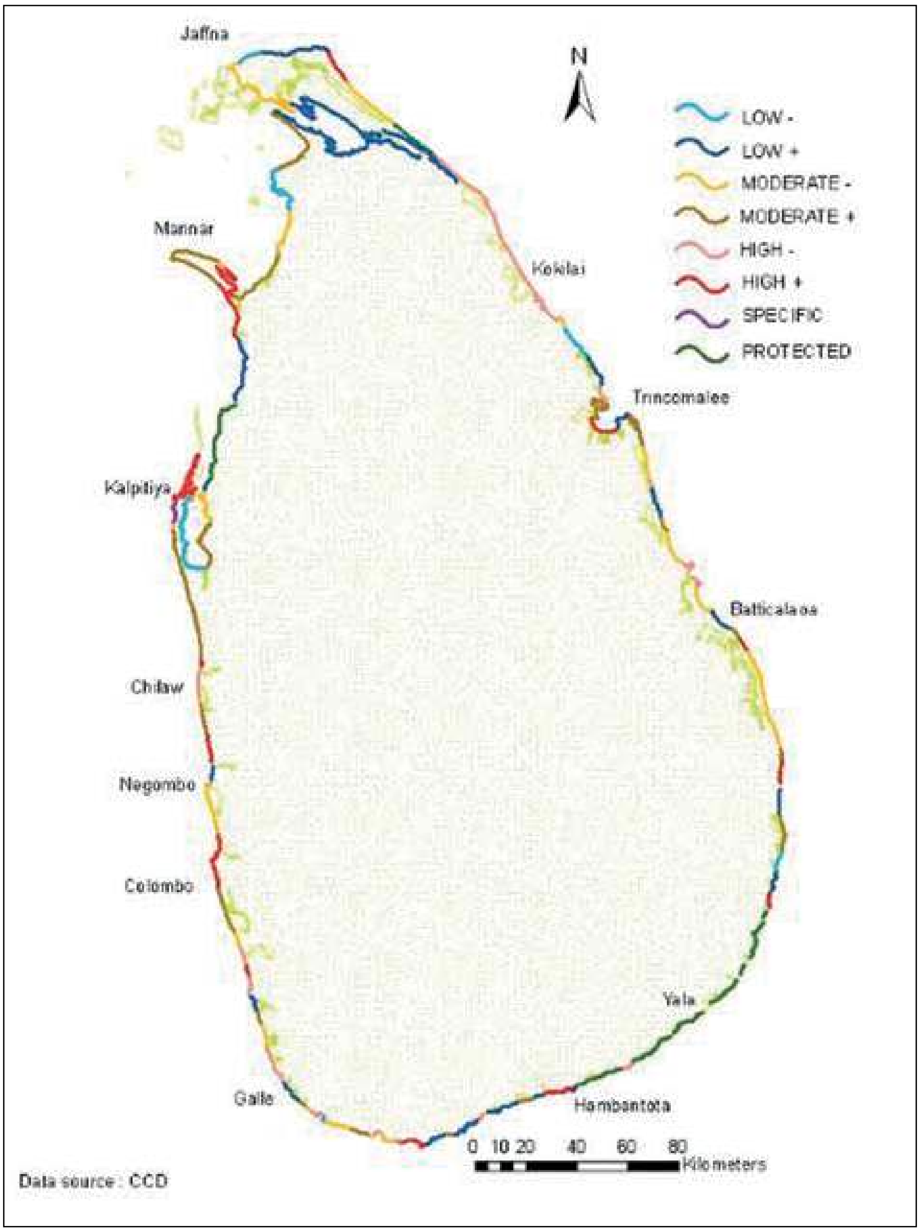


Figure 3.20 Vulnerability levels of fisheries sector (Arulananthan, 2016)

Threats to aquaculture due to climate change are more manageable. However, shrimp farming in the north-western coast found to be particularly vulnerable to climate change. There is insufficient scientific information available on the climate change impacts of inland fisheries. The freshwater ecosystems are threatened by changes in temperature, drought, precipitation, run off and floods. These impacts create a high risk environment for fish stocks. Recent studies illustrate that inland fisheries in northern, north-western, north-central and eastern provinces are subject to high risks from climate change impacts.

In marine fisheries sector, Kalpitiya in Puttalam district emerges as highly vulnerable to sea level rise. Kalpitiya area has 43 fishery landing sites providing livelihoods to approximately 6,000 people and they are highly vulnerable due to sea level rise. The inland and brackish water fisheries in the dry and intermediate zones have been identified to be vulnerable to droughts (MERE, 2011).

Coastal fishery infrastructure development should be in line with possible coastal inundation due to sea level rise. Implementation of sand nourishment and structures to overcome sand erosion will be required. Other potential adaptation measures are climate proof infrastructure development and alternative livelihoods for fishing communities. Enrichment of catchment areas to maintain sufficient water flow in the inland irrigation systems and development of new varieties which could adapt to climate shocks.

Figure 3.21(A) Sea-level rise impacts on coastal fisher population in coastal districts in 2030

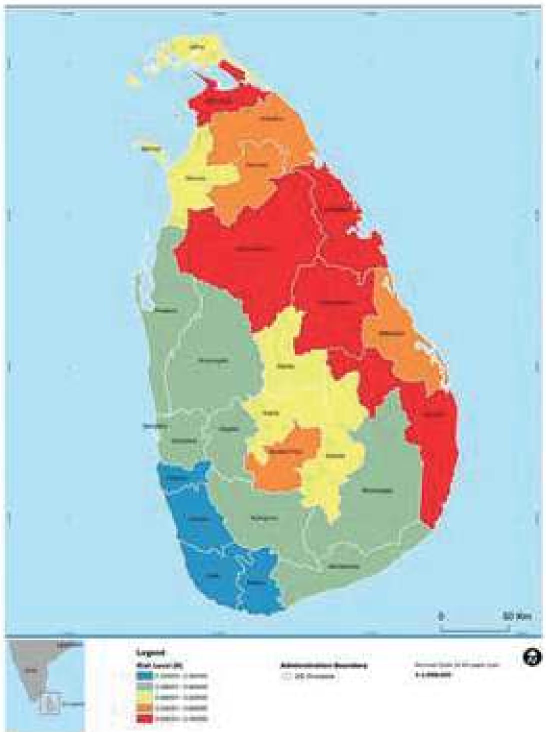


Figure 3.21(B) Inland fishery sector risk to climate change impacts

According to the risk map in Figure 3.21 (A), the districts with high risks for coastal fishing populations from sea level rise are located in the northern and eastern provinces. Further, low lying coastal fishing settlements of these districts are prone to multiple natural hazards based on climate change impacts in addition to sea level rise.

In Figure 3.21(B), illustrates high risk areas for inland fisheries sector from climate change and indicates the vulnerability of districts in the northern, northcentral and eastern provinces. The risk for inland fisheries would be further aggravated due to the rainfall anomaly of the northeast monsoon in 2030 and 2050, and temperature anomaly as per RCP 8.5 scenario (Figure 3.2, 3.3, 3.4 and 3.5).

Adaptation measures needed: Establishment of an efficient climate information management and communication system, including satellite-based vessel monitoring system to provide early warnings is one of the adaptation measures needed. Adaptive management and co-management approaches that recognize the threats and counter the impacts of climate change could be included in policies related to fisheries. Research and development should be conducted to assess climate impacts on fisheries sector.

3.6.4 Climate change impacts on human health

Climate variability has multiple influences on human health with direct impacts which include the effects of rising temperatures and more intense heat waves and floods. Increasing temperatures could encourage spread of vector borne diseases such as dengue. Sri Lanka has recently experienced outbreaks of diseases those are closely connected with extreme weather events.

Polluted surface water, secondary to floods increases the risk of vector borne, rodent borne and water borne diseases. Extreme weather conditions which are aggravated due to impacts of climate change could further lead to disasters which cause injuries and fatalities (MoE, 2010). Changes in rainfall patterns, intensities, increasing temperatures and prolonged droughts could impact on food security, affecting nutritional status and lead for psychiatric illnesses, predominantly among the rural poor (WHO, 2015).

In identifying vulnerability of health sector, this section focuses on vector borne diseases (dengue, malaria, filariasis, leishmaniasis), zoonotic diseases (leptospirosis), nutritional status, food and water borne diseases, extreme climate related health concerns, heat induced health issues and diseases associated with air pollution. Further, this section describes predictions targeting the year 2030 with vulnerability to climatic changes and repercussions on human health in Sri Lanka.

A. Vector borne diseases: Vector borne diseases transmit through a bite or sting of mainly insects such as mosquitoes and ticks though it could be transmitted by other animals as well. Spread of vector borne diseases in to new areas with changing patterns of local climate is a potential health hazard that needs close attention. Increasing temperatures have a positive correlation with disease occurrences. Climate change may increase the risk of some infectious diseases especially those in warmer areas spread by mosquitoes and other insects where the climatic conditions will be favourable for the growth of the vector organism. Rainfall is one of the principal climatic factors influencing mosquito population, because it increases the extent of mosquito vector breeding sites. The rainfall also modifies the temperature and relative humidity which influence for higher longevity and vector survival. Normally higher temperatures increase the number of blood meals taken and number of times the eggs are being laid. This will also induce for parasite multiplication. Therefore, increasing temperature may have a positive correlation for disease occurrences.

B. Dengue: Dengue has become the main vector borne disease of the country. It is invading newer areas with outbreaks occurring more frequently and explosively. A Sri Lankan study conducted in the western province provides evidence for a strong correlation between dengue outbreaks and rainfall. The distribution patterns of dengue vector mosquitoes overlap with monsoon rains.

The Colombo Municipal Council area has shown the highest risk for dengue under the prevailing climate conditions. The districts of Colombo, Gampaha, Kalutara, Kandy, Ratnapura, Kurunegala, Galle, Jaffna and Matara exhibit higher risk for dengue especially in urban setups. However, the risk of dengue remains at a moderate to high risk level throughout the country. According to temperature and rainfall anomaly maps of 2030 and 2050, rainfall will increase in southwest monsoon in the wet zone and positive anomaly for temperature for entire country poses (Figure 3.2, 3.3, 3.4 and 3.5). As a result of, a notable increment of dengue outbreaks is shown in Figure 3.22(A).

C. Malaria: Malaria is transmitted though mosquitoes of the genus Anopheles. Sri Lanka achieved "malaria free" certificate from the WHO in September 2016 for maintaining zero indigenous malaria cases during 2012-2016 (Simac et al., 2017). However, the country remains vulnerable to its re-introduction and transmission due to the continuous influx of migratory malaria cases through travellers to the country. Some studies conducted in previous malaria endemic areas in Sri Lanka highlight that the climatic factors; especially temperature, rainfall, relative humidity are favourable for malaria epidemics (Gunathilaka et al., 2016).

Climate change risk on malaria: According to the risk assessment, all the districts in Sri Lanka indicate a moderate risk for Malaria, except Colombo and Galle districts denoting low risk level. The expected increments in rainfall and temperature anomaly for 2030 and 2050 as per the RCP 8.5 scenarios (Figure 3.2, 3.3, 3.4 and 3.5) would influence the breeding and distribution of Anopheline vectors, thereby further increasing the risk [Figure 3.22(B)].

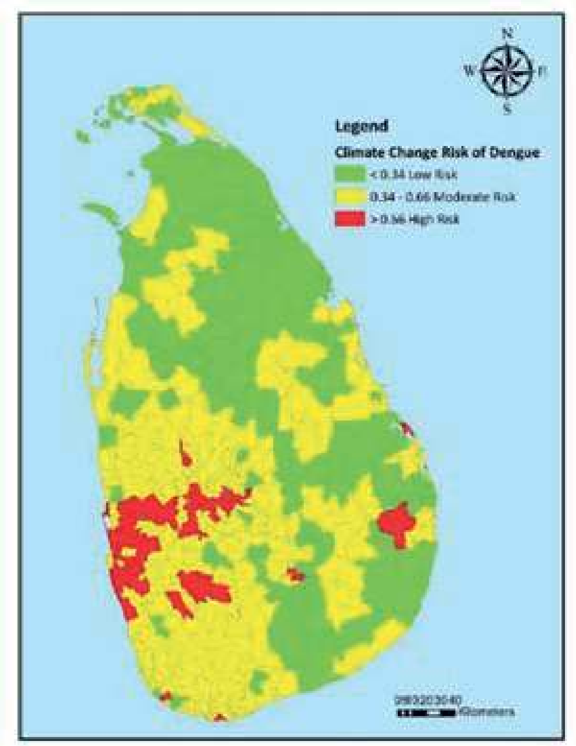


Figure 3.22(A) Climate change risk on dengue

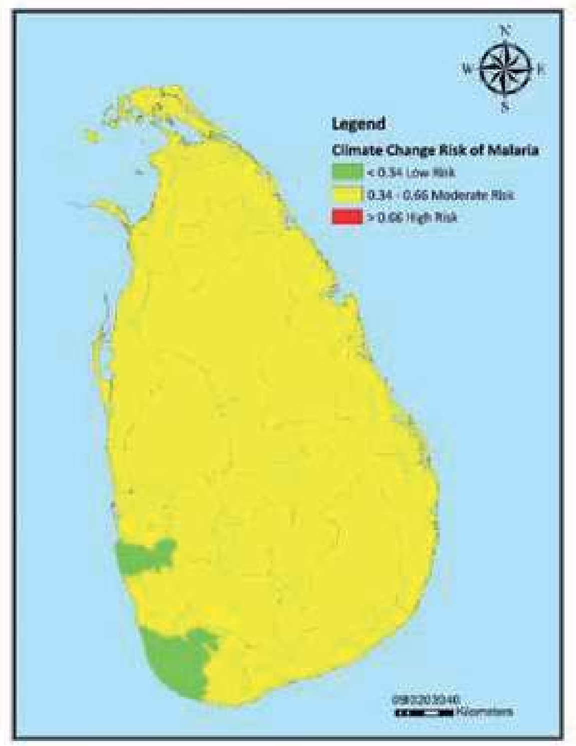


Figure 3.22(B) Climate change risk on malaria

D. Leishmaniasis: Leishmaniasis is newly established in Sri Lanka with the first reported case in 1990's. Previous studies reported that the occurrence of leishmaniasis is seasonal (Adegboye et al., 2017). The main method of transmission of this disease is through the bite of the female sand flies of subfamily Phlebotominae (Diptera: Psychodidae). Climatic changes in rainfall, humidity and atmospheric temperature influence behavioural activities and life cycle of the vectors and reservoir hosts. According to the records from 2009 to 2016, it indicates a seasonal trend in the northcentral part of the country during July to September and in the southern region during October to December. It is further noted that the maximum temperature humidity and wind speed are significantly associated with climatic variables with the occurrence of disease incident in endemic areas.

A moderate risk level is shown by majority of districts in Sri Lanka for leishmaniasis, except for the MOH areas without previous incidents. However, the districts of Anuradhapura, Hambantota, Polonnaruwa, Kurunegala and Matara had relatively higher risk levels for leishmaniasis than the rest. The predicted increments in rainfall and temperature would directly influence the behavioural activities and life cycle of vectors and reservoir hosts, thereby elevating the overall risk for leishmaniasis within the country in 2030 and 2050 according to the RCP 8.5 temperature and rainfall scenario (Figure 3.2, 3.3, 3.4 and 3.5).

E. Filariasis: Filariasis is a mosquito borne protozoan disease mostly transmitted by mosquitoes in genus Culex and Mansonia. In Sri Lanka, Wuchereria banacrofti and Brugia malayi are the causative parasites for lympatic filariasis. However, majority of microfilaria positive cases were due to Wuchereria bancrofti. The disease is endemic in eight districts; Colombo, Gampaha, Kalutara, Kurunegala, Puttalam, Galle, Matara and Hambantota belonging to western, southern and north western provinces. Colombo district denotes the highest microfilaria rate. Changes in temperature, rainfall and relative humidity is also important in the transmission, as mosquitoes can survive longer and disperse further in areas with suitable relative humidity. Further, unplanned urban development may lead to create suitable breeding habitats for disease transmitting vectors.

Adaptation measures needed: Dengue spreads through prolific breeding of the Aedes vectors in unattended water pockets after rains. Often when the public health outbreak occurs the breeding is well on its way. Open dumping contributes to water collection and vector breeding and hence the most micro level waste management is required. Real time risk mapping and dengue risk modelling, utilization of additional vector indices such as pupal indices and motivation of entomologists/ MOH/ PHI (Public Health Inspectors) at the regional and local level are important in dengue management. Meanwhile, proper motivation and training of vector controlling officers, community participation and better multi institutional coordination for vector control are required urgently to contain outbreaks and implement early control actions. Implementation of integrated vector control methods based on climate risks and rainfall forecasts issues by the DoM are vital. Further, exploring feasibility of using novel vector control strategies such as Sterile Insect Technique, Incompatible Insect Technique, Genetically Modified strategies or gene drive mechanisms could be recommended after complying risk assessment and biosafety procedures under a proper monitoring system. In patient management, development of molecular based rapid diagnostics tools would be beneficial.

Improvement of current surveillance system and establishment of a rapid response system for patient management, continuous monitoring of vector densities and strengthening of research studies on potential vectors and their vectoral capacity remain as the key adaptation measure to control malaria. In addition, promoting public awareness on potential malaria risk and sustaining further funding for maintaining the malaria free status in Sri Lanka are also important. Assessing the vectoral capacity of available vectors by vector incrimination and molecular based studies could be recommended to identify the entomological risk for disease transmission. Finally, in order to prevent reestablishment of malaria, continued financial support (local and international), sustained surveillance for vector species present in Sri Lanka and effective control of imported cases through rapid detection and early diagnosis are all required.

Strengthening the current vector surveillance system by using GIS based risk prediction methods, establishment of an early warning system linked to rainfall/temperature forecasts and further study of vector biology are key adaptation measures to control climate-induced spread of leishmaniasis in the country. In addition, development of disease forecasting models locally would be a useful tool in disease control and management. Meanwhile, raising awareness of medical staff, vector control officers and the public on vector management, disease symptoms and effective patient treatment methods could also play a major role in epidemic management. Given the importance of Leishmaniasis vectors, investigations of the biology, behaviour, distribution and population dynamics of these insects should be integrated into routine of public health services, especially in areas where the disease is endemic and climate vulnerability persists. Therefore, it is high time for health authorities to assess the need of establishing a Leishmaniasis Control Unit to conduct such activities in a systematized manner.

Strengthening the current vector surveillance system, incorporation of risk prediction/ early warning approaches, further study of vector ecology and improvement of diagnostic facilities can be identified as the major adaption measures for Filariasis. Raising awareness on Filariasis and encouraging community based vector control approaches are also important for management of Filariasis. Preparation of guidelines for screening of tourist and foreign workers influx from disease endemic countries could be better adaptive measure in order to minimize the transmission and re-establishment of the disease to a public health importance in the country.

F. Zoonotic diseases: Leptospirosis is prevalent in the western province. Outbreaks have been reported from new areas except Jaffna since 2008. Although the disease is reported throughout the year, peaks usually correspond to the two main monsoons with some variations during epidemic years. Some studies have indicated that in the wet zone, reported cases of leptospirosis have increased significantly with land preparation and harvesting seasons of agriculture. Outbreaks of leptospirosis have been associated with regional and seasonal conditions such as high mean ambient temperature, increased rainfall and alkaline soil pH (Levett, 2003).

The leptospirosis risk remains moderately high in the districts of Colombo, Kalutara, Gampaha, Ratnapura, Galle, Matara, Kegalle, Matale and Kurunegala while other areas denote a lower risk level. The predicted temperature rise and rainfall increase in the wet zone by 2030 and 2050 as per the RCP 8.5 scenario (Figure 3.2, 3.3, 3.4 and 3.5) further trigger the risk for leptospirosis in the urban and suburban MOH areas.

Adaptation measures needed: Strengthening the current vector surveillance system by using GIS based risk prediction methods, establishment of an early warning system and further study of vector biology can be recommended as the key adaptation measures to control a leptospirosis in the country. Meanwhile, raising awareness of farming community on disease prevention and controlling outbreaks, vector controlling officers, the public community and effective patient treatment methods could also play a major role in epidemic management.

G. Nutritional status: Nutrition is an essential factor in the human health and it depends on the availability of food and access to sufficient nutritional food. According to the available literature under-nutrition (severe, moderate and mild), micronutrient malnutrition (anaemia, iron deficiency, vitamin A deficiency and Iodine deficiency), overweight and obesity are the major nutritional associated issues in Sri Lanka. All these complications may directly or indirectly associate with climate change and will obstruct the overall development in the country (MRI, 2009). Climate change will affect food production, especially cereal crops due to changes in temperature, rainfall patterns, soil moisture and fertility. Situations of food insecurity as a result of climate change would lead to widespread malnutrition and hunger affecting mainly children and pregnant mothers (MRI, 2009).

Adaptation measures needed: Strengthening policies and programmes on nutrition and nutrition related education on evidence based approaches, continuous monitoring of nutrition deficiencies and potential risk factors and facilitation of nutrition clinics can be recommended to the reduce risk. Establishment of a comprehensive national nutrition surveillance system, multisectoral coordination, promotion of nutrition enhancement, assurance of food security at the household level and conducting further research can also be recommended.

H. Heat-related illnesses: Heat-related illness, also called hyperthermia is a result of exposure to extreme heat where a rapid rise in body temperature observed (CDC, 2017). According to the available information, there is no reported evidence on heat-waves in Sri Lanka. This may be due to lack of research and proper investigations. Adverse health effects related to extreme hot environments include chronic dehydration, heat exhaustion and heat stroke, kidney disease (Kjellstrom et al., 2009).

According to the World Health Organization, the kidney disease is the seventh most common cause of death in Sri Lanka (WHO, 2012). The aetiology of the disease is unclear, but researchers have proposed that "heat stress nephropathy may represent one of the reasons for chronic kidney disease (CKDu) in Sri Lanka (Jayasekara et al., 2019). Some studies have emphasized that the occupational heat stress is more common in the north central province, since majority of the population is engaged in farming, where temperature and other environmental factors are thermally stressful (Siriwardhana et al., 2015).

Further, exposure to hotter temperatures increases vulnerability to heat-related illnesses and death mainly in elderly, children and those with existing cardiovascular and respiratory diseases (Martinez-Austria and Bandala, 2018). Mostly agricultural and other outdoor workers, school children and outdoor sportspersons exposed to direct sunlight are subject to heat related illnesses.

Adaptation measures needed: Provision of occupational health services, strengthening the existing patient identification systems and identification of potential risk communities play a major role in strengthened adaptation measures. Promotion of climate smart cities, climate resilient villages and schools; tree planting and shading in urban areas; well-ventilated and insulated recreational facilities and public places will increase resilience. This can be supported with continuous public awareness campaigns during high risk periods/days, research studies, heat early warning system and adopting action plans for Heat Health.

I. Respiratory related illnesses: Climate changes depress air quality through different pathways. In addition, emission of greenhouse gases has contributed to air pollution and ultimately causing adverse impacts on human health. Some of air pollutants can directly cause respiratory complications or aggravate existing conditions in susceptible population, especially among children and elderly populations, while influencing the occurrence of lung cancers, cardio vascular diseases and stroke. Some of the impacts that climate can have in the respiratory system include chest pain, coughing, throat irritation, pneumonia and lung inflammations leading to Chronic Obstructive Pulmonary Disease (COPD) and lung cancers.

Adaptation measures needed: Improvement of current air quality monitoring facilities to cover the entire country, strengthening diagnostic facilities of related diseases and raising awareness of air quality and risks can be identified as major adaptation measures. In addition, development of policies and regulations for air pollution control, conducting research studies on the climate change impacts on air pollution, novel methods for air pollution control and introduction of training programs for environmental and occupational health and safety are also important for risk reduction. Proper monitoring system of vehicles emissions and testing services should be strengthened. In addition, monitoring and certification system for industrial emissions should be established. Creating green zones in city areas with forest cover and encourage home gardening could also be recommended. Establishment of a national multi-stakeholder platform for formulation and coordination of all air quality improvement and management programs, ensure source identification, quantification, monitoring & reduction of harmful air pollutants, formulate, strengthen and implement an appropriate regulatory framework for ensuring effective air quality management and capacity building programs for Air Quality Management could also be recommended.

3.6.5 Climate change impacts on drinking water sources

Sri Lanka, in comparison to many other countries, possesses abundant water resources in terms of total aggregate water availability. However, spatial and temporal fluctuations in rainfall lead to variations in both surface and ground water availability. Historically, the monsoon rainfall patterns created a need for planned water conservation and good water governance practices. Historical practice of water governance in the dry zone ensures water for all living beings in varied ecosystems. However, much of the historical water governance systems are no longer functional.

During the past few decades, a number of warning signals have pointed out for the need of sustainable management of water resources in Sri Lanka. Competition for water, and seasonal water shortages are drastically increasing. Watersheds are also drying due to prolonged droughts. Recent and more frequent extreme weather events are causing profound and long term impacts on the spatial and temporal water availability.

Risk assessment shows that 44 DSDs represented as high water risk to drought and 125 DSDs denoted as a moderate risk, in addition, 159 DSDs in Sri Lanka exhibit specific low for drinking water (Figure 3.23). With temperature and rainfall anomalies projected for 2030 and 2050 as per the RCP 8.5 scenario, the situation would be further aggravated in the dry and intermediate zones via evapotranspiration (Figure 3.2, 3.3, 3.4 and 3.5).

Colombo and Gamapaha districts lying in the Kelani river basin, Matara in Nilwala river basin and Hambanthota district have a high degree of flood-associated risks for drinking water quality (turbidity, micro-organisms and colour). The risk will be greater when rainfall anomaly projections for 2030 and 2050 as per the RCP 8.5 scenario (Figure 3.2, 3.3 and 3.4), especially in the wet zone.

Adaptation measures needed: Increasing green cover for catchment preservation and de-siltation of village reservoir cascades could improve ground water recharge and water availability in downstream dug wells, especially for communities in the dry zone. Moreover, protection of upper watersheds, increased groundwater recharging facilitates, introduction of community-owned and managed water supply schemes, implementation of storage capacities, strengthening government water supply schemes to respond to drought warnings, demineralization plants, and use of solar powered desalination plants to supply drinking water in coastal districts are some of practical adaptation measures.

One of the best adaptation measures to address drinking water issue in a prolong drought situation for the community living in the dry zone, where there is no access to safe drinking water, is the establishment of rainwater harvesting tanks. In addition to that, construction of salinity barriers, replenishing upper watersheds by fog interception through cloud canopy improvement, introduction of separate pipelines to convey reclaimed water to use of non-potable water are additional adaptation measure for drought risk on drinking water. Other measures are; analysis of water demand increasing and taking actions to meet the increased demand; introduction of an integrated water resources management policy; construction of small weirs/dams; new dedicated storage reservoirs for drinking water.

Designing new water facilities that incorporate flood modelling and implementing new purification technologies are key adaptation measures. Others include green roofs and infiltration surfaces, storm water drain maintenance, flood retention basins and storm water tunnels in urban areas. Establishment of water quality monitoring stations, preservation of wetlands and creating of natural wetlands, monitoring and maintains of periodical cleaning of storm water drains, introduction of infiltration trenches along roads, construction of large scale storm water tunnels in populated areas, converting intakes pumps to submersible wet well type or converting intake structures to suit vertical turbine pumps and fuel storage located above high flood levels to avoid oil contamination are suggested additional adaptation measures to improve the resilience against to flood.

The risk of drought for sanitation services could be addressed by improving water availability, improving sanitation infrastructure and ensuring adequate coping and adaptive capacities during a drought. Moreover, introduction of better water treatment facilities, especially membrane filters and enrichment of catchment areas to improve the partial water retention capacity are considered as practical adaptation measures. Other measures include better human settlement management and improved downstream drainage.

3.6.6 Climate change impacts on irrigation

Sri Lanka has a historical irrigation-based cultivation system dates back over two millennia and inherited an advanced hydraulic infrastructure and knowhow. Sharp variations of water availability for agriculture over space and time led to the development of an intricate irrigation and water supply system giving rise to one of the world most advanced hydraulic engineering accomplishments.

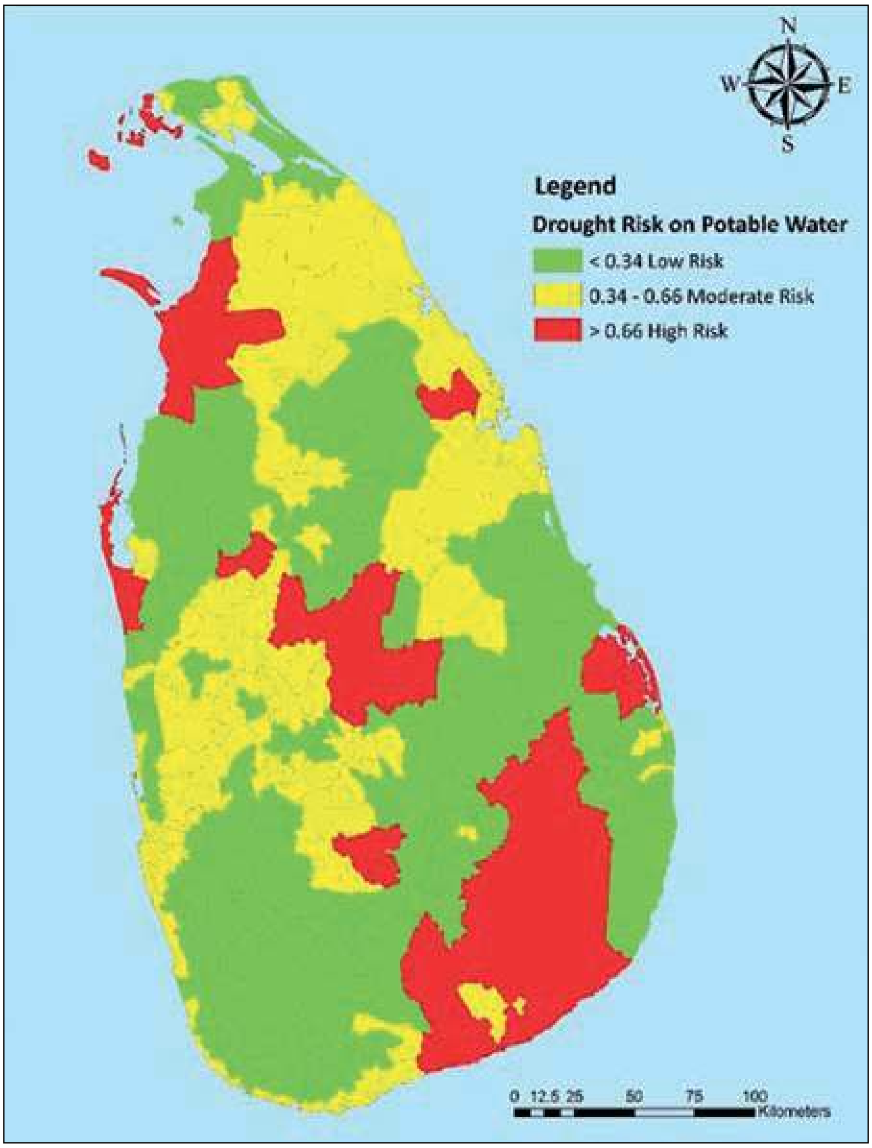


Figure 3.23 Drought risk on drinking water

Irrigation systems in the country are categorized in accordance with the size of the command area. Major irrigation schemes that have command area or flood mitigation above 6.1km^2 while medium schemes are between 0.8-6.1km^2. Small tanks or minor irrigation schemes are those having an irrigated command area of 0.8 km^2 or less.

Climate risks for irrigation: Agricultural activities during the two main cropping seasons; *Yala* and *Maha* - use rainwater stored in irrigation systems. The north western and north central provinces have a large number of minor and major irrigation schemes to collect rainwater for agriculture. The increasing trend of longer droughts and altered rainfall patterns threaten water storage in irrigation networks. The increasing intensity of ambient temperatures and evapotranspiration from these water bodies further reduce water availability. Siltation due to soil erosion in uplands reduces the depth of reservoirs, aggravating water loss via evaporation.

The projected climate scenarios for 2030 and 2050 as per the RCP 8.5 shows an increase in maximum ambient temperature and negative rainfall anomalies in the dry zone during northeast monsoon (Figure 3.2, 3.3 and 3.4) and as a result, drought risk for irrigation will be further aggravated in the dry zone. The study reveals that districts of Anuradhapura, Polonnaruwa and parts of Ampara are highly risk to the current climate change context.

Adaptation measures needed: The village irrigation system built with a cascade of small and large tanks having with numerous environmental safeguards and climate resilience over two millennia. This system is at present being rehabilitated as one of the most vital adaptation measures to address the water scarcity due to adverse impacts of climate change in the dry and intermediate zones. The rehabilitation of climate resilient features in this ancient tanks cascade system such as hydro-catchment deserves and the tree girdle around water bodies and irrigation canals could help minimize water loss from evapotranspiration and dry winds. Water use efficiency for agriculture can be improved by introducing technologies such as drip irrigation, smart agricultural practices, crop diversification and vertical gardening. To enhance climate resilience, research and development in breeding and farming practices, and water usage would be vital. Further, adaptation measures could be implemented to control water loss through evaporation by establishing floating solar panels and shade balls without harming to the biodiversity of reservoirs. Education, communications and awareness should be increased among the farmer communities to improve irrigation water use efficiency.

3.6.7 Climate change impacts on coastal resources

Sri Lanka is richly endowed with varied coastal and marine ecosystems that include estuaries and lagoons (214,522 ha), mangroves (11,656 ha), seagrass beds (37,137 ha) salt marshes (27,520 ha), coral reefs and large extents of beaches including barrier beaches, spits (5,731 ha), sand dunes, mangroves and associate waterbodies (10,363 ha). Each of these coastal habitats possess a significant amount of species and provides an array of ecosystem services vital to human. In addition to the environmental services, these habitats support livelihoods of the coastal communities in significant manner to enhance their economic status and maintain social integrity. Many coastal and nearshore resources associated with the coastal habitats support a developing export industry based on export of prawns, lobsters, crabs, beach de mer (sea cucumber), chanks and shells and other fishery products which earned over LKR 24,716 million in 2015 (SLCZCRMP, 2018).

Coastal ecosystems are among the most popular destination for outdoor recreation and tourism. The coastal region in the country supports a range of nationally important economic activities including fisheries, tourism and ports/harbours. In Sri Lanka, around 25% of people live in the coastal region.

Over the last century, mean sea level has risen by 15 cm. Generally, coastal ecosystems are affected with varying degrees by inundation, coastal erosion and change in ecological systems/processes due to sea level rise. Coastal flooding will be accompanied by coastal erosion and salinization of coastal soils and ground water. Since most coastal towns and cities are densely populated, communities and people in coastal areas face the risk for loss of properties and livelihoods due to climate change.

The risk assessment focuses on identifying the degree of future risks and vulnerable areas induced by climate change and sea level rise. Likely impacts of climate change on coastal areas include sea level rise and associated saline water intrusion further inland. This results in increased salinity making the existing primary production activities untenable. The above impacts could be further exacerbated by reduced river flows, causing a reduction of fresh water flushing in their annual cycles of change, thereby salinity around estuaries and lagoons are increased. Increased flooding of the lower coastal areas and changes in monsoonal weather patterns could aggravate all of the above impacts. All or some of the above impacts, acting alone or in combination, are likely to bring about many changes in different ecosystems in the coastal belt, threatening availability of spawning and nursery grounds for important food/commercial fishery which is main livelihood in the coastal belt.

Marine habitats are threatened from climate change induced sea level rise and ocean acidification. Frequent storm surges and coastal flooding are occurred. Loss or changes in coastal habitats and species distribution, landward migration of coastal wetlands, resulting loss of freshwater and brackish water habitats that are important for fisheries and coastal aquaculture. Changes in salinity of lagoons and estuaries may affect fish and crustaceans. Salinity also affects near shore habitats and associated fishery resources and near-shore reefs. Storm surges can particularly affect reefs which could lead to more serious coastal erosion and high levels of saline intrusion. Damage to coastal habitats such as coral reefs, mangroves and sea grass beds due to climate change associated disasters will affect availability of fish stocks for the marine fishery as they serve as feeding and breeding grounds for fish.

The coastline within a 2 km band is located between 'flooded' and 'run-up' areas while most places including the areas closer to water bodies are susceptible to the impacts of ocean surges (Figure 3.24).

Higher sea surface temperatures increase the risk of coral bleaching and lead to coral death with subsequent loss of critical habitats for other species and the tourism industry. During the El Nino in 1998, the sea surface temperatures in the Indian Ocean were elevated to 3-5°C above normal, and wiped out almost all coral reefs at the Bar Reef Marine Sanctuary, more than 90% in Hikkaduwa Marine Sanctuary, 60% at Weligama and 80% at Rumassala (Rajasuriya, 2010).

With increasing sea levels, inter-tidal zones could shift to towards land and potentially affect the total extent of mangroves, corals and seagrasses. However, increased surface temperatures combined with atmospheric CO_2 are expected to affect mangroves and other coastal ecosystems by not only changing species composition and the phonological patterns, but also changing metabolic activities (UNEP, 1994). Thus, a changing climate will threaten the resilience of mangrove ecosystems that typically occupy intertidal zones. Seagrass areas along the coastline that are already affected by human activities (causing e.g. sedimentation, nutrient enrichment, eutrophication and other environmental destruction) are most vulnerable to climate change impacts such as physical damages, light intensity, changes in sea surface temperature and changes in ocean current and atmospheric CO_2.

Based on the mapping done for this assessment, Jaffna, Mullaitivu and Kilinochchi districts exhibit a high risk of inundation of sensitive coastal habitats (coral reef, seagrass, salt mashers, sand dunes and mangroves) due to sea level rise by 2030 (Figure 3.25). As per the risk assessment, low-lying coastal wetlands of these districts are at a high risk from climate change impacts. Further, Kilinochchi and Batticaloa districts show the highest risk on coastal populations due to sea level rise. Low-lying coastal settlements of these districts are vulnerable to multiple natural hazards related to climate change.

Adaptation measures needed: Physical structures in coastal areas (manmade and natural) are prone to damage or even complete removal by the force of ocean surges due to sea level rise and storms. Integrating coastal vegetation such as mangroves, seagrass beds and sand dunes could enhance protective buffering. Port and harbour infrastructures such as breakwaters along the coast provide greater protection against ocean surges. Better infrastructure and settlement planning along the coast can also reduce vulnerability to sea level rise.

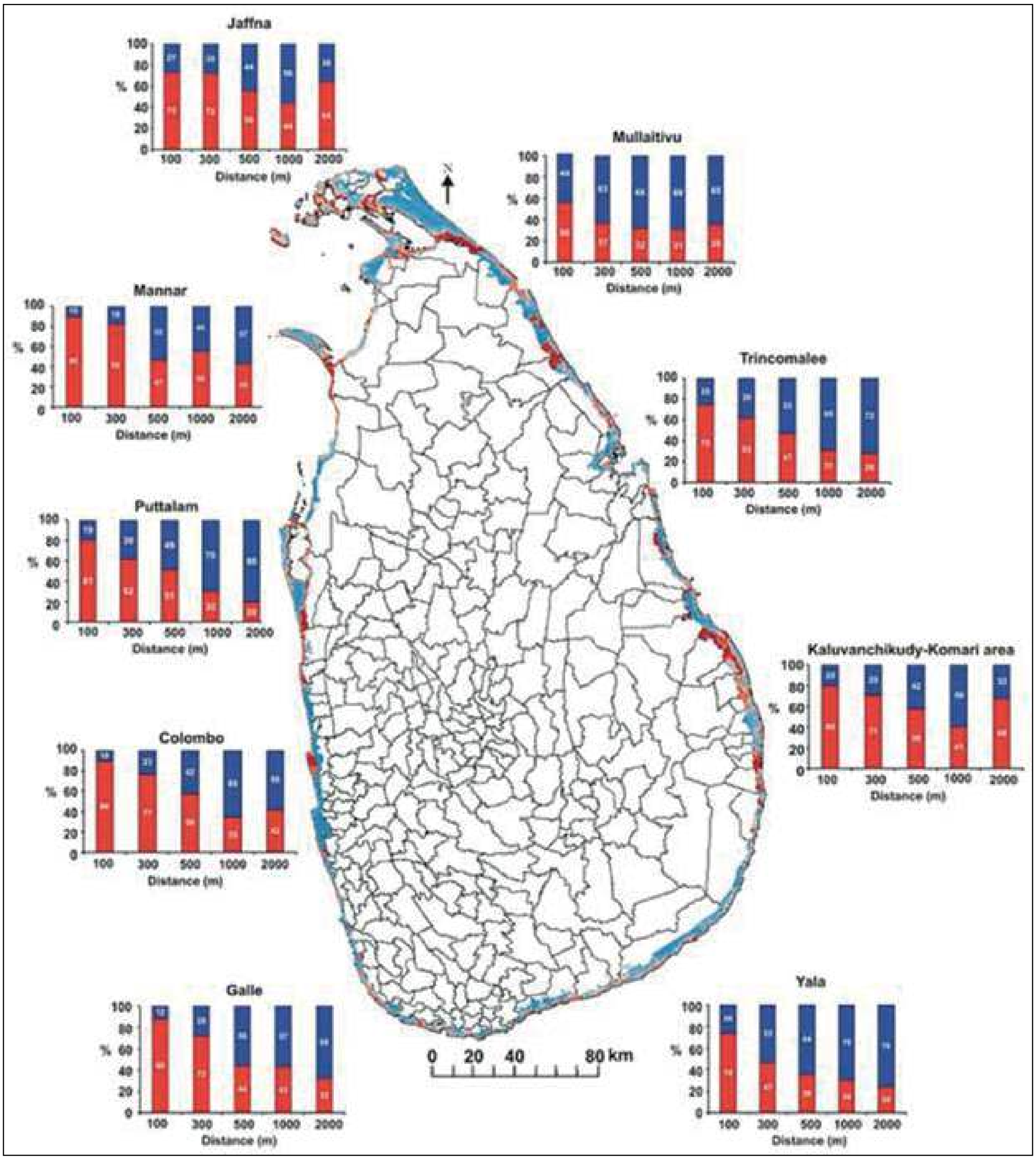


Figure 3.24 Climate vulnerability index of vulnerable (red) and less vulnerable (blue) areas along the coast

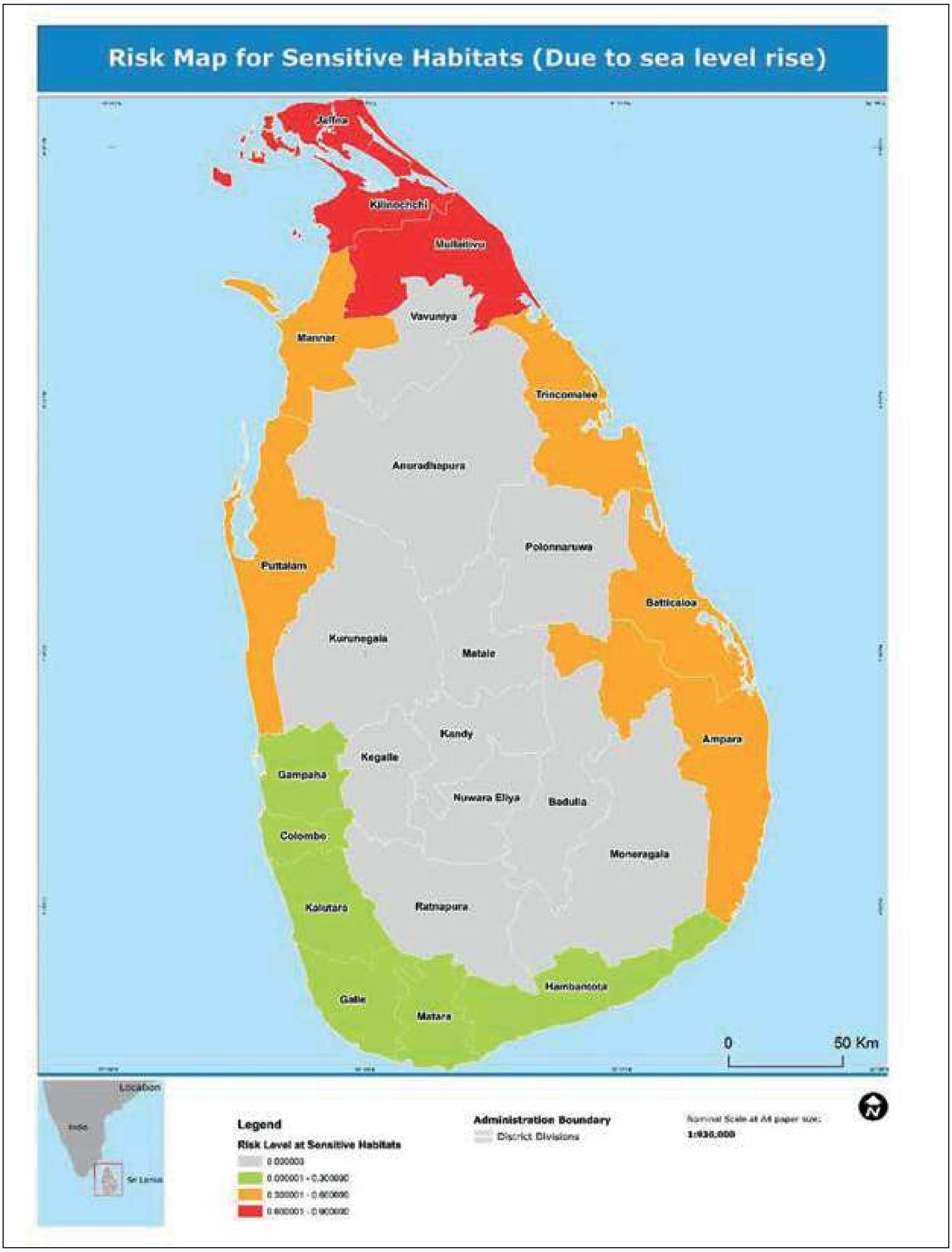


Figure 3.25 Coastal sector risk to sea level rise based on inundation of sensitive coastal habitats in coastal district by 2030

Onshore and offshore measurements of meteorological indices, sea level rise, wave measurements and sediment transport will be useful for the implementation and monitoring of adaptation measures efficiently and effectively. The establishment of a network of monitoring stations is recommended to support development of a Digital Elevation Model (DEM) for the entire coastal zone using GIS and remote sensing. A coastal resources database could enhance coastal adaptation measures and resilience. Re-establishment of the mean sea level around the country could lead to baseline maps including inundation maps of coastal habitats that are needed to monitor long term changes. Identification of patterns of connectivity between coastal ecosystems to improve the design of marine protected area networks and allow for ecological linkages and shifts in species distribution would help to address climate change adverse impacts occurred in the coastal belt.

Enhanced public participation through raising awareness of the value and threats of coastal habitats could further strengthen resilient efforts. Promotion of in-situ and ex-situ conservation, elimination of invasive alien species and temporary migration/translocation of species to suitable habitats based on scientific analysis are additional adaptation measures.

Coastal erosion accelerated by sea level rise and storm surges needs to be managed and minimized to safeguard human settlements and infrastructures in the coastal belt. Introduction of physical barriers could help protection of coastal resources. Vegetation growing on high salinity conditions can be introduced as salinity barriers near estuaries and low-lying coastal areas.

3.6.8 Climate change impacts on biodiversity and ecosystems

Sri Lanka (along with India's Western Ghats) is one of the world's 36 biodiversity hotspots of the world. Though its relatively small size, Sri Lanka has a diverse array of ecosystems with a very rich species composition of fauna and flora. The diversity of ecosystem distribution in Sri Lanka is based on spatial variation of rainfall, temperature, topography and soil. This diversity is highest in the southwestern part of the country which is the wet zone. The few remaining rainforests here are home to nearly all of the country's woody endemic plants and about 75% of its endemic animals. The diversity and high endemism significantly contribute to the country's species richness. Based on the patterns of distribution of the angiosperm flora and their endemicity, 15 different floristic regions have been recognized in the island (Gunatilleke et al., 2017). According to the National Red List 2012, there are 349 flora and 5,717 fauna of which 27% and 17% respectively are endemic to Sri Lanka and also has a rich biodiversity in lower plants and invertebrates.

Sri Lanka has a multitude of terrestrial (19,334 km^2), coastal (2,352 km^2) and marine (517,000 km^2), and aquatic ecosystems (2,024 km^2). The terrestrial ecosystem hosts a dense forest cover of 14,382.75 km^2 (29.7%), grasslands across 680 km^2 and dry monsoon 11,213 km^2. There are six wetlands recognized by the Ramsar Convention covering a total area of 1,982 km^2. Montane forest ecosystems located at the central highland complex rise up to 2,500m and have been declared as a World Heritage Site by UNESCO in 2010 consisting of the Peak Wilderness Protected Area, Horton Plains National Park and Knuckles Conservation Forest which is considered a super biodiversity hotspot. According to UNESCO's Man and the Biosphere Programme, the country has four biosphere reserves: Hurulu, Sinharaja, Kanneliya-Dediyagala-Nakiyadeniya and Bundala. The coastal landform in Sri Lanka is approximately 1,700km in length and is comprised of estuaries, lagoons, beaches, rocky shores, sand dunes, salt marshes and mangroves. The Gulf of Mannar has the most extensive shallow coral reefs and seagrass beds in Sri Lanka while fringing coral reefs are common in the northern, eastern and southern coastal waters.

Deforestation and forest fragmentation are the predominant threat to Sri Lanka's biodiversity, while invasive alien species are increasingly dominating the landscape aided by climate changes. Very few studies have been conducted on the impacts of changing rainfall patterns and temperature increases on forest species and ecosystems. Habitat sensitive species such as freshwater fish, pteridophytes (ferns), orchids and other aquatic plants are sensitive to water availability. In 2010, severe bleaching of the coral reefs in the Pigeon Island National Park and Dutch Bay in Trincomalee damaged the coral ecosystems (Rajasuriya, 2010). Similar coral bleaching has been recently observed (2019), especially for reefs in the east and north coasts.

Habitat suitability assessment: To understand the survival of and threats to endemic and indigenous species and eco-systems in the climate change context, a study was carried out for threatened categories (MoE, 2012). To represent the entire fauna and flora in Sri Lanka, two species of endangered higher plants (*Strobilanthes habracanthoides* and *Strobilanthes helicoides*), one species of butterfly (*Parantica taprobana*) and a reptile (*Ceratophora stoddartii*) were selected to study the correlation between species distinction and climatic variables among the initially selected 27 threatened species.

According to the study, *Strobilanthes habracanthoides* favors montane to mid-elevation southwestern regions. It faces the threat of losing its existing range (around 4% of habitats) owing to montane habitat loss by 2050 (Figure 3.26). The *Strobilanthes helicoides* demonstrates a similar contraction of suitable habitat from 2% to 1% in 2050 (Figure 3.27). The reptile species studied- *Ceratophora stoddartii* could lose its already isolated habitats and could result in fragmentation and isolation in to small unviable populations by 2050 (Figure 3.28). The species *Parantica taprobana* showed loss of suitable habitats from 3% to 2% in 2050 with the increase of less suitable habitats by 4% to 5% (Figure 3.29).

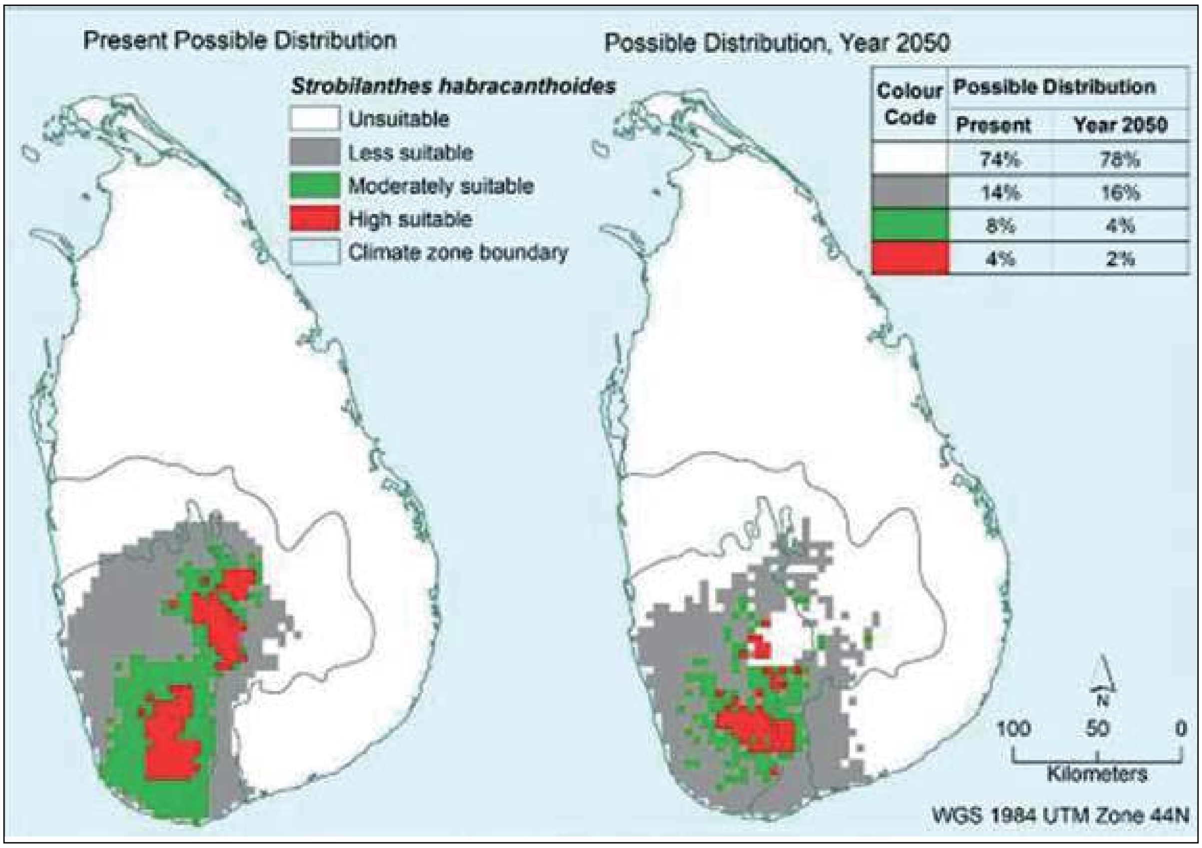


Figure 3.26 Present and future possible distribution of Strobilanthes habracanthoides

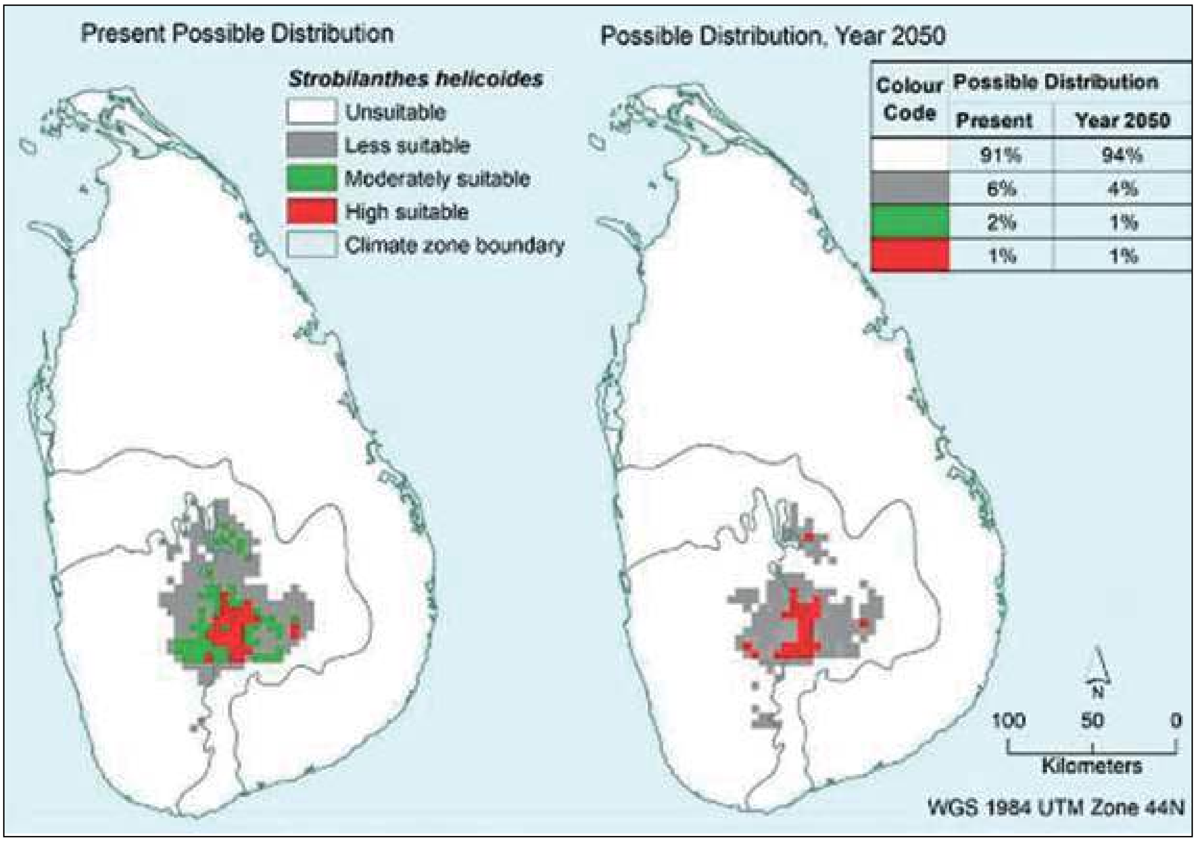


Figure 3.27 Present and future possible distribution of Strobilanthes helicoides

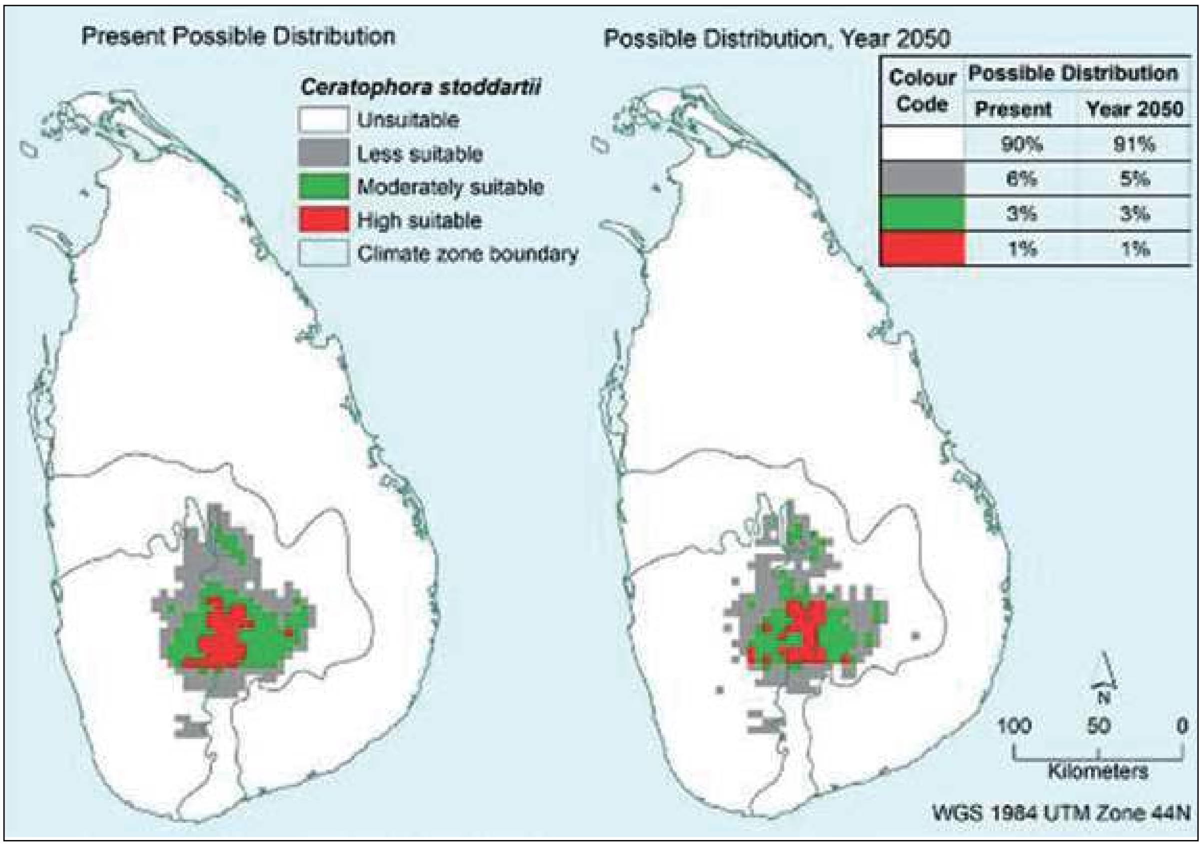


Figure 3.28 Present and future possible distribution of Cerotophora stroddarti

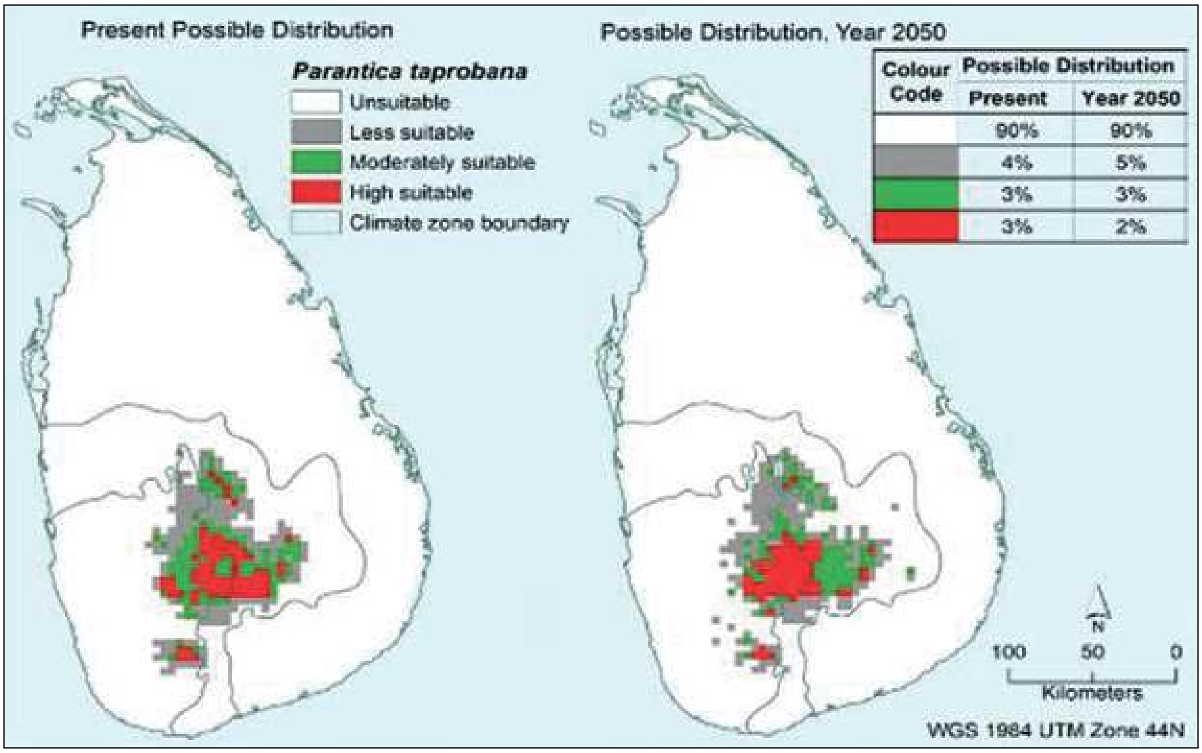


Figure 3.29 Present and future possible distribution of Parantica taprobana

Climate change impacts on mangrove habitats: The study carried out on impacts of 1m sea level rise to mangrove forest distribution published by the Department of Forests Conservation in 2010 revealed that vegetation along the coastal belt is subject to inundation by sea water, changing species diversity, composition and their interactions (Figure 3.31). The Figure 3.30 clearly shows that a 1m inundation due to sea-level rise along 911.5 km^2 of land is going to inundate the area from Puttlam to Jaffna including islands located in north western side of Sri Lanka (Kalpitiya and Jaffna Islands; Wedithalathiwu), which represent a higher mangrove species diversity. This will result in a shift in species composition, abundance and ecological services provided by mangrove habitats.

Figure 3.30 One-meter inundation map in 2010

Figure 3.31 Mangrove distribution

Adaptation measures needed: Species diversity and distribution depend on climatic and micro-climatic conditions that moderate habitat suitability. Change in macro environmental parameters, especially precipitation, humidity, temperature and pH, trigger considerable threats to favourable micro climates sought by already threatened/rare/endemic species. Climate induced threats can undermine connectivity of ecosystems resulting in forest fragmentation, species isolation and inability to maintain viable populations or the requisite gene pool to foster physiological adaptations to these changes. Adaptation measures for conservation could start with preserving existing high-conservation value forests which provide much needed micro climates for many rare and endemic species and protect forest corridors which could preserve connectivity. Establishment of micro climatic monitoring plots, declaration of Environment Sensitive Areas and enhancement of protected areas with effective monitoring could enhance resilience of outside protected areas. Further, identification of new biodiversity hotpots, while strengthening conservation of existing ones, will enhance the sector's resilience. Promotion of in-situ and ex-situ conservation, identification and elimination of invasive alien species, preparation of the list of species recovered from extinction and temporary migration/translocation of species to suitable habitats based on scientific analysis are additional adaptation measures. Implementation of community driven conservation projects and programmes and promotion of traditional methods of biodiversity conservation can further increase resilience.

3.6.9 Climate change impacts on human settlements

Human settlements in Sri Lanka comprise of urban, rural and estate sectors. The rural population is 77.4% of the total population, while urban and estate populations constitute 18.2% and 4.4% in 2014. However, while defined as rural, many people are crowding in to peripheries of regional cities and district capitals and creating sprawling suburbs. As forecast in the Urban Development, Human Settlements and Infrastructure report of 2010, 70% of Sri Lanka's population is expected to reside in urban settlements by 2030.

Human settlements are highly vulnerable to the adverse impacts of climate change including higher temperatures, longer periods of drought and disasters caused by erratic rainfall patterns, floods, landslides and sea level rise. Urban and rural settlements are susceptible to flood risk while settlements in slopes over 450 area are highly threatened to landslides. 25% of the country's population living within two kilometers of the sea, and the generation of 45% of GDP earned through coastal economic activities. Thus, climate change impacts on settlements in the coastal region through sea level rise are a key socioeconomic threat faced by the nation.

Risk for urban settlements from floods: Major urban areas and cities in specific districts are at high risk to floods (Colombo, Ratnapura, Kalutara, Galle, Matara and Puttalam) while some areas in Jaffna and Mannar districts show moderate risk of flood. The RCP 8.5 rainfall anomaly maps for 2030 and 2050 (Figure 3.2, 3.3 and 3.4) indicate that the southwest monsoon and the two inter monsoons yield more rain that will generate more frequent and intense flood events in the wet zone in future.

Risk for urban settlements from drought and temperature increase: According to the map on drought risk to urban settlements, a few areas in Nuwara Eliya, Trincomalee and Vauniya districts and some urban settlements in other DSDs are currently experiencing moderate risk of drought. Though many urban settlements have better infrastructure facilities than rural settlements, a continued drought might increase the limits of resilience in these areas. More people and/or higher population densities could also impact on coping capacities for drought. According to the prediction for 2030 and 2050 for RCP 8.5 (Figure 3.5), the positive temperature anomaly will create more drought conditions in the dry zone areas.

Adaptation measures needed: Given the existing and future risk in urban settlements to floods, careful planning is required and recommended to improve adaptation. Urban councils and local authorities should plan and construct infrastructure to prevent or mitigate damages to humans, properties and ecosystems. Conserving existing flood retention areas, especially wetlands, and demarcation and development of new open spaces or reservoirs for flood capture and storage are some recommended adaptation measures. In response to flooding, actions should be taken during post disaster situations to further support affected communities to build back better. Further, in preparedness, systems should be designed with scenarios developed through intelligent flood modelling to minimize the damage.

Zonal planning with guidelines for buildings and other infrastructure could be the starting point towards climate smart urban settlements. Planning is needed to avoid the extreme conditions brought by climate change such as urban heat islands and saline intrusion into drinking water which are made worse by drought. Encouraging spatial planning and green buildings using natural wind flows and green spaces to create more liveable conditions are sound adaptation measures. Preserving and enhancing green cover including urban forests, urban wetlands and water bodies can minimize heat impacts.

Risk for Rural settlements from floods: The most rural areas in eastern, western, southern and Sabaragamuwa provinces and the parts of northern province are vulnerable to frequent floods. However, past records show that Puttalam district in north-western province has also faced frequent floods in the last few years. The RCP 8.5 rainfall anomaly maps for 2030 and 2050 (Figure 3.2, 3.3 and 3.4) indicate that the southwest monsoon and the second inter-monsoon will generate a higher positive rainfall anomaly which could result in frequent flood events especially in the rural and urban areas in the wet zone.

Risk for rural settlements from drought: The risk assessment findings shows that the rural districts and DSDs in north-western, northern and eastern provinces will face a moderate risk from drought exposure. Resilience of rural settlement to drought can be identified as moderate due to the large number of manmade village reservoirs providing multi-uses of water nonetheless with reduced functionality due to rapid siltation and catchment degradation. This will be aggravated by the reduction of rainfall, especially the weakening of NEM and first Inter-monsoon and rising ambient temperatures. According to the RCP 8.5 climate scenario for 2030 and 2050 for Sri Lanka, the negative rainfall anomaly and positive temperature anomaly for dry zone will be expected to increase the vulnerability to rural settlement for the dry zone (Figure 3.2, 3.3 and 3.4).

Adaptation measures needed: Both urban and rural locations in the wet zone are prone to floods, especially in western, southern and Sabaragamuwa provinces. These areas are predominantly low-lying and need special adaptation measures and interventions such as in flood retention areas and capture and storage facilities for flood. At risk for climate induced disasters, rural infrastructure needs to be rebuilt. Emergency plans and improvement of flood management capacities in cities and rural areas are of utmost importance to enhance coping ability.

The existing cascading reservoirs and related rural infrastructures are resilient enough to adapt to moderate risk to droughts in rural settlements. However, the future climate risk would challenge the resilience of rural settlements. Therefore, improving infrastructure by upgrading existing village reservoir networks with additional climate resilient features such as enrichment of catchment, addition of ponds, enhancement of perennial green cover, introduction of eco-friendly housing solutions, and eventually climate smart villages and settlements could make rural settlement more resilient to climate change.

Risk for rural settlements from landslides: Hazard maps show that landslide risk is higher in rural settlements in DSDs in Kegalle, Nuwara Eliya, Badulla, Ratnapura and Kandy districts. The risk maps demonstrate a moderate risk in Rattota, Matale DSDs in Matale district and Agalawatta in Kalutara district. In 2030, the rainfall anomalies show intensified rains in the wet zone. This situation will be aggravated by 2050 according to projected rainfalls as shown in the rainfall anomaly maps. Therefore, the risk for landslides in these areas can further intensify and advanced adaptive measures should be implemented. However, the rainfall anomalies show a lesser rainfall in Badulla district in 2030 than in 2050 (Figure 3.2, 3.3 and 3.4). This may reduce the landslide risk in Badulla; however, intense rainfall events may still trigger landslides even though overall annual rainfall may see a decline.

Adaptation measures needed: The landslide risk is intensified in the western slopes of central highlands during the southwest monsoon. Most of these rural areas are on high elevations and steep slopes and hence need to consider identification of safe human settlements and infrastructure development solutions. Introduction of early warning systems, soil stabilization and scientifically developed vegetation cover without planting heavy trees in those areas and implementation of the zonal demarcations as per the guidelines developed by the NBRO could further help to climate change adaptation and resilient building.

Risk for estate settlements from floods: The estate settlements refer to the communities living in tea plantations. The study shows the most estate settlements in Nuwara Eliya, Ratnapura, Kegalle, Kalutara, Galle and Matara districts possess moderate risk from floods. In the 2030 and 2050 of RCP 8.5 climate scenario (Figure 3.2, 3.3 and 3.4), the positive rainfall anomaly expected from southwest monsoon could cause floods, especially in the rubber and coconut plantations in the wet zone.

Risk for estate communities from Landslide: The landslide risk for the estate communities is very high and incrementally increasing, especially during the southwest monsoon in the areas of Kegalle, Kandy, Nuwara Eliya, Matale, Rathnapura, Kalutara and Matara districts. A low literacy rate coupled with poverty in the estate sector further reduces coping capacity and makes them more vulnerable to increased risk of climate change.

The projected climate scenarios for 2030 and 2050 as per the RCP 8.5 indicate positive rainfall anomalies in the wet zone during south western monsoon (Figure 3.2, 3.3 and 3.4) and, as a result, the risk from landslides will be further aggravated, especially in areas already identified as high risk.

Adaptation measures needed: Much of the labour force in the plantation sector lives in housing provided by the estates where they work. These houses are risks associated with floods where there are floods occurred frequently. Improvement in sanitation facilities and effective drainage networks could minimize flood related epidemics and improve their living standards. The estate labour force consists of day wage earners and hence, during floods, they would require social security to rely on daily income and meet immediate cash needs. The early warning systems and flood retention housing should introduce for estate settlements where frequently flood occurred.

Similar to adaptation measures for the rural sector, the estate communities could be resettled to safer areas, preferably in the same plantation or an adjacent one as their livelihood is tied to the plantation work. Settlement planning coupled with early warning systems, soil stabilization and plantation of scientific vegetation cover are other adaptation measures.

3.6.10 Climate change impacts on tourism

Sri Lanka is a popular tourist destination and has been described as one of the best island countries to visit for its contrasting geophysical and climatic zones that can be accessed within hours of each other. The country is identified as one of the top ten countries showing the strongest growth potential via improved governance of tourism sector, prioritization of tourism and investment incentives (WTTC, 2017).

Tourism Development Plan of 2011-2016 and 2017-2020 have embedded strategies to enhance the tourism industry and boost arrivals to 2.2 million in 2016 and 4.5 million by 2020. The tourism sector contributed 11.5% to GDP in 2016, making it the third highest earner of foreign exchange for the national economy (Central Bank of Sri Lanka, 2018). The current strategy sought earnings of 7 US$ billion by 2020 while it is targeted to 10 US$ billion by 2025. The sector employs 360,000 people directly and indirectly (SLTDA, 2017).

The tourism sector is highly vulnerable to the adverse effects of climate change such as temperature rise, heat waves, sea level rise and extreme weather events (storm surges, prolong drought, flash flood and landslides). The majority of tourism facilities are located in the coastal areas (60%) where elevation is less than 2m which further exposes the sector to risks from sea level rise and storm surges (Nayanananda, 2007). In addition, climate change would exacerbate loss of beaches and marine biodiversity (eg. coral bleaching), spread of infectious diseases, warmer temperatures and heat stress for tourists and lack of water in certain areas. Moreover, prolonged droughts could undermine sightseeing in wildlife parks and reserves, mainly located in the dry zone.

Risk to tourism from floods: The risk assessment indicates that Colombo (the tourism hub of the country) has a high risk from floods along with Kalutara, Ratnapura, Kegalle, Batticaloa and Ampara districts. The rainfall anomaly maps for 2030 and 2050 showed a positive anomaly for the wet zone and a negative anomaly for the dry zone as per the RCP 8.5 scenarios (Figure 3.2, 3.3 and 3.4). As such, both flood and landslide risks could increase in the wet zone, threatening infrastructure for tourism.

Risk to tourism from drought: The risk assessment shows a high risk of drought in Trincomalee district which is one of famous tourist destinations in the country. The entire dry zone has significant tourism facilities centered around the ancient capitals and wildlife parks and has a medium risk from drought. The sector would need to adapt to the situation with more options for cooling and air conditioning, designing better buildings and other tourism infrastructure to modulate the heat, as well as implementing more water conservation strategies. Rainwater harvesting and revival of village irrigation schemes could be useful for tourism practices in the dry zone.

Adaptation measures needed: Better networking among hotels, local authorities and district disaster management committees is needed to develop contingency planning, flood early warning systems and early evacuation of tourists out of flooded areas, all of which could further enhance resilience. Planning of tourists to the country based on the climate change scenarios and develop tourism packages accordingly is one of the best adaptation measures that can be applied.

Effective adaptation measures include implementing policies that make rainwater harvesting compulsory for all new hotels and registered homestays and providing technical facilitation for rainwater harvesting. Moreover, use of potable water for mundane uses such as toilet flushing, gardening and vehicle washing should be banned and grey water use should be a prerequisite for granting approval for registration. This is a medium-term adaptation measure which requires new by-laws. Further, increase of the green cover in all tourist establishments and destinations as well as approach roads should be recommended. Arrival of tourists to the country in accordance with projected climate change scenarios should be planned and developed niche packages for specific destination is one of the best adaptation measures that can be implemented.

3.7 Triggering inter sectoral climate change vulnerability

The irrigation sector of the country has a direct interrelationship with agriculture for sowing practices and in the maintenance of minimum water coefficients during different stages of particular crops. The failure to maintain these coefficients results in crop damages as well as saltwater intrusions during the driest seasons. Scarcity of water during prolonged droughts, especially in the dry zone, negatively impact the feeding grounds (pastures) for fodder to the livestock rearing by farmers. The disturbances to agricultural based livelihoods trigger internal migration of farmers to other labour markets such as construction, taxi driving and security.

Spillages of large quantities of water during high-intensity rains damages irrigation infrastructure, agricultural crops and other vegetation. Lack of irrigation water affects the spread of communicable diseases through food, water and vector-borne diseases. Lack of water availability also aggravates non-communicable diseases such as the Chronic Kidney Disease of unknown aetiology. The performance of inland fisheries is proportionate to the availability of irrigation water that is threatened by prolong droughts. Unplanned drainage patterns in urban dwellings and ad-hoc settlements as well as upland monoculture plantations tend to alter waterways and decrease river flow, resulting in greater salinity in estuaries which leads to a loss of fish and aquatic plant species. High sedimentation in coastal areas and reservoirs alters primary production, thereby triggering imbalances in the coastal and inland terrestrial ecosystems.

Extended droughts create cross-sectoral multiple stresses in agriculture, livestock, fisheries and water sectors that could eventually lead to undernutrition and vitamin deficiencies. Biodiversity concentrated in protected areas that are located in the dry zone are subject to numerous impacts. The forests could easily catch fire during droughts and damage biodiversity. Human settlements and water resources are also linked to access to safe drinking water and sanitation. During floods and droughts, water sources are subject to pollution by inundation or concentration of pollutants, thus creating further need for purification. The tourism sector relies on the availability of water resources. Some tourist attractions are based on unique experiences such as biodiversity and scenic beauty. However, climate change induced disasters such as droughts, floods, landslides and cyclones create negative temporal impacts on tourism in the short run.

CHAPTER FOUR

Mitigation Analysis and Options

CHAPTER FOUR

Mitigation Analysis and Options

4.0 Introduction

This chapter aims to identify the actions already taken and potential measures that can be implemented to reduce anthropogenic emission of greenhouse gases (GHGs) in different sectors at national level in Sri Lanka. The mitigation analysis was totally based on the GHG inventory in the chapter two of this report. Energy (electricity generation, transport and manufacturing industries, household and commercial), Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU) and Waste are the sectors of this analysis.

4.1 Methodology

For each sector, two types of scenarios were constructed as baseline scenario and mitigation scenario, and it was done in accordance with the UNFCCC approved methodology. According to the aforesaid methodology, the baseline scenario assumes that no mitigation policies or measures will be implemented that are already in force and/or are legislated or planned to be adopted. The baseline scenario was developed as a projection of the emission levels from 2010 which is the base year to future emission levels up to 2030 for all the sectors studied.

The mitigation scenario was structured according to a set of criteria reflecting country specific conditions such as potential for large impacts of GHGs emission reduction, economic impacts, consistency with national development goals, potential effectiveness of implementation policies, sustainability of an option, data availability for evaluation and other sector specific criteria.

The data which were collected up to 2015 was used to construct the baseline scenario and mitigation scenario, and projected up to 2030.The projections were based on assumptions on population growth, GDP growth and other macro variables, which were obtained from official sources.

4.2 Sector specific mitigation assessment

4.2.1 Energy sector

Sri Lanka has been ranked in the mid-range of United Nations Human Development Index, while the annual GDP per capita is at GDP 3,698 US$ in 2017. The Government's drive to reach the upper middle-income level within this decade intensifies the role of energy sector in Sri Lanka's economy. Sri Lanka maintains a very low energy intensity of economy, using 0.05 tonnes of oil equivalent (toe) to produce 1000 US$ of GDP in 2017 (World Bank, 2017). This compares favourably with the global average of 0.13 toe, the South Asia average of 0.12 toe and a developing country average of 0.11 toe for the same year as reported by the (International Energy Agency, 2019). The challenge posed to Sri Lanka is to maintain this lower energy intensity, while accelerating economic growth. Energy intensity measured in terms of primary energy and GDP from 2000-2017 is shown in Figure 4.1.

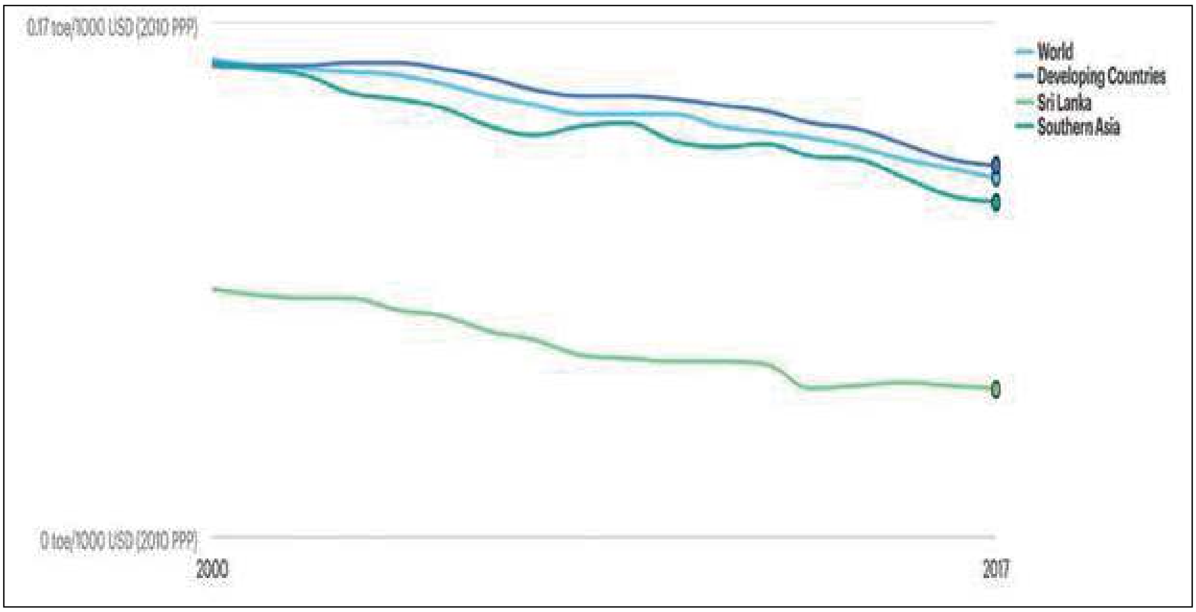


Figure 4.1 Energy intensity in terms of primary energy and GDP, 2000-2017

As of 2017, the largest energy consuming sector was the household, commercial and other sector, accounting for a share of 39.4% of the country's total energy demand. The transport sector's share of energy consumption which was mainly met through liquid petroleum products, accounted for 36.3%. The share of the industrial sector consumption was 24.3% (National Energy Balance, 2017).

The energy needs of the country are fulfilled either directly by primary energy sources such as biomass and coal, or by secondary sources such as electricity produced using petroleum, biomass, hydro power, refined petroleum products and non-conventional renewable energy such as solar and wind. Sri Lanka has reached the important milestone of 100% electrification, thereby fulfilling the goal of providing modern energy sources to all the citizens. Table 4.1 shows the primary energy supply by source from 2010 to 2017 in Peta Joule (PJ) and as a percentage % of the total (National Energy Balance, 2015 & 2017).

It is apparent in the table 4.1 that biomass (fuelwood, charcoal, agricultural residues, coconut husks etc.) is the second largest energy supply source, satisfying a greater portion of the cooking energy requirements of the domestic sector. While hydropower has already been extensively developed for electricity generation, studies have indicated that there is a large potential for wind and solar power development. Further, studies are presently underway to establish the availability of offshore petroleum resources. The total amount of electricity generated in 2017 was 15,004.2 GWh out of which 69% was from thermal plants (National Energy Balance, 2017).

Economic growth amidst universal access requires the energy supply capacity to be steadily increased. The growth in demand can also be managed by improving the efficiency of energy conversion. Continued efforts to maintain a low energy intensity status would require to be rewarded with a lower burden on the economy and environment. Increased efforts from demand side management through policy-driven incentives are required to meet this goal amidst high economic growth.

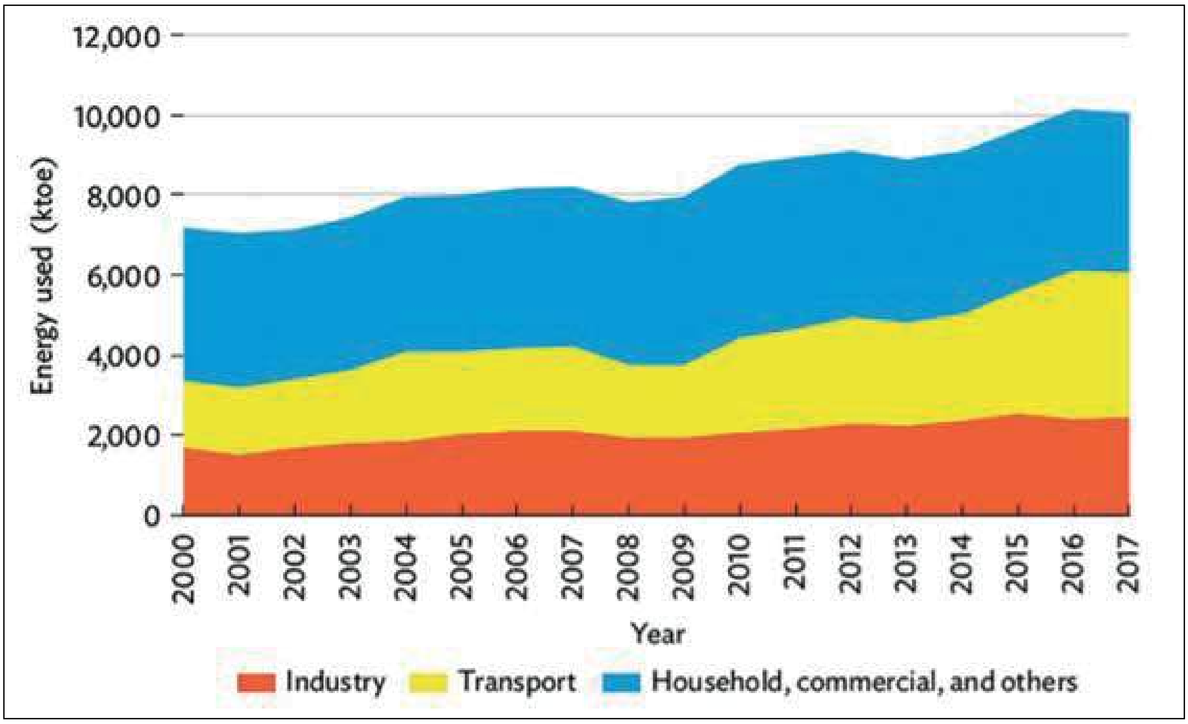
Table 4.1 Primary energy supply by source (2010-2017)

Year	Unit & %	Energy Type					Total
		Biomass	Petroleum	Coal	Major hydro	New Renewable Energy	
2010	PJ	207.4	185.1	2.5	50.1	7.5	**452.7**
	%	45.8	40.9	0.6	11.1	1.7	
2011	PJ	207	205.8	13.6	40.4	7.5	**474.3**
	%	43.6	43.4	2.9	8.5	1.6	
2012	PJ	203.5	218.5	19.1	27.4	7.6	**476.1**
	%	42.8	45.9	4.0	5.7	1.6	
2013	PJ	201.6	171.8	20.1	60.4	12	**465.9**
	%	43.3	36.9	4.3	13.0	2.6	
2014	PJ	205.6	190.8	38.5	36.7	12.6	**484.2**
	%	42.5	39.4	8.0	7.6	2.6	
2015	PJ	202.2	202.6	51.9	49.3	15.3	**521.4**
	%	38.8	38.9	9.9	9.5	2.9	
2016	PJ	196.3	239.3	54.9	35.0	12.6	**538.0**
	%	36.5	44.5	10.2	6.5	2.3	
2017	PJ	192.9	232.0	56.9	30.9	16.2	**528.9**
	%	36.5	43.9	10.8	5.8	3.1	

Source: National Energy Balance 2015 & 2017

The National Energy Policy and Strategies (NEPS) in 2019 presents how Sri Lanka plans to meet the challenge of developing and managing the energy sector to ensure delivery of reliable, cost-effective and competitively priced energy services from diverse sources to fuel the economy. In its 2017 revision of the NEPS, the government has set targets to ensure energy security, least-cost energy supply, access to energy services, conservation of energy, improvement of energy efficiencies, care for the environment, increase of renewable energy, good governance in the energy sector, and opportunities for innovation and entrepreneurship. It places significant emphasis on the reliability and affordability of both indigenous and global energy supplies. Strong emphasis was placed on developing the increasingly competitive newly assessed resources for electricity generation such as solar and wind. Biomass is a convenient fuel for household use and a dependable resource for industries which can help Sri Lanka to be an energy empowered nation by developing strategies and conversion technologies to use this vast indigenous resource. Whilst continuous efforts will be made to strengthen the petroleum sector from upstream resource development to downstream diversification, initiatives will be made to elevate the status of electricity as a major energy source. The energy transition in the transport sector, from liquid petroleum to other energy resources will be actively pursued.

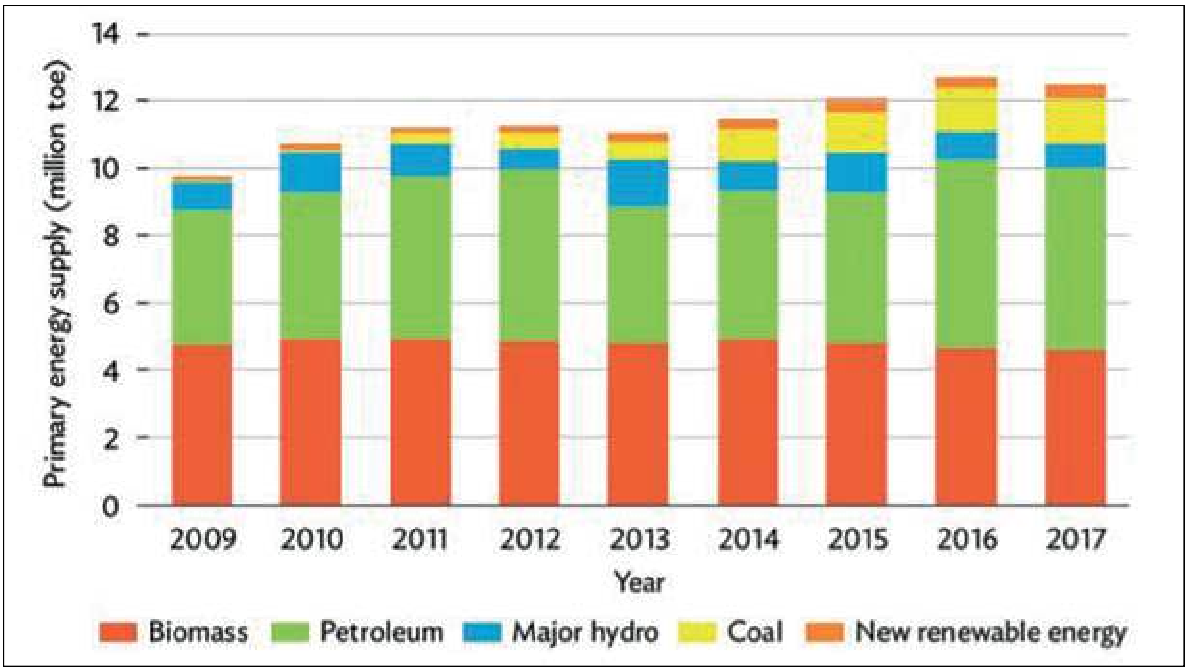
Whilst securing land resources for important energy infrastructure elements such as gas terminals, electricity generation sites and transmission corridors, energy storage will be taken as a prime carrier to transcend the space and time boundaries which constrained the traditional energy systems. Aligning Sri Lanka with Goal 7 of SDGs, this policy would contribute to achieve universal access to affordable, reliable, sustainable, and modern energy for all. The policy will also contribute to reduce the dependence of Sri Lanka on fossil fuels to below 50% of the primary energy supply and to reduce the specific energy use across all end use by 20% of the 2015 level by 2030. This policy will pave the way to realize the vision of Sri Lanka in achieving carbon neutrality and a complete transition of all the energy value chains by 2050. According to the Sri Lanka Energy Assessment Strategy and Road Map (2019) the total energy used (ktoe) had increased from 8,500 in 2010 to 10,000 in 2017, an increase of 17.6% as shown in Figure 4.2.



Source: Sri Lanka Sustainable Energy Authority

Figure 4.2 Energy use by sector 2000-2017

Of the sectors using energy, the highest consumer is household, commercial and others followed by transport and then industry. The variation of primary energy supply by different sources from 2009 to 2017 is shown in Figure 4.3.



Source: Sri Lanka Sustainable Energy Authority

Figure 4.3 Primary energy supply 2009-2017

The share of renewable energy (comprising biomass, major hydro and non-conventional renewable energy) in the primary energy mix is about 46% in 2017, showing a 5.8% reduction, compared with 2015. The stagnant supply and demand for biomass, especially in household and commercial sectors, is the reason for the declining contribution of renewable energy to the national energy mix, despite growing contributions of hydropower and new renewable energy sources used for electricity generation. Figure 4.4 shows the GHGs emissions contribution of energy sub sectors in 2010.

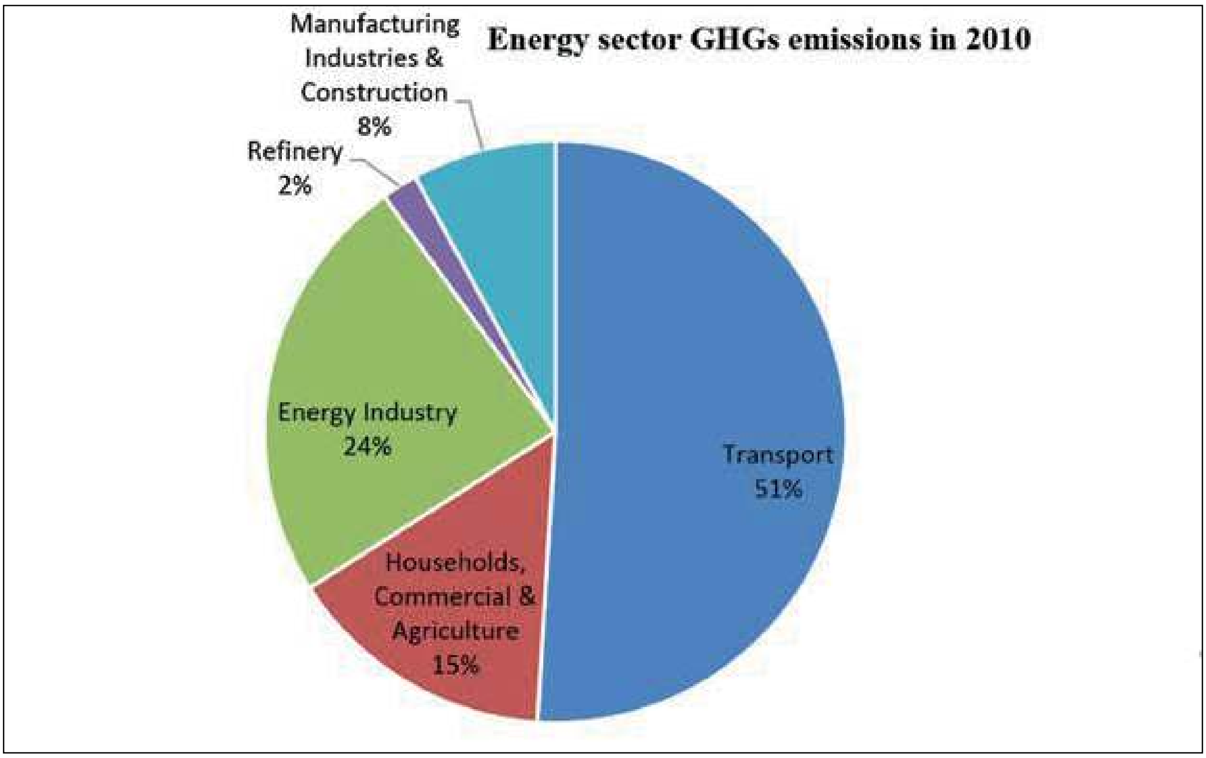


Figure 4.4 Energy sector GHGs emissions in 2010

Figure 4.5 shows the baseline scenario for projected emission from the energy sector (energy industry, transport sector and other sectors) from 2010 to 2030 based on the current trends.

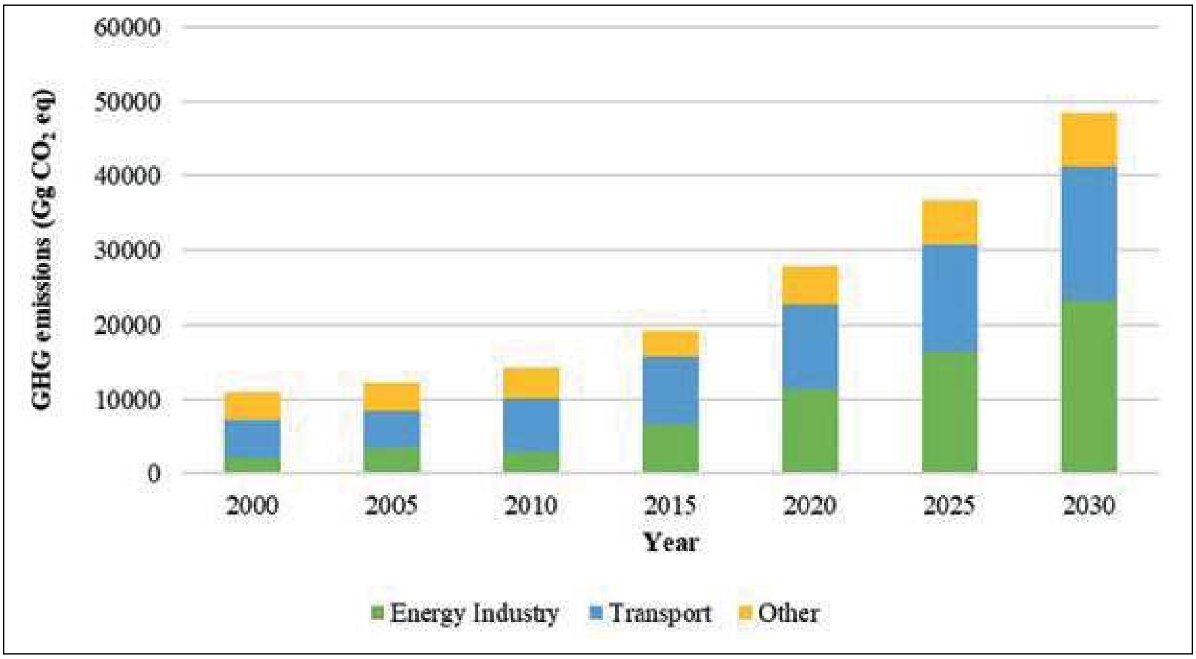
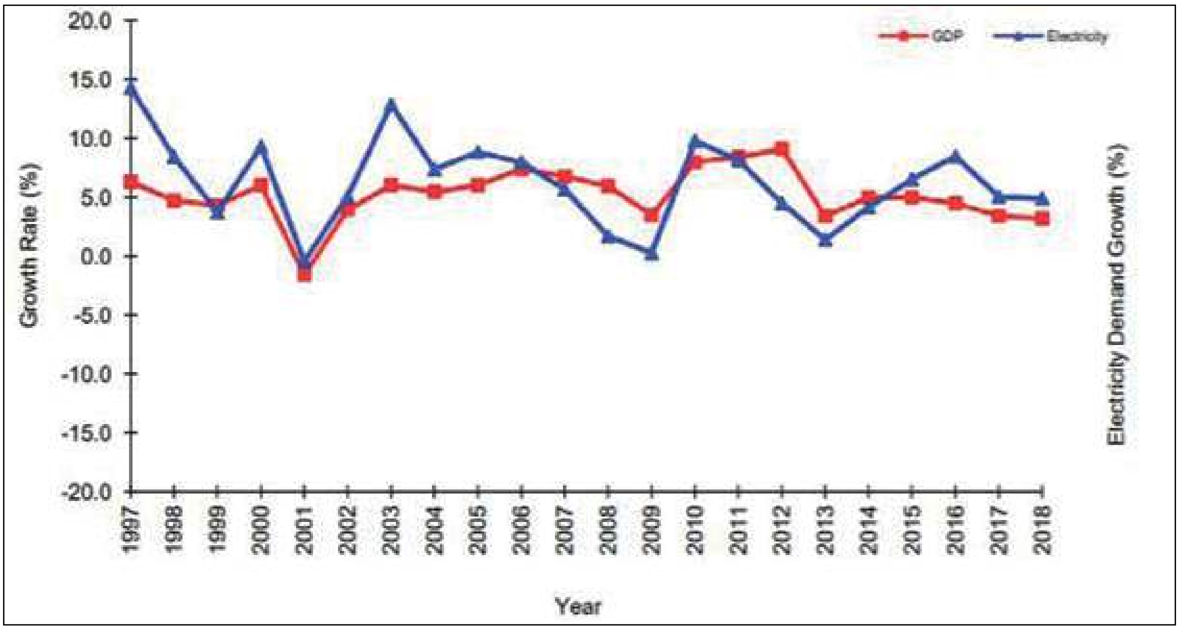


Figure 4.5 Baseline scenario for GHG emission of energy sector

4.2.1.1 Electricity Generation

Electricity demand growth rate in the past has most of the times revealed a direct correlation with the growth rate of the country's economy. Figure 4.6 shows growth rates of electricity demand and GDP from 1997 to 2018.



Source: LTGEP 2020-2039

Figure 4.6 Growth rates of GDP and electricity sales

Baseline scenario: The impacts of electricity generation on the environment is due to one or several factors including particulate emissions; gaseous emissions (CO_2, SO_X, NO_X etc.); warm water discharges into streams, rivers or sea; liquid and solid waste (sludge, ash); inundation (in the case of large reservoirs) and changes of land use. Particulate and gaseous emissions are of primary importance in the case of electricity generation using fossil fuels. During the preparation of this report, the real-time data related to GHG emissions in electricity generation up to 2015 was collected. The GHG emission trends from 2015 to 2030 was taken from the Long Term Generation Expansion Plan (LTGEP) of 2015-2034 as it had projected same using several parameters including population and GDP growth. According to the LTGEP, demand for electricity will increase from 11,516 GWh in 2015 to 25,598 GWh in 2030. The annual growth will increase from 4.1% in 2015 to 4.9% in 2030. Accordingly, electricity generation will increase from GWh 12,901 in 2015 to GWh 28,410 in 2030. In the LTGEP base case scenario, coal will be the major source of power having its share reaching 40% by 2020 and 60% by 2034. The contribution of renewable energy sourced power will increase to 40% by 2025 and then decline to 35% by 2034 (LTGEP, 2015-2034). Figure 4.7 shows the GHG emissions in the baseline scenario for electricity generation.

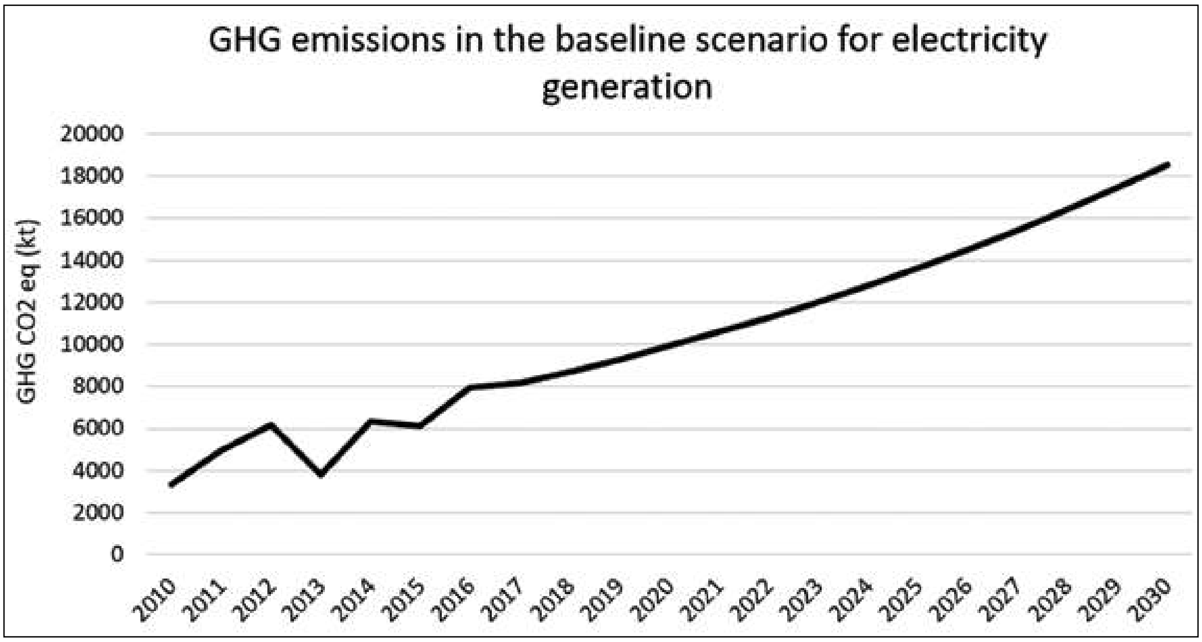
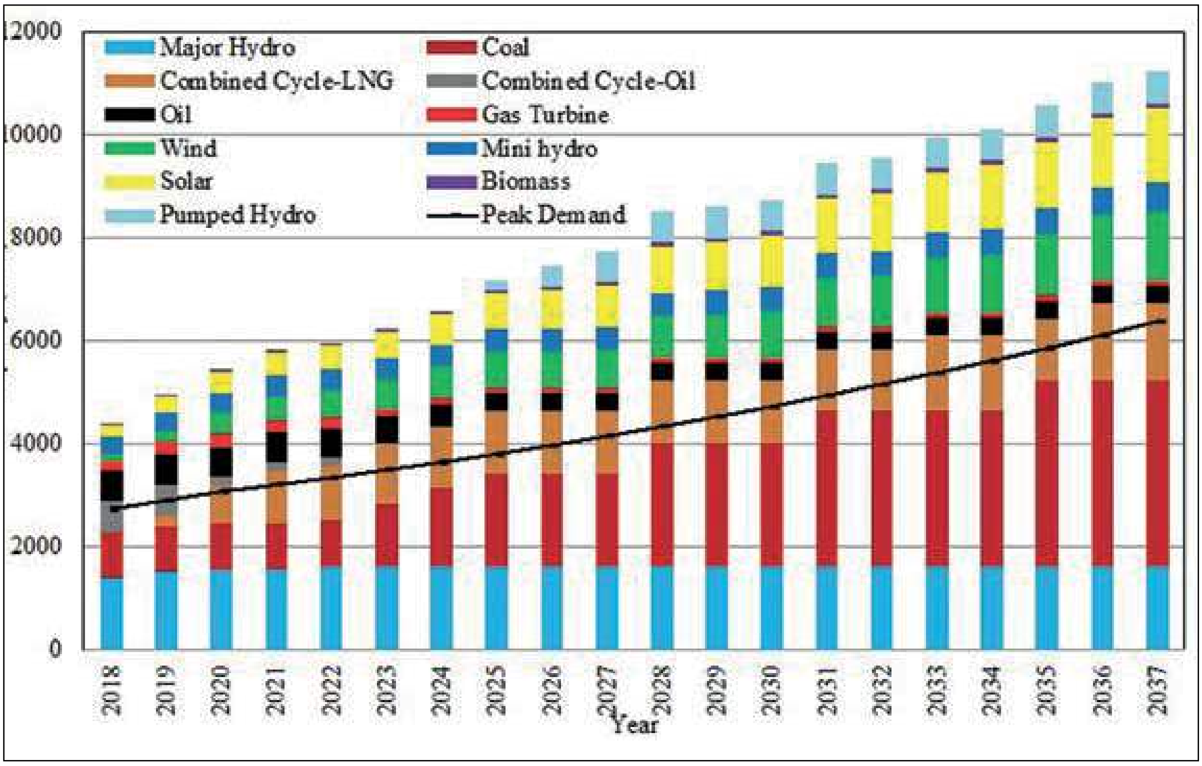


Figure 4.7 GHG emissions in the baseline scenario for electricity generation

Mitigation scenario: The mitigation scenario is based on the directions for reduction of GHG emissions by increasing the share of the renewable energy and introduction of Liquid Natural Gases (LNGs), loss reduction in electricity transmission and distribution and demand side management. According to the LTGEP (2018-2037) which was used for the development of the mitigation scenario, substitution of 4,700 MW of coal power with renewable energy sources and the introduction of LNGs (1400 MW) for thermal power generation in place of petroleum by 2030 are significant. The details of the current interventions are; (a) maximizing hydro potential in the country through the remaining large and small hydro power projects; (b) development of wind parks in the potential sites mostly in the northern and north-western coastal areas in the country for the generation of about 300 MW; (c) promotion of solar power generation of about 500 MW in different modalities (solar roof-top, solar parks etc.); and (d) a significant increase in biomass power generation.

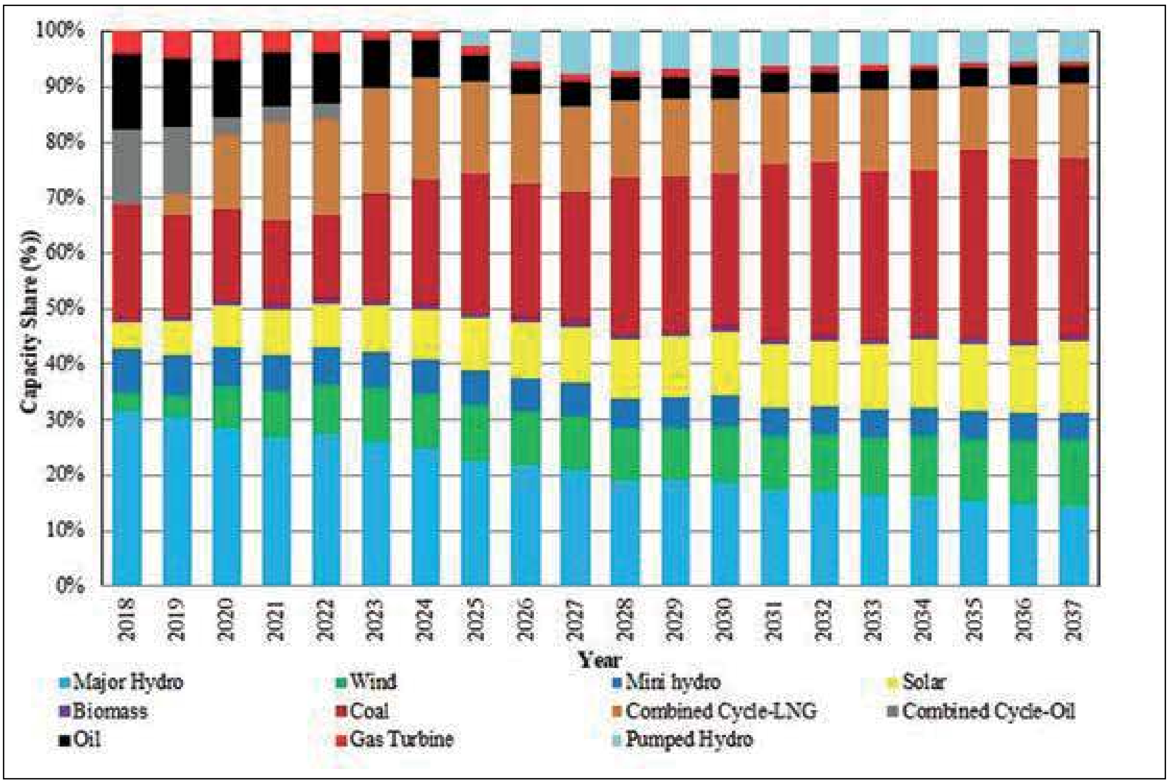
Cumulative capacity by plant type and the capacity share (%) over a period of 20 years from 2018 - 2037 are shown in Figures 4.8 and 4.9.



Source: LTGEP, 2018-2037

Figure 4.8 Cumulative capacity by plant type from 2018-2037

Sri Lanka's Nationally Determined Contributions (NDCs) submitted to the UNFCCC in 2016, enumerated targets aimed at increasing the use of renewable and sustainable forms of energy, resulting in a 20% reduction of GHG emissions (36,012 Gg) from the energy sector during the period 2020 -2030 as compared to 2010. This breaks down to 4% unconditional reduction and 16% conditional reduction. According to the LTGEP of 2018-2037, about 50% of total demand will be met by renewable sources.



Source: LTGEP, 2018-2037

Figure 4.9 Capacity share (%) of 2018-2037 period

Demand Side Management (DSM): In accordance with the International Energy Agency, the energy efficient technologies will contribute substantially towards achieving carbon neutrality by 2050 (Sri Lanka Sustainable Energy Authority - http://www.energy.gov.lk). A Presidential Task Force on energy DSM was established and nine thrust areas have been identified for assessment; efficient lighting, efficient fans, efficient motors, efficient refrigerators, energy management systems, eliminating incandescent lamps, efficient air conditioning, green buildings and efficient pumps and the likely contribution to reduce the GHGs by 2020 has been calculated to be 1,895 Gwh (www.energy.gov.lk/ODSM/odsm.html). Figure 4.10 shows the mitigation scenario drawn against the baseline scenario.

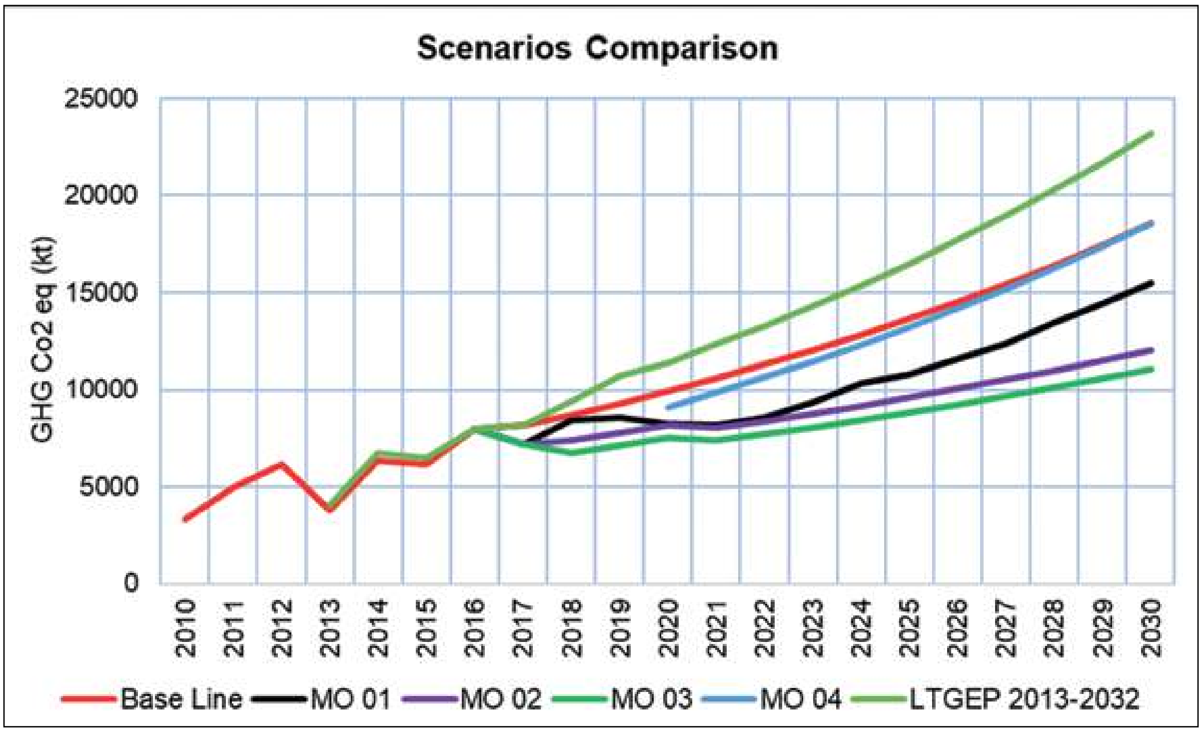


Figure 4.10 Mitigation scenarios composed against the baseline scenario

MO - Mitigation Option

MO 01: reduction of transmission loss and addition of renewables in LTGEP 2018-2037

MO 02: addition of a 1,400 MW of LNG in LTGEP 2018-2037

MO 03: 1,400 MW of LNG and DSM in LTGEP 2018-2037

MO 04: 20% emission reduction by NDCs of 2016

According to the Figure 4.10, the net saving emissions by 2030 in the mitigation scenario is 8,100 Gg CO_2-eq against to the baseline scenario.

4.2.1.2 Transport

Sri Lanka depends heavily on its public transport system with buses and trains while sea and air transport having only a limited presence. The private transport is primarily made up of cars, vans, three wheelers and motor cycles. The transport sector has played a crucial role in Sri Lanka's economic and social progress. In 2003, the sector contributed 10% of the country's GDP and generated about 4% of employment. By 2012, its contribution to GDP had increased to 14% (Department of Census and Statistics, 2015). However, the sector is also responsible for a large majority of the country's GHG emissions, about 51% of the total emissions in the energy sector are from transport (Figure 4.4). The various modes of transport prevalent in the country are discussed as follows;

(a) Road Transport

Sri Lanka road transport accounts for about 93% of the land transport. There are 12,496,337 km of A and B class roads and expressways. Over 70% of traffic in Sri Lanka uses the road network.

In 2012, the demand for passenger travel was around 80 billion passenger-kilometres (pkm) per year of which road transport accounted for 93%. About 97% of freight traffic measured in ton/km was also done by road (ADB, 2012). Therefore, roads dominate Sri Lanka's transportation landscape. There is a progressive increase of different modes of land vehicles from 2012-2016 (Table 4.2).

Table 4.2 Vehicle population of Sri Lanka from 2012-2016

Year	2012	2013	2014	2015	2016
Motor Cars	499,714	528,094	566,874	672,502	717,674
Motor Tricycle	766,784	850,457	929,495	1,059,042	1,115,987
Motor Cycles	2,546,447	2,715,727	2,988,612	3,359,501	3,699,630
Buses	91,623	93,428	97,279	101,419	104,104
Dual Purpose Vehicles	280,143	304,746	325,545	365,001	391,888
Motor Lorries	323,776	329,648	334,769	341,911	349,474
Land Vehicles - Tractors	315,520	326,292	333,362	343,339	353,624
Land Vehicles - Trailers	53,020	55,286	57,298	59,426	63,088
Total	**4,877,027**	**5,203,678**	**5,633,234**	**6,302,141**	**6,795,469**

Source: Department of Motor Traffic, 2016

According to the Table 4.2, during the period of 2012-2016, the vehicle fleet of motor cars increased by 43%. Motor tricycles (three wheelers) and motorcycles increased by 45% during this period. The increase in the bus fleet was modest at 13.6%. In terms of fuel consumption, 71.3% of the cars used petrol, 10.3% used diesel, 17.6% were hybrid cars and 0.8% were fully electric by 2016.

(b) Railways

Sri Lanka Railways with 1,450 km of track played a dominant role in passenger and freight movements in the past. Currently, it operates with only 200 diesel locomotives along with 46 diesel power sets. Despite the fact that the number of Passenger Kilometres had increased from 2010 onwards according to the Sri Lanka Railways Performance Reports.

(c) Ports

The port of Colombo is the country's main commercial port among the four major ports (Trincomalee, Hambanthota and Galle) and is considered to be one of the premier ports in Asia. After economic liberalization of Sri Lanka in 1977, the introduction of a port expansion programme, along with the onset of containerization and transhipment cargo, led to the growth of port traffic at an average rate of 6.5% per year. By 2010, port traffic in Sri Lanka had reached the equivalent of four million containers of twenty-foot equivalent units (ADB, 2012).

(d) Air Travel

Sri Lanka has 05 international airports and 11 domestic airports. The national carrier operates international routes while there are private carriers operating domestically. The civil aviation sector has shown considerable growth in recent times, through most of this growth has come from international passenger and cargo movements.

Policy and institutional environment for transport sector: The Draft National Policy on Transport in Sri Lanka (2017) set out government interventions in ensuring that existing and potential mobility needs within the country to be met safely and efficiently at least cost to the economy by using the minimum amount of resources and causing least impact on the environment. Sustainable priorities from this and other policies are summarized in Table 4.3.

The main objectives which are in support of climate change mitigation interventions in transport policy are (a) encouragement of the use of public transport, high occupancy vehicles and non-motorized transport; (b) reduction of the dependency on petroleum fuels for the country's mobility requirements; (c) reduction of vehicles circulating within urban areas in order to make a greater proportion of limited road space available for high occupancy vehicles; (d) utilization of high priority bus lanes, light transit systems (trains) or bus rapid transit (BRT) systems; and (e) provision of tax rebates for new technologies such as hybrid vehicles and new sources of fuel such as bio-fuel. The use of online platforms for e-commerce, e-education and other e-services should reduce the passenger load on the roads and railways, thus contributing to significantly reduce the GHG emissions. This would be somewhat offset by the energy requirements of digital technologies.

Table 4.3 Sustainable transport priorities based on existing policies

Pubic Modes of Transport	Large scale development and introduction of efficient public transport systems such as BRT, LRT and MRT systems leading to a modal shift from private to public modes of transportation
Alternative Vehicles	Increased adoption of electric and hybrid vehicles running on alternative fuels such as electricity, biofuels etc.
Urban Congestion and Pollution	Reduce traffic congestion and air, noise pollution in urban areas especially the Colombo Municipal Area through increased adoption of public and alternative modes of transportation
Energy Security	Achieve greater diversity of fuel sources and reduce dependence on imported sources of fuel especially petroleum
GHG Emissions	Reduce GHG emissions from the transport sector through the adoption of alternative clean fuel vehicles and public modes of transport, decreasing its reliance on fossil fuels

Baseline scenario: The data from 2010-2015 were collected for setting the baseline scenario for transport sector. These data were extrapolated to the year 2030. The Figure 4.11 shows the baseline GHG emissions in transport sector (road and railways only) projected from 2010-2030.

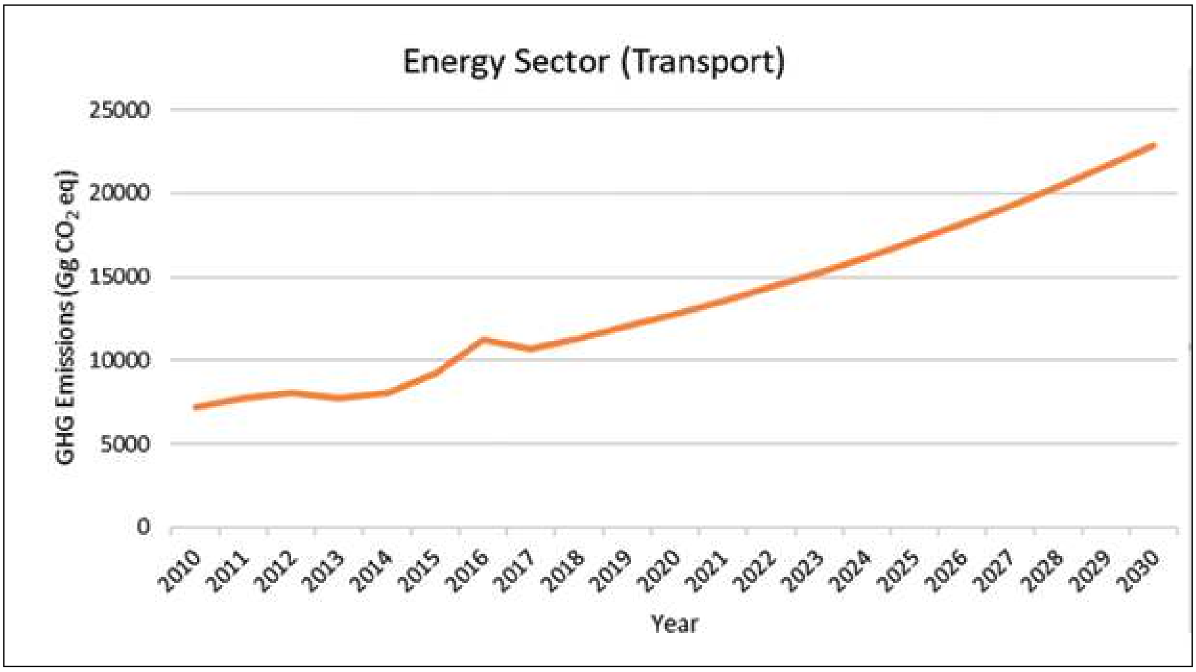


Figure 4.11 Baseline GHG emissions in transport sector from 2010 - 2030

Mitigation Scenario: The NDCs of Sri Lanka submitted to the UNFCCC in 2016 includes the activities that could be undertaken to reduce GHG emissions in the transport sector. They are (a) avoidance/reduction of journeys; (b) modal shift; (c) improvement of energy efficiency of modes of transport and vehicle technologies; and (d) fuel improvement. Among these, a greater emphasis was placed on the modal shift to increase the share of public transport which is supported by policies and action plans. The public transportation contributions to the entire transport sector is about 55% in 2020. It is expected to decrease to 47% by 2030 in the base case (Megapolis Transport Masterplan, 2016). However, in the mitigation scenario which is designed taking into consideration, the road and rail modes of transport are drawn on the premise that public transport share would increase to 62% by 2030 through the interventions mentioned above. An emphasis is also placed on efficiency improvements in new vehicles using improved fuel which emit fewer GHGs. The GHG emissions of approximately 81g CO_2/passenger km is expected to be reduced to 73g CO_2/passenger km. The more specific and detailed actions to be taken are as follows;

(i) Urban transport system development for Colombo Metropolitan Region and Suburbs (COMTrans) taking into consideration the transport corridors, high transport volumes, urbanization level, population density and network functions as envisaged in the JICA Transport Plan for COMTrans projected up to 2035.

(ii) Preparation and operationalization of Transport Nationally Appropriate Mitigation Action to introduce electric buses for the Galle Road Bus Rapid Transit.

(iii) Megalopolis and Western Development Master Plan where proposed interventions in the Plan would improve transportation and thus reduce GHG emissions in the long run. This entails: (a) more flexible working hours; (b) vehicle parking management; (c) intersection control; (d) traffic flow management; (e) public transport improvement; (f) restructuring public bus service; (g) modernization and improvement of the quality of the buses and services; (h) improvement of office and school bus services; (i) regulation and improvement of door-to-door taxi service; (j) development of multi modal transport hubs; (k) railway electrification and modernization; (l) new rapid transit systems; (m) introduction of new water transit system in inland water ways; (n) capacity improvement by development of road links; (o) capacity improvement in existing expressway network; (p) improvement of walkability in roads; (q) intersection controls to reduce vehicle emissions; (r) construction of new expressways; (s) encouraging bicycle use for travelling; (t) increase of electric vehicle rapid charging centres; (u) encouraging the use of electric vehicle through tax incentives offered; and (v) encouraging online services such as e-commerce, e-education and other consumer services which reduce vehicles on the roads and railways.

Figure 4.12 shows the GHG emissions in the mitigation scenario which has taken into account the modal shift to public transport, efficiency improvement of fuel types, use of electrical and hybrid vehicles, and reduction of the use of transport compared with the baseline.

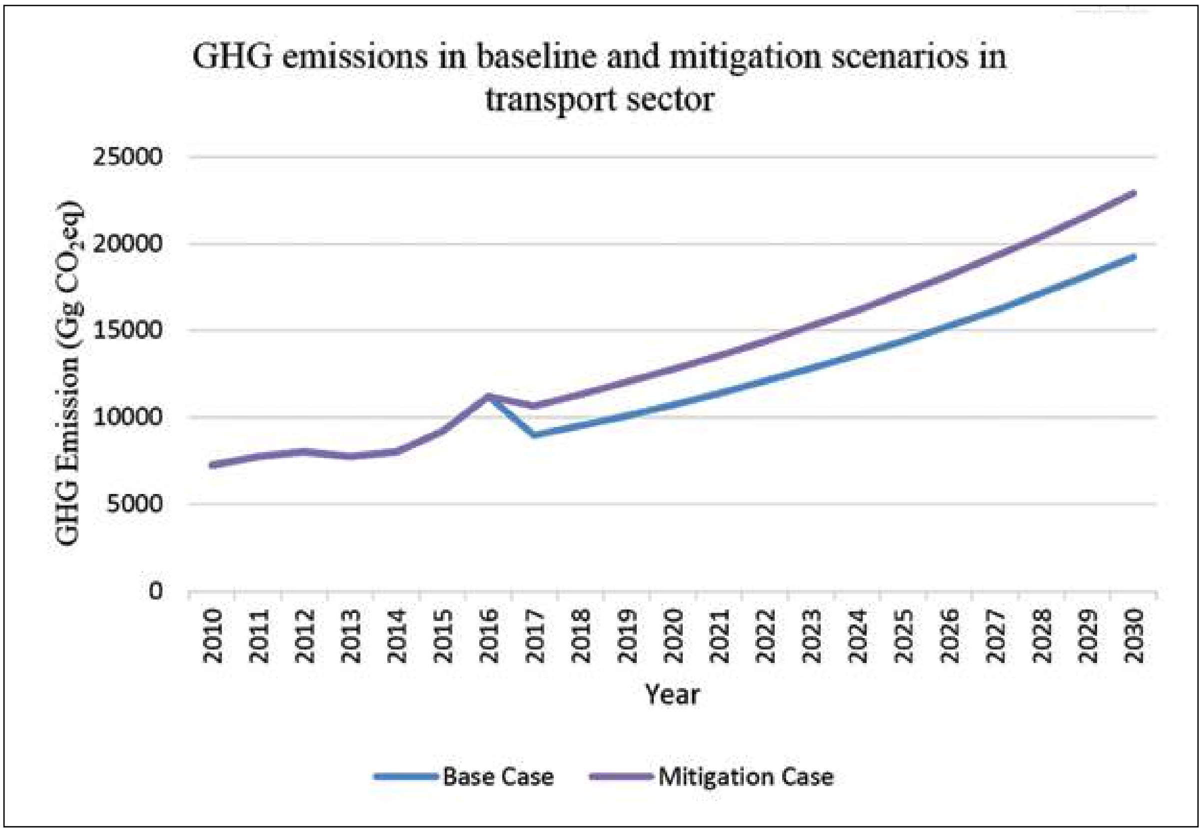


Figure 4.12 Projected GHG emissions baseline and mitigation scenarios

According to the Figure 4.12, the net saving in the emissions by 2030 in the mitigation scenario is 3,668 $GgCO_2$-eq compared with the baseline scenario.

4.2.1.3 Household, Commercial and Manufacturing Industries

Baseline: Industrial production growth in Sri Lanka averaged 5.24% from 2004 until 2017, reaching an all-time high of 35.2% in July 2010 and a record low of 11.4% in April of 2016. Of the types of industries, manufacturing of food products (35.2%) and wearing apparels (19.8%) were significantly greater than rest of the groups. The minimum contribution to the production index comes from manufacturing of leather and related products (0.3 %) from 2010-2015. The share of different types of industries, as measure of index of production from 2010-2015 is shown in the Figure 4.13.

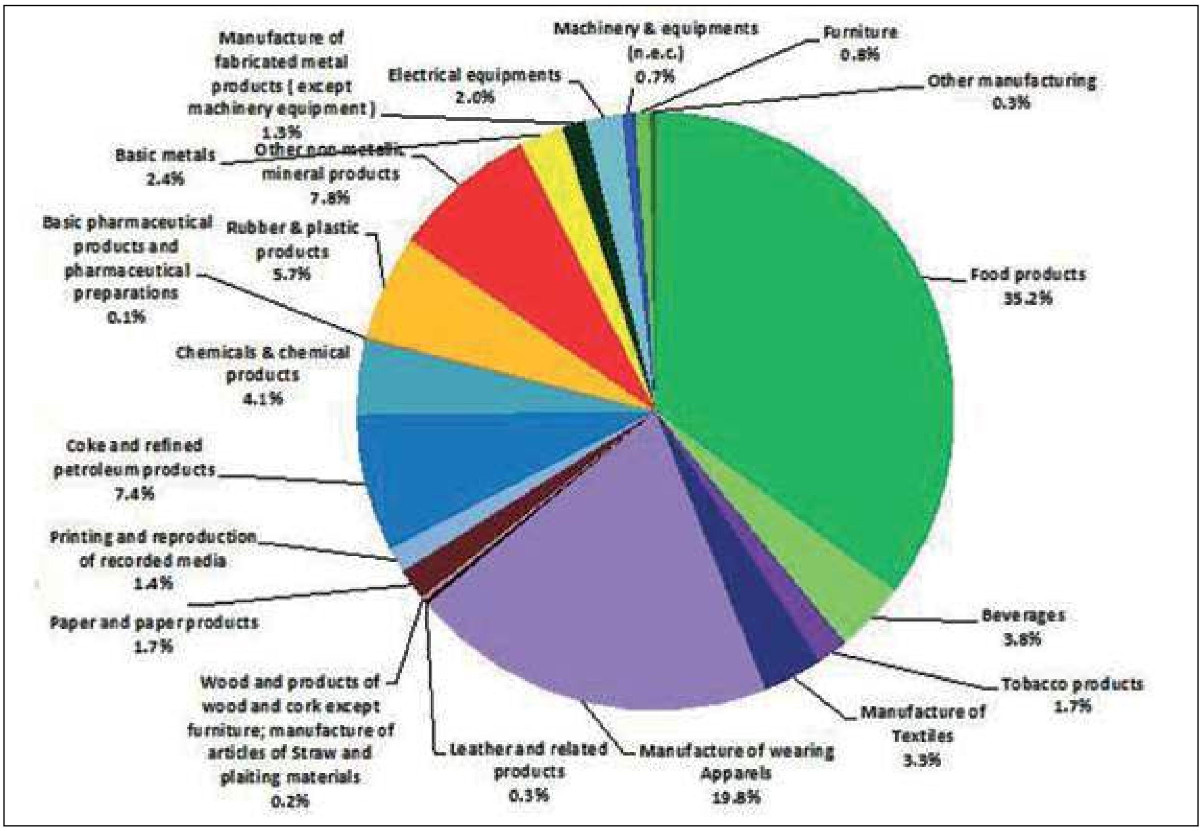


Figure 4.13 The share of industries as a measure of index of production, 2010-2015

In industry sector, there had not been any regulatory action for the reduction of GHG emission rather than on voluntary basis. Later on, the following actions have been taken with a view to enhance the standards of the sector and also to reduce GHG emissions such as consolidation of cleaner production in industries, establishment of eco-industrial parks, ISO certification of industries, and introduction of National Green Reporting System (NGRS) etc. Energy labelling had been proceeded with single appliance i.e. CFL bulbs. Sector specific energy consumption benchmarks were prepared for certain sectors based on limited sample studies.

The NGRS was introduced by the Ministry of Environment with the objective to facilitate the manufacturing and service sector to periodically measure and report their sustainability performance with respect to economic, environment and social aspects in order to continually improve their production policies and services, relationship with stakeholders and enhance their image while contributing towards the sustainable development in the country.

Baseline scenario: The data from 2010-2015 were collected for setting the baseline scenario for this sector. These data were extrapolated to the year 2030. It was assumed that the activities proposed in the Haritha (Green) Lanka Action Plan and its products including consolidation of cleaner production in industries, fuel switching and use of efficient motors where applicable and certification of industries, have been considered. Figure 4.14 shows the baseline scenario up to 2030.

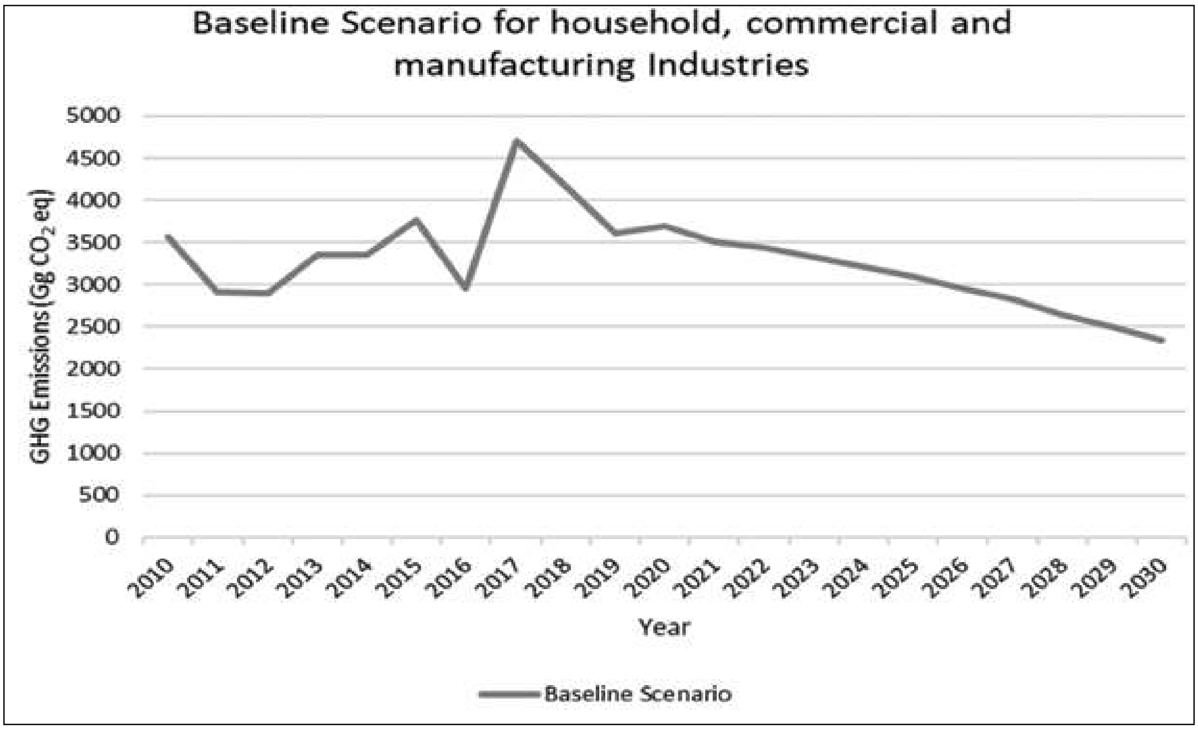


Figure 4.14 Baseline scenario for household, commercial and manufacturing industries

Mitigation scenario: The mitigation scenario was developed based on the assumption that the proposed NDCs submitted by Sri Lanka to the UNFCCC in 2016 will be implemented during the period 2020-2030.

The NDCs for industrial sector include modernizing and facilitating industries to follow recognized standards for GHG emission reduction i.e. environmental management systems; fuel switching; improvement of industrial energy, water and raw material efficiency; application of eco-efficiency and cleaner production; greening the supply chain; introduction of high efficiency motors; etc. In addition to the above, switching into cleaner fuel sources such as LPG and applying ISO 50001 for energy management systems were considered.

Figure 4.15 shows the mitigation scenarios in household, commercial and manufacturing industries against the baseline scenario for the period of 2010-2030.

4.3 Industrial Processes and Product Use (IPPU) Sector

According to the UNFCCC categorization, IPPU category includes mining industry, chemical industry, metal industry, non-energy products from fuels and solvent use, electronic industry, product uses as substitutes for ozone depleting substances, and other product manufacture and use. In Sri Lanka, the cement industry, lime industry, brewing, refrigerant replacement and refinery improvement have been selected under this category.

Baseline scenario: As per the GHG Inventory in this report, the IPPU sector contributes to 2% of the total emissions of the country. Cement and lime production are the major contributors to the IPPU sector and it is a share of 74%. In the construction of the baseline scenario, the data on cement and lime industries from 2010-2015 were taken and extrapolated to 2030 based on population growth, GDP and other trends in the industry. Figure 4.16 shows the baseline scenario in this sector.

Mitigation scenario: The mitigation scenario for the IPPU sector which is mainly focused on clinker production, is mitigated by two main approaches: reduction of clinker content in cement by using additives, such as fly ash and slags, and reducing the content of cement in the final application by replacing a portion of cement with suitable substitutes. The main cement manufacturer in Sri Lanka uses around 4,000 MT of sorted non-recyclable polythene fraction of the Municipal Solid Waste in 2020 in its cement kiln which is called co-processing and it is hoped to increase this to 12,000 MT by 2022. A further increase of 10% is expected by 2030.

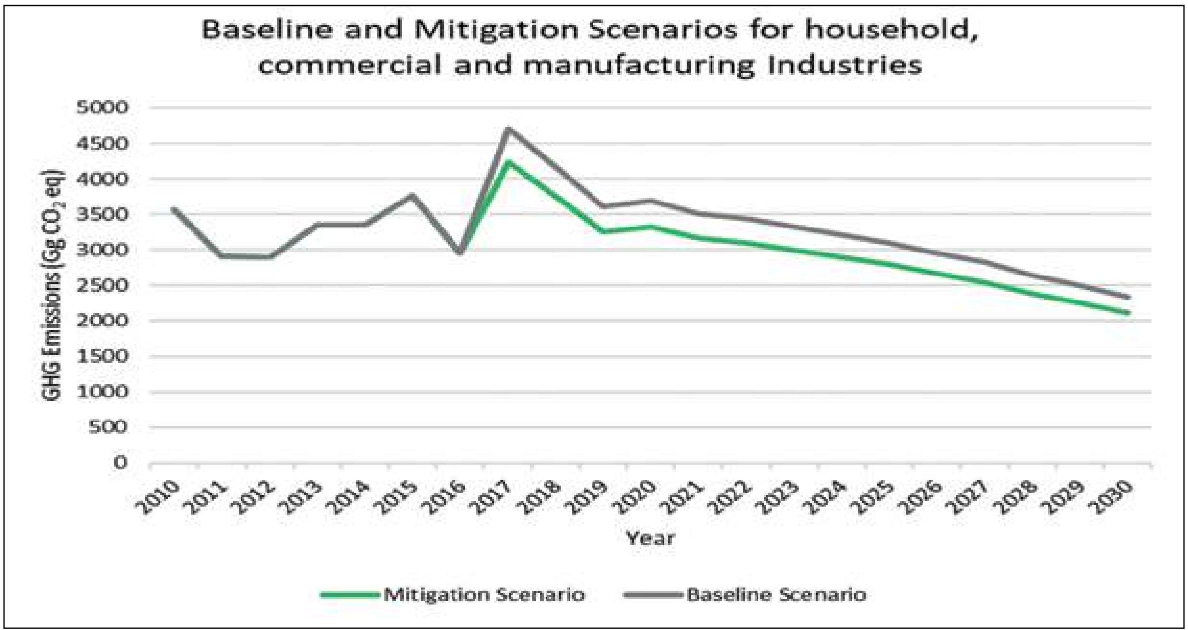


Figure 4.15 Baseline and mitigation scenarios in household, commercial and manufacturing industries

According to the Figure 4.15, the net saving GHG emissions by 2030 in the mitigation scenario is 342 Gg CO_2-eq compared with the baseline scenario.

In 2018, 100,000 tonnes of fly ash was used as a substitute to clinker by cement producing company in Sri Lanka. Though the company wants to increase the use of fly ash usage, the limitation in supply of fly ash hinders its efforts to further reduce the GHG emission. For the mitigation scenario, it is assumed that the proposed coal power plants for the power generation will provide additional fly ash for the clinker production facility in 2024. Hence, the GHG emission would be reduced by 5% from the baseline scenario.

At present, the addition of steel slag is mainly done form cement manufactured using imported clinker. This is due to the fact that the slag has to be imported and its use in mixing facilities near the ports is more economical than transporting to the local clinker producing facility. It is assumed that the use of the slag in the clinker producing plant will result in a further reduction of 5% of GHG emissions from the baseline scenario. Accordingly, a total of 11.8% GHG emission reduction from IPPU sector (10% from clinker production and 1.8% from other industry categories) could be projected in the mitigation scenario, as shown in Figure 4.17.

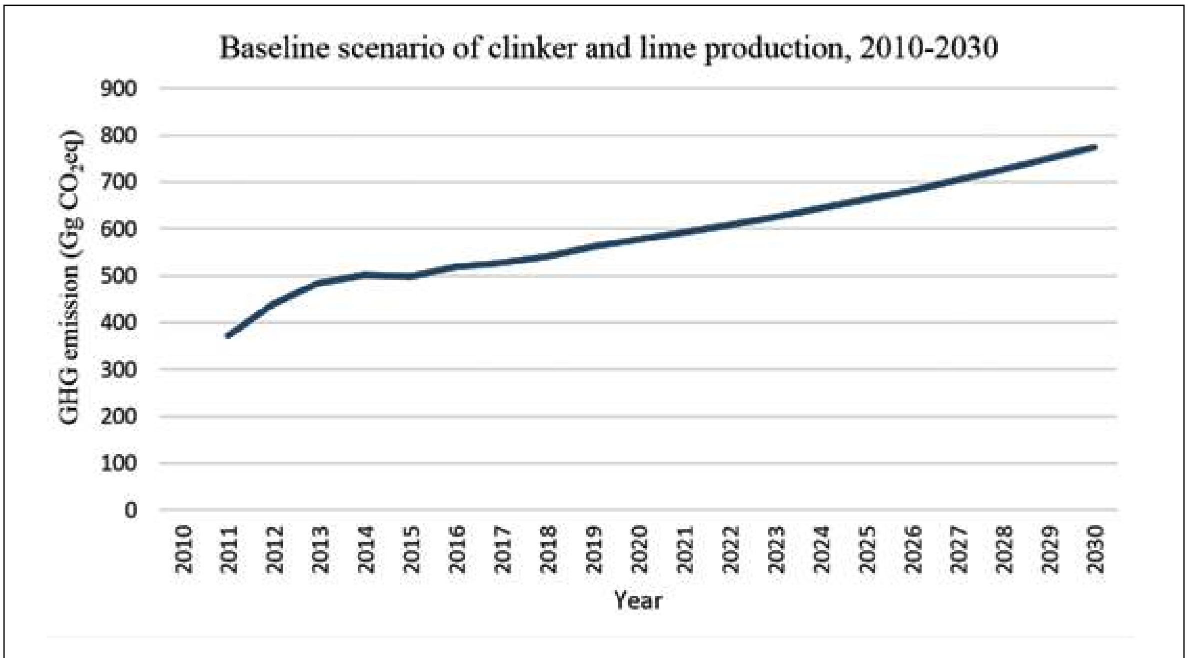


Figure 4.16 Baseline scenario of clinker and lime production, 2010-2030

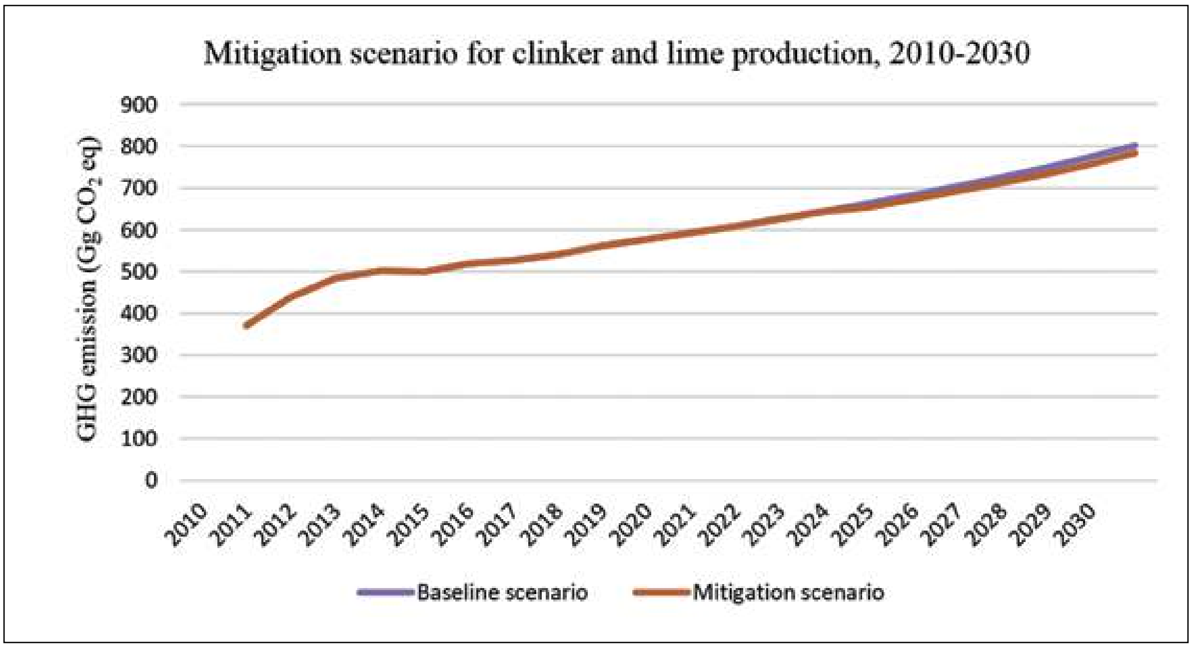


Figure 4.17 Mitigation scenario from clinker and lime production, 2010-2030

According to the Figure 4.17, the net saving GHG emissions from IPPU sector by 2030 in the mitigation scenario is 85 Gg CO_2-eq compared with the baseline scenario.

4.4 Waste sector

Municipal Solid Waste (MSW) generation in Sri Lanka is around 6,500 to 7,000 Mt/day and half of which (3,500 Mt/day) is collected (Mannapperuma, 2017). Western Province accounts for 59% of the country's MSW generation and the other eight provinces contributed the remaining 41% into the total waste generation as at 2017. In general, the composition of biodegradable waste in the country is around 57.6% of MSW, i.e. a relatively high organic composition. The daily waste generation in the Western Province is expected to be 3,583 Mt and 4,073 by 2020 and 2030 respectively.

There are about 112 compost facilities at present in the country and the total processing capacity of them reached 542 tonnes/day resulting from the *Pilisaru Project* and supported by the National Solid Waste Management Support Centre (Ministry of Local Government and Provincial Councils, 2018). The Western Province has 21 compost plants and the remainder are spread over other eight provinces.

Health care waste generation, primarily from hospitals consists of hazardous as well as non-hazardous waste and amounts to 25 Mt/day. Health care waste management is outsourced to a private company while small scale incinerators and metamizers (a hybrid autoclave technology) are operated in hospitals scattered around the country.

The National Water Supply and Drainage Board (NSWDB) operates 10 common commercial waste water treatment plants located in the Export Promotion Processing Zones and 11 common household waste water treatment plants elsewhere in the country. It had planned to cover 3.5% of households in the country in its pipe-borne sewerage facilities by 2020. Waste water discharge by industries is regulated by the National Environment Act No. 47 of 1980.

Baseline scenario: The GHG emission of the waste sector is expected to increase from 854 Gg CO_2-eq/yr and 123 Gg of fossil CO_2 in 2010 to 1,340 Gg CO_2-eq/yr and 175 Gg of fossil CO_2 in 2030. Methane and Nitrous Oxide emissions from human sewage were calculated based on population growth in Sri Lanka and the protein consumption factor of 26.93 kg per capita per year. The baseline scenario was constructed extrapolating the GHG emission data collected from 2010-2015 based on population growth and GDP up to 2030. The current trends in waste management including open dumping, recycling and composting were taken into consideration in this context. Figure 4.18 shows the baseline scenario in the waste sector.

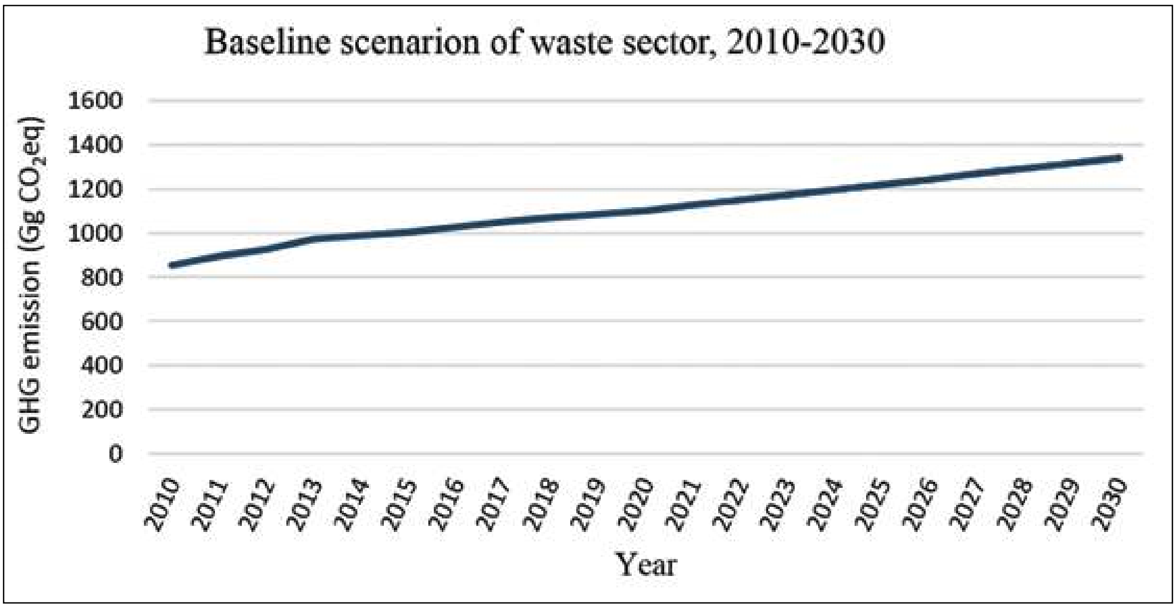


Figure 4.18 Baseline scenario of GHG emission in waste sector

Mitigation scenario: The NDCs for the waste sector include introducing source separation system at the household level and improved SWM collection; improving composting for each local authority and increasing organic fertilizer for agricultural purposes by providing facilities to control quality and stimulating a market for produced compost; introducing energy generation from waste (waste to energy programmes); improving waste collection by designing and implementing comprehensive solid waste management strategies for 40% - 60% Local Authorities by 2030; monitoring of waste management activities; and system management of industrial / hazardous and clinical waste. The 3R system (Reduce, Reuse and Recycle) should be introduced to all Local Authorities along with improved composting facilities in Local Authorities where the waste collection is below 30Mt/day. In areas where waste collection is more than 30 Mt/day, technologies such as incinerators, waste-to-energy systems and mechanically operated composting systems were also identified.

With the current solid waste generation pattern mentioned above, a significant increase is shown from 2020-2030. Therefore, the Waste Management Authority of Western Province (WMAWP) prepared targets for MSW treatment and disposal in the Western Province for the period of 2016 to 2020. The Plan anticipated disposing 83% of waste in landfills, 9% in compost preparation and 8% totally recycled. Updated targets for MSW treatment and disposal in the Western Province (2017-2023) are given in Figure 4.19.

According to the Master Plan, open dumping of waste in the Western Province will be significantly reduced and waste will be collected in mass disposal enclosures in Local Authorities, with some used for waste-to-energy projects.

In parallel to the Master Plan, two new compost facilities will be established with solid waste processing capacities of 100 Mt/day and 350 Mt/day at Karadiyana and Muthurajawela respectively. The Ministry of Provincial Councils and Local Government is planning to establish Kawashima (aerobic, screw type) composting facilities, each with a capacity of 50 Mt/day in all provinces. All these projects are considered in the mitigation assessment of the waste sector. The commissioning of composting plants at Karadiyana, Muthurajawela and all provinces could reduce GHG emission by 1,029 Gg CO_2-eq over the period of 2020 to 2030.

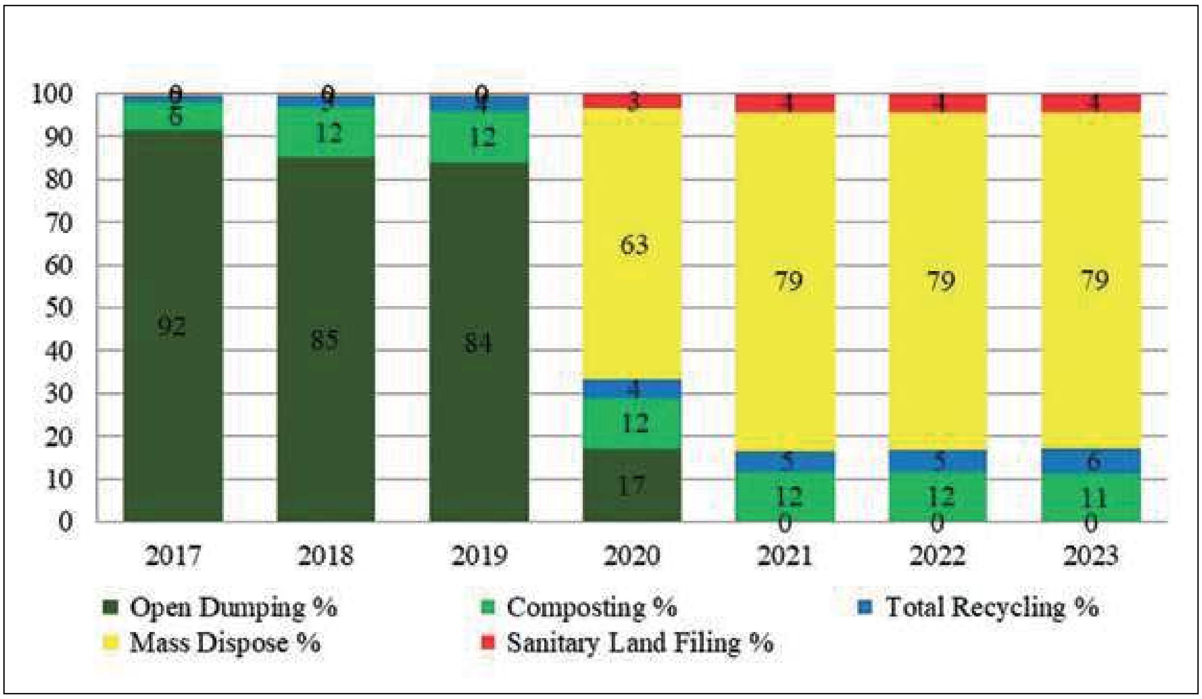


Figure 4.19 Targets for MSW treatment and disposal in Western Province as per Master Plan of WMAWP for the period of 2017-2023

Waste-to-energy projects proposed in the Master Plan of WMAWP have the potential to reduce GHG emissions by 4,780 Gg CO_2-eq/yr during the period of 2020-2030. Further, waste-to-energy projects proposed have the capacity to reduce GHG emission by 2,448 Gg CO_2-eq/yr from each. The total GHG emission reduction potential from above activities proposed for solid waste sector is therefore, 7,708 Gg CO_2-eq/yr in 2030.

Figure 4.20 GHG emission in solid waste sector (Gg CO_2-eq/yr) under baseline and mitigation scenarios

4.4.1 Waste water

Domestic waste water emitted 472.83 Gg CO_2-eq in 2010. It is assumed that 25% of septic tanks would be converted to bio-energy pits by 2030 in urban and semi-urban areas of the country where waste collection is carried out. Further, it is proposed that organic waste generated from these households would also be utilized in bio-energy pits. New regulations are required to accommodate bio-energy pits in the country in the future instead of domestic septic tanks.

With regards to GHG emissions, it is envisaged that approximately 30% of emissions could be reduced by the proposed activity compared to the GHG emission in 2030 under baseline scenario. Further, Nitrous Oxide generation will be avoided through anaerobic digestion of organic waste from households. The sludge resulting from the anaerobic digestion could be utilized as a soil fertilizer. The conversion of septic tanks into bio-energy pits is having the potential to reduce GHG emissions by 1,468 Gg CO_2-eq during 2020-2030. Figure 4.21 shows the GHG emissions reduction from conversion of domestic waste water tanks into bio-energy pits.

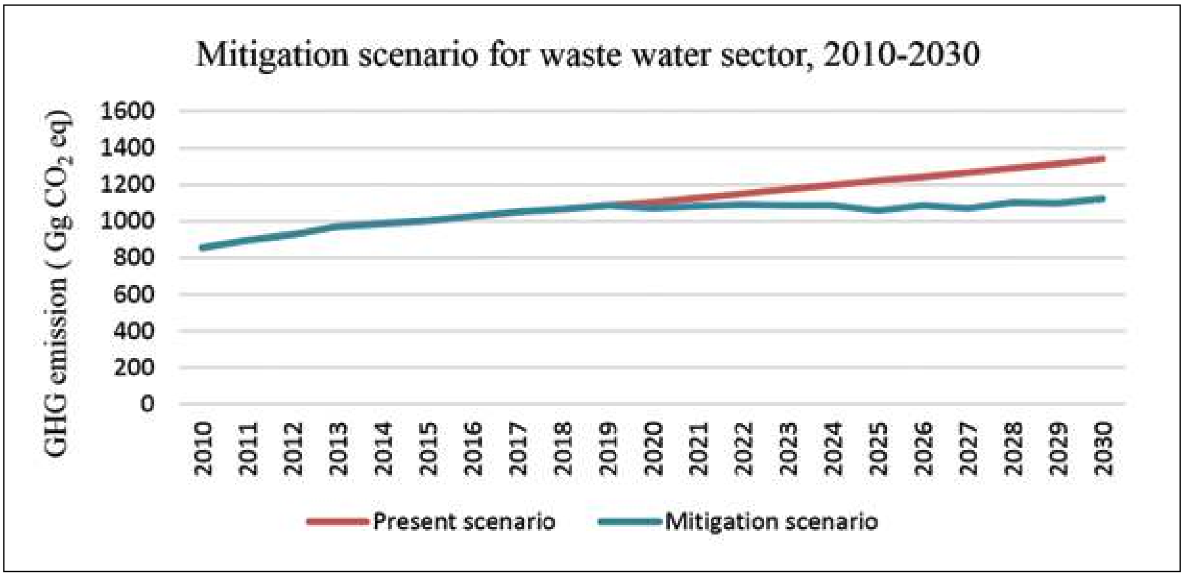


Figure 4.21 GHG emission in waste water sector under present (baseline) and mitigation scenarios

The total net saving in the waste sector under baseline and mitigation scenarios is shown in Figure 4.22.

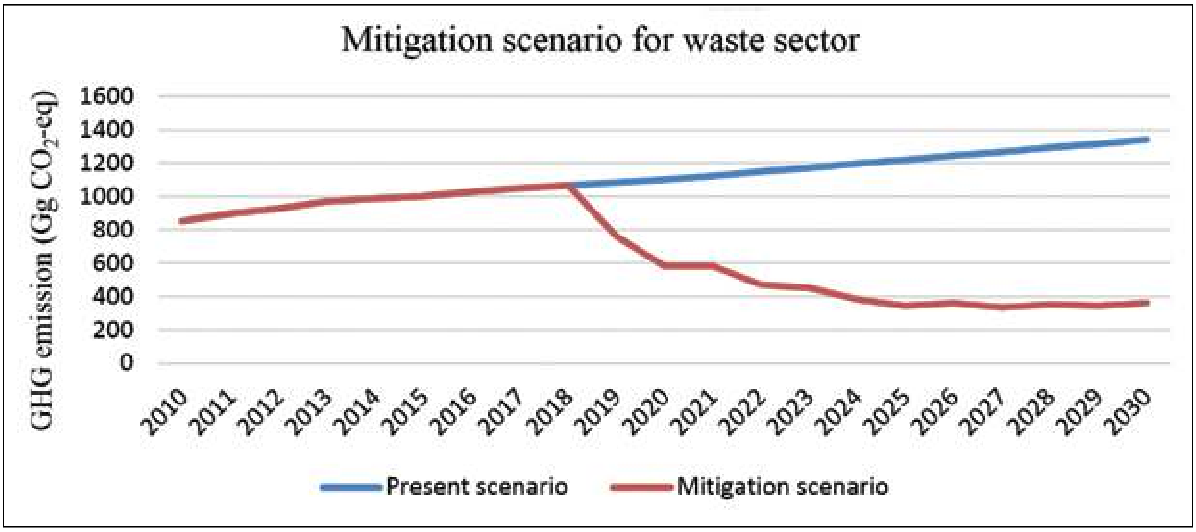


Figure 4.22 GHG emission in waste sector under baseline and mitigation scenarios

According to the Figure 4.22, the net saving in the emissions in 2030 in the mitigation scenario is 974 Gg CO_2-eq compared with the baseline while total GHG emission reduction is 9,176 Gg CO_2-eq for the period of 2020 to 2030.

4.5 Agriculture, Forestry and Other Land Use (AFOLU) sector

4.5.1 Agriculture sector

Agriculture sector consists mainly of crop and animal production systems. Total annual extent under paddy cultivation for both seasons *Yala* (South West monsoon) and *Maha* (North East monsoon) has been a range of 1.0 -1.2 million ha. However, cultivated extent during 2016 and 2017 was reduced greatly due to drought conditions. The paddy cultivated areas as a percentage is 58% in the dry zone, 22% in the wet zone and 20% in the intermediate zone.

Cattle, buffaloes, swine, and poultry dominate the animal husbandry in the country. The demand for livestock is on the increase. Hence, livestock-based GHG emissions can also be expected to grow up.

Baseline scenario: Paddy cultivation and livestock farming contributed significantly to the GHG emissions in the agriculture sector. The area of 949,800 ha is of rice cultivation in 2010 and it has progressively increased to 1,097,000 ha in 2018 and is projected to increase to about 1,338,000 ha by 2030. With regards to the GHG emissions from rice cultivation, it showed an increase from 1,250 Gg CO_2-eq in 2010 to 1,335 Gg CO_2-eq in 2015 (the average GHG emission rate in CO_2-eq is 1.45/ha). With regards to the livestock, the population of dairy cattle, poultry and swine can be considered as significant. Livestock comprising of cattle, buffalo, swine and poultry had increased in numbers from 15,694,425 in 2010 to 18,225,080 in 2015 (DCS, 2015).

Baseline scenario was constructed only for the rice cultivation up to 2030 based on the trends in population increase and GDP. Figure 4.23 shows the baseline scenario for the GHG emissions in rice cultivation from 2010 to 2030.

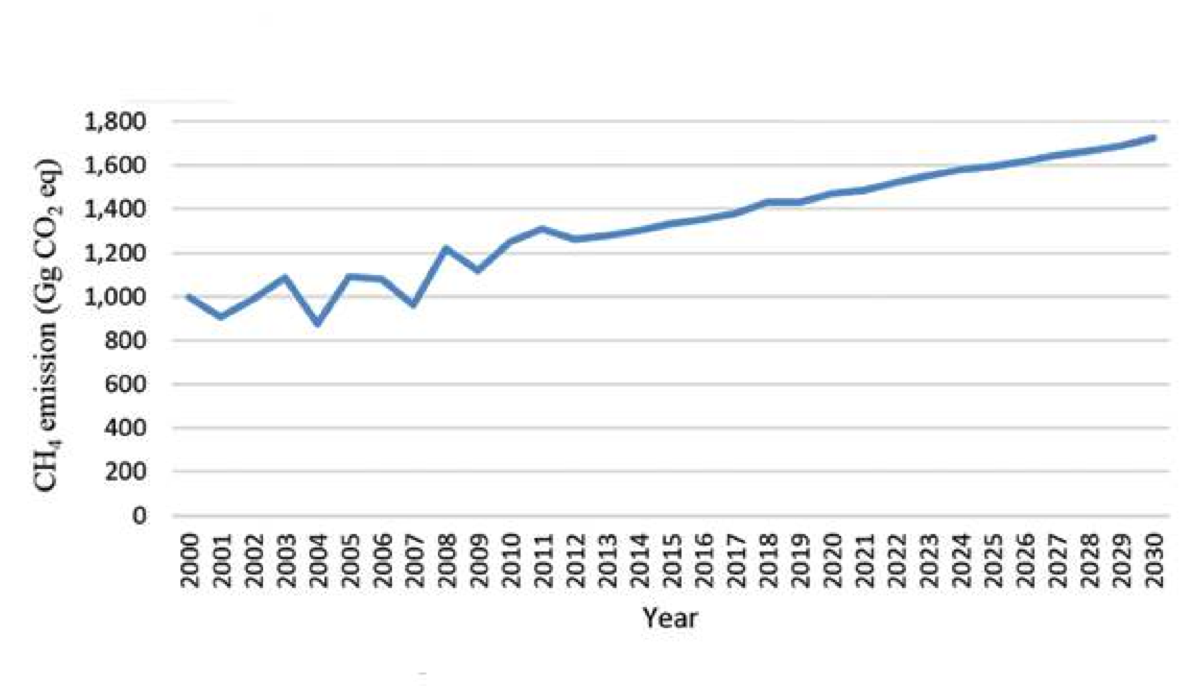


Figure 4.23 GHG emissions of rice cultivation in baseline scenario, 2010-2030

Mitigation scenario: In the presence of climate vulnerability, the country's future food requirements, productivity variation and changes in the cost of production in different macro-climatic regions etc. will also change in the future. In response to these future changes, agriculture experts' opinion implies a reduction of the area under rice cultivation by about 10% (0.9 million ha) or setting aside part of that land previously hitherto restricted to rice cultivation for higher-value-priced crops such as maize, soya beans, mung beans, etc. Agriculture development plans also intend to use fertilizer more efficiently and effectively, thus curtailing the emissions of GHG as Nitrous Oxide. In view of the above intended mitigations, at least two mitigation scenarios can be emulated;

(a) Mitigation scenario 1: This has been developed to relegate rice cultivation to only high potential areas/ seasons, e.g. focus on rice cultivation during the *Maha* season when water is plentiful and shift to higher-value crops in the *Yala* season when water is scarce. With the required productivity improvements such as efficient application of fertilizer and other technological enhancements, the expected rice demand can be met. The expert assumptions are that emissions will be reduced by 5% by 2030 due to increased productivity and decreased cultivated area.

(b) Mitigation scenario 2: Mitigation scenario 2 incorporates improved efficiency of fertilizer use for rice cultivation with improved farming techniques. Taking the recent trends into account, the Department of Agriculture plans to reduce inorganic fertilizer use in paddy cultivation by 10-15% and introduce site-specific fertilizer recommendations as well as the use of leaf colour charts for fertilizer need assessment, promoting the use of compost approach and improved fertilizer types. It is also expected that the application of the 4R (right combination, right rate, right time, and right placement) will reduce GHG emissions. In this scenario, it is assumed that the urea application in rice cultivation will be reduced by 12.5% by 2030 compared to current rates (2016) and the emissions from rice cultivation will be reduced by about 10%. Figure 4.24 shows the two mitigation scenarios in rice cultivation compared to the baseline scenario.

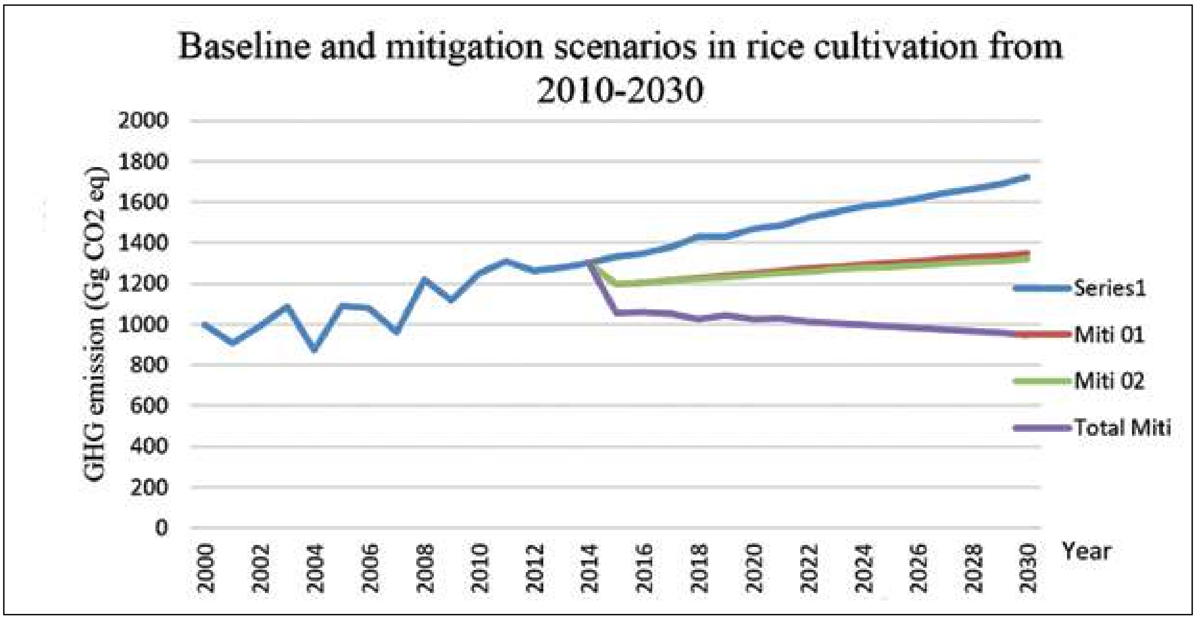


Figure 4.24 Baseline and mitigation scenarios in rice cultivation from 2010-2030

According to the Figure 4.24, the net saving GHG emissions by 2030 in mitigation scenario is 720 Gg CO_2-eq compared with the baseline scenario.

4.5.2 Forestry sector

By the dawn of the nineteenth century, Sri Lanka's forest cover was about 70% of the total land area. Since then, the forest cover has decreased progressively over the time.

The country's forest cover in 2015 was 29.87% of the total land area and comprise of 21.88% of dense forest, 6.26% of open and sparse forest, 1.43% savannah and 0.3% mangroves. Furthermore, home gardens occupy 13% and coconut and rubber lands occupy 8% (FD, 2015). The rate of deforestation at present is 5,000 ha per year. The deforestation is primarily due to change of forest land use to non- forest land uses for development projects and also due to illegal encroachment of forests. There are many policy and program level initiatives to conserve and increase the forest cover with the intention of increasing the carbon sinking capacities of forests.

Baseline scenario: In the construction of baseline scenario, the deforestation rate was taken as 8,000 ha per year from 2010-2015 and then reduced to 5,000 ha per year. Thereafter since there were many projects and programs in operation to conserve forests and reduce the loss. This trend was extrapolated to 2030 based on the population growth and GDP. In construction of the baseline scenario the natural forest cover, forest plantations and rubber plantation (as per the FAO definition) were considered. The trees outside the forests such as home gardens, coconut plantations, shade trees in tea plantations, avenue planting etc. were excluded. The standard UNFCCC emission factors were taken for the GHG emissions calculations for deforestation while the carbon sequestration capacities of natural forests were taken from published literature relevant to the tropical region. The Figure 4.25 shows the baseline scenario from 2010 to 2030 which shows the deforestation while Figure 4.26 shows the forest carbon dynamics in baseline scenario including emissions and sequestration.

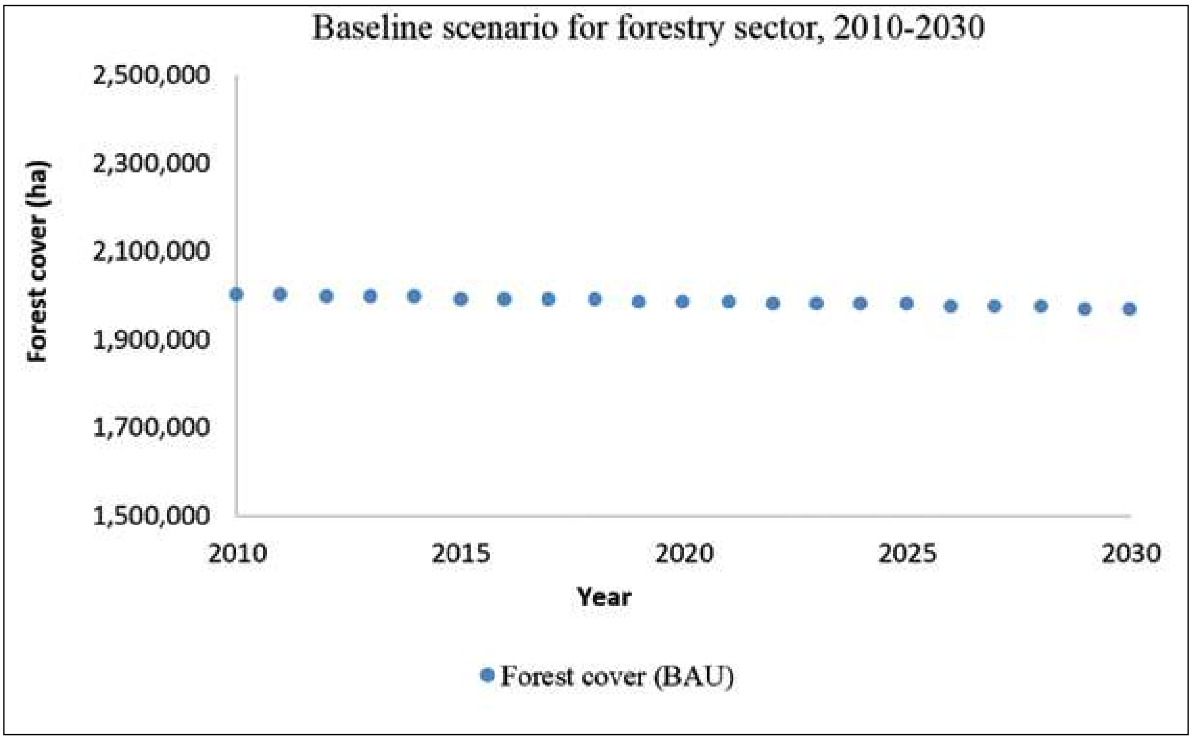


Figure 4.25 Baseline scenario for forestry sector, 2000-2030

Mitigation scenario: The mitigation scenario for forestry sector was developed based on the increase in forest cover from 29.87% in 2015 to 32% by 2030. Since trees/forests has the capacity to absorb/sequester atmospheric carbon dioxide into their life processes and be carbon sinks, increasing the forest cover and conserving the forests is of prime importance. It mainly focuses on the restoration and improvement of degraded forests and establishment of new forest plantations as well as the increase of rubber plantations.

Assuming gradual increase of forest cover due to reforestation and/or afforestation to reach the forest cover target of 32% by 2030, addition of carbon to the forestry sector was estimated. This increase in the forest cover will be done by planting of trees in areas where there is no forest cover or have a very degraded forests which cannot be considered under the definition of forests. It has been estimated that about 67,700 ha of land will be required to meet this target of 32% by 2030. In addition to new plantings, attempt will be made to conserve the existing forests and improve its carbon stocks. Figure 4.27 shows the expected increase in the forest cover in mitigation scenario as against to baseline scenario while Figure 4.28 shows the carbon sequestration of mitigation scenario in relation to baseline scenario.

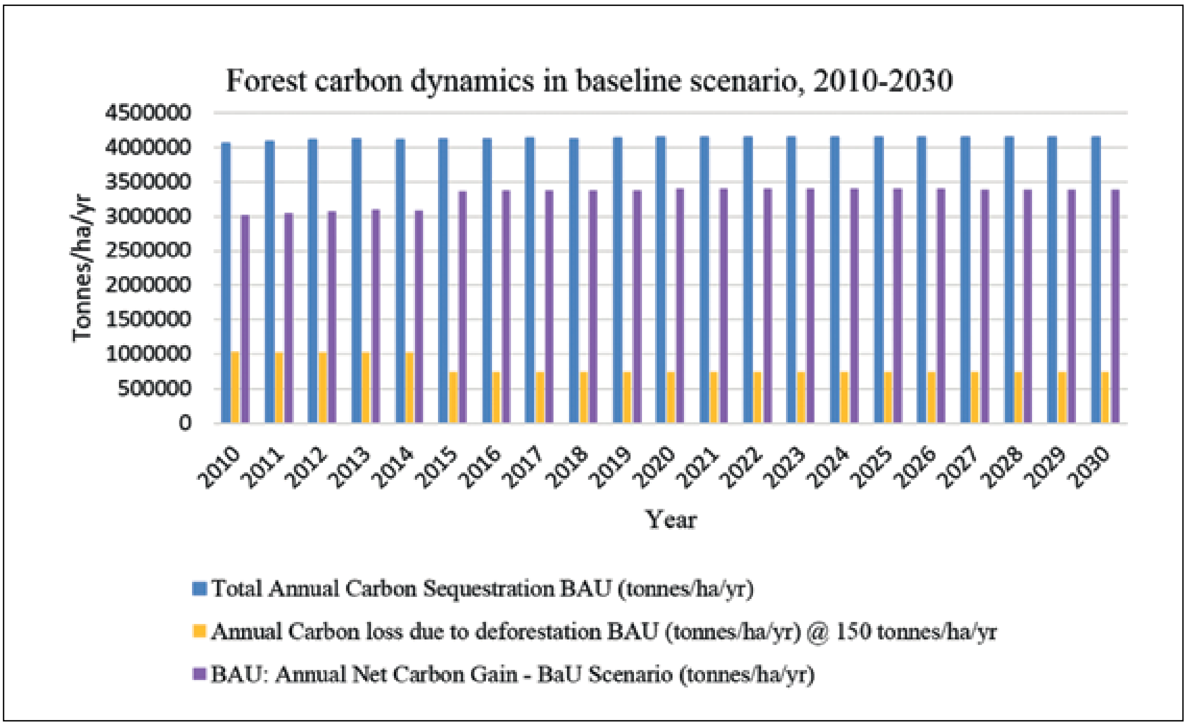


Figure 4.26 Forest carbon dynamics in baseline scenario, 2010-2030

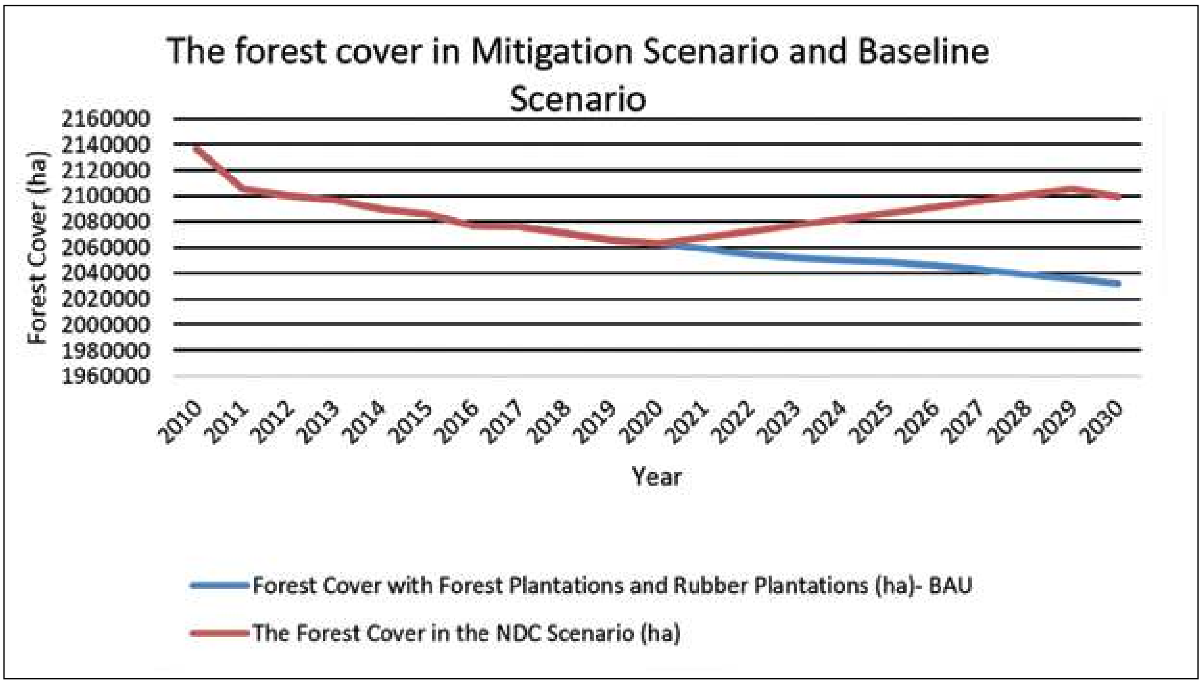


Figure 4.27 Forest cover in mitigation baseline scenarios, 2010- 2030

According to the Figure 4.28, the net savings in carbon emissions in mitigation scenario is 366 Gg CO_2-eq) compared with the baseline scenario.

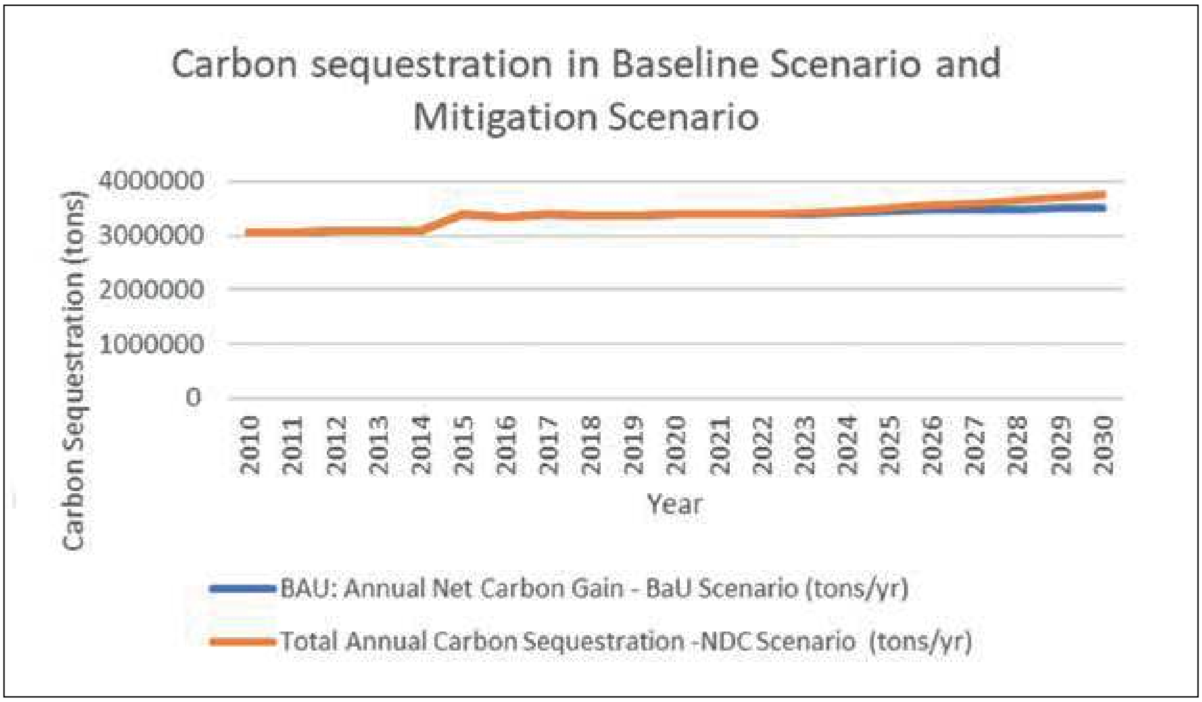


Figure 4.28 Carbon sequestration in baseline and mitigation scenarios, 2010-2030

4.6 Summary of GHG emissions savings

This section summarizes the total expected GHG emissions savings in all sectors by 2030. Table 4.4 presents Baseline emissions, emissions from the Mitigation Scenario, net GHG emission reductions and these reductions as a percentage of the baseline emissions. If all mitigation measures are implemented, Sri Lanka could achieve a 27% reduction in GHG emissions by 2030.

Table 4.4 Baseline emissions, emissions of the mitigation scenario and net GHG emission reductions by 2030

Sector	Emissions in baseline scenario (Gg CO_2-eq)	Emissions in mitigation scenario (Gg CO_2-eq)	Net emission savings (Gg CO_2-eq)	Reduction %
Energy: Electricity	18,500	10,400	8,100	44
Energy: Transport	22,923	19,255	3,668	16
Energy: Household, commercial and manufacturing industries	2,342	2,000	342	15
IPPU	869	784	85	10
Waste	1,340	361	979	73
Agriculture	1,700	980	720	42
Forestry	-3,507	-3,873	366	10
Total	**44,167**	**29,907**	**17,767**	**40**

CHAPTER FIVE

Education, Training, Awareness and Capacity Building

CHAPTER FIVE

Education, Training, Awareness and Capacity Building

5.0 Introduction

Strengthening education, training, public awareness and capacity building in respect of climate change provides a vital strength to the national focal point (Ministry of Environment) to the UNFCCC together with relevant stakeholders such as government, private sector, civil society organizations, universities and educational institutions, media and UN organizations etc., to address the impacts of climate change effectively. Already, certain efforts have been made in this regard by the above stakeholders, however still much remains to be done.

Over the past seven decades, Sri Lanka has continuously provided free education to its nation and physical facilities in schools have been vastly improved. Education in government schools is free and schooling till a student reaches 13 years of age has been made compulsory. Once a pupil passes the General Certificate of Education, Ordinary Level (GCE O/L) examination at the Grade 11, the pupil has to study for another two years preparing for the university entering examinations [General Certificate of Education, Advanced Level (GCE A/L)]. Those who are not qualified for university entrance they will joint for tertiary education at an advanced technical education institute. Others who fail at GCE O/L and GCE A/L examinations have the possibility to find the jobs in the technical and non-technical fields or revert back to their parents' livelihoods.

At the GCE A/L examination, there is a very stiff competition to gain admission to the state universities in the country even with some concessions are accorded to students coming from the remote districts. Some of the disqualified candidates for the state universities who have passed the GCE A/L join the private universities and other higher educational institutes or proceed to fee levying overseas universities for higher education.

5.1 Educational programmes on climate change

Education is a key component in enhancing the early adaptive capacity of a nation by instilling knowledge and skills needed for them to be ready to cope with moving environmental realities in the change of ecological, social and economic backgrounds. Hence, when a climate change consciousness foundation is laid in the minds of the children early at school, that will later turn to be a life-long consciousness of "where, when and how" the climate change around them takes place and what adaptation measures to be taken to improve climate resilience. Children are among one of the most vulnerable groups to the adverse impacts of climate change. They need not to be considered passive or helpless victims. Through education, project oriented actions, they can be made to contribute and make at least very simple mitigation and adaptation actions to be taken. In this regard, it should be noted that educating girls and women is one of the best ways of strengthening community adaptation measures to climate change. They are the ones who are disproportionately affected by the adverse impact of climate change. In many situations, females' livelihoods are dependent on climate sensitive sectors such as agriculture, water resources, livestock and forestry.

Steps have been taken by the National Institute of Education (NIE) to introduce environmental consciousness education up to the GCE A/L together with the programmes of education and social cohesion of the Ministry of Education in a process of introducing topics related to climate change. Teachers are being trained to teach climate change related subjects in schools. Education level and climate change competency level in the education system in the country are presented in the Table 5.1.

Table 5.1 Core competencies of climate change education in Sri Lanka

Education Level	Core competency in climate change	Competency level
Early Childhood (Nursery and Pre School)	Play group activities/access to environment	Level 1
Primary Education (1-5 Grades/years)	Play group, simple games, field observations, environmental interest activities	Level 2
Junior Secondary (6-9 Grades/years)	Basic understanding of science and its keywords, ecological understanding	Level 3

Education Level	Core competency in climate change	Competency level
Secondary (10-11 Grades/years)	A certain extent of understanding and moral development	Level 4
Senior Secondary (12-13 Grades/years)	Understanding on issues, impacts and potential solutions	Level 5
University degree level	Approach to research and advanced skills	Level 6
Professional and non-university education	Enhance the professional practices	Level 7
Postgraduate education	Research elaborations	Level 7
Vocational training	Moral/skills development	Level 4/5
Technical education	Skills development	Level 5
Advance technical education	Advanced skills	Level 6

At the University level, faculties of Agriculture, Science, Engineering, Humanities and Social Sciences (Arts) in many universities are teaching subjects related to climate change to undergraduates. It is to be noted that there is a growing interest among university graduates even to do postgraduate research studies on climate change adaptation and mitigation.

5.1.1 Technical, Vocational Education and Training

Technical, Vocational Education and Training (TVET) plays an essential role in addressing climate change as only the skilled workers and experts can deal with energy and resources in their jobs and at their work places efficiently and sustainably. Efficient use of energy and resources in a job is not only the responsibility of specialists, but also for every employee. Hence, solutions for related issues have to be provided through training. This can be done by the TVET comprised of 402 public sector training centres, 400 private and NGO training centres and a large number of non-formal TVETs providing training in Information Technology (IT). As the whole, the job-oriented training courses that they offer need to incorporate climate change related training courses as well. University of Vocation Technology is the degree awarding arm of TVET system in Sri Lanka, which is presently conducting 13 vocational technology related degree courses. These degree courses have only one climate related course unit in the third year, namely the Environmental Management and Cleaner Production Course.

The universities in the country have the enormous potentials to introduce several climate change mitigation and adaptation courses and degrees. This change requires to be fulfilled by the professionals in designing appropriate courses concerning climate change processes, vulnerability to impacts, mitigation, adaptation, loss and damage estimates and other related issues and ultimately the public will minimize and adapt for climate change risks. Further, many universities have organized the post graduate diploma on climate change for giving the opportunities for students for studying the impacts on climate change and researchers.

5.1.2 Non-formal education on climate change

Formal education is normally delivered by trained teachers in a systematic manner within the schools, higher education institutes or the universities. Non-formal training is through an organised training process that occurs outside the formal learning environment.

There is convincing evidence of successes coming from the non-formal education strategies adopted by Sarvodaya Sangamaya, Sanasa Campus for Cooperative and Development Studies, Sri Lanka Technical Institute, 'Diyagala Boys Sri Lanka', Mahila Samithi of Sri Lanka, Red Cross Society and Christian Children's Fund etc., where the technical skills, service oriented activities, personal development programmes, para-professional development activities and vocational development activities are reasonably well imparted to their trainees through non-formal system of education. There is a great opportunity to provide many facets of climate resilience and awareness through these organisations using their non-formal education techniques and methods.

5.2 Trainings on climate change

Government, semi-government and private sector institutions including non-governmental organizations offer climate change related short-term training courses for the students, officials and general public. The Central Environmental Authority (CEA) offers pioneer environmental training programmes to school principals, teachers, environmental pioneers and school eco-project implementers. In these trainings, climate change information has been shared to make aware them to build resilience. In addition, many government organizations prepare educational materials to adapt for address impacts on climate change such as prolong droughts, flash floods, sea level rise and promote home gardening to enhance family food security, establish green parks, organise environmental promotional exhibitions etc.

During the past years, NBRO has conducted four types of training programmes through its human settlement planning and training division in collaboration with Divisional Secretariats, Plantation Human Development Trust, Urban Development Authority and Disaster Management Centre. The purpose of these programmes is raising awareness and providing training on disaster risk reduction. Planning officers, *Grama Niladharies*, masons and senior school children were the participants in these programmes which included information on hazard resilient housing construction to deal with human settlement issues in landslide-prone areas.

The Centre for Environmental Studies in the University of Peradeniya has been organising short training courses on climate change. The module of these courses has been developed to teach about the impacts of climate change and its consequences, giving a better understanding of this phenomenon.

The National Cleaner Production Centre (NCPC) publishes its trainings schedule in their website (www.ncpcsrilanka.org). Accordingly, climate change related training programmes have been conducted every year through courses such as quantification of GHG emissions and calculating carbon footprint according to ISO 14061-4. Further, Education training and awareness division of the Ministry of Environment conducts numerus training programmes on environmental issues including climate change for different stakeholders such as school children, teachers, media and university students etc,..

Considering the climate change consequences to the environment, Dilmah Conservation Group identified a need for improving the space and capacity for local level field research on the causes and consequences of climate change in Sri Lanka. As a result, Dilmah Company's founders and scientists from universities has established a research station, at Dilmah's Queensbury Estate in Nawalapitiya, Sri Lanka. The station was set up to address the dearth of scientific research of climate change in Sri Lanka, thereby facilitating the development of climate change adaptation and mitigation strategies.

Dilmah Research Centre invites scientists from universities, state and non-governmental agencies, for the purpose of understanding climate change in Sri Lanka, including current and possible future changes in climate, and options for mitigating and adapting to those changes, especially to benefit the plantation agriculture.

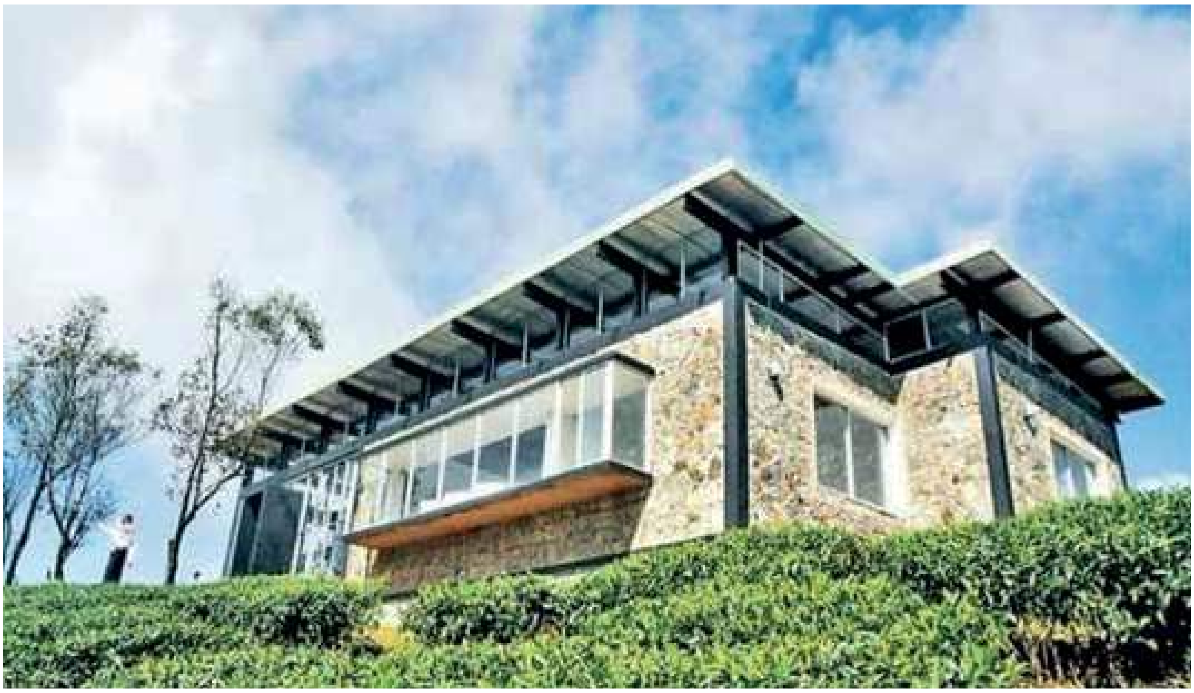


Figure 5.1 Dilmah Research Centre on Climate Change at Queensberry Estate, Nawalapitiya, Sri Lanka

5.3 Public awareness programmes

Awareness programmes on climate change have been conducted by the government, semi-government institutions, NGOs, private sector, media and public movements. Ministry of Environment conducts numerus awareness programmes in different parts of the country in collaboration with relevant institutions and other respective divisions of the Ministry.

The Climate Change Secretariat (CCS) being the operational focal point to the UNFCCC, it has been mandated to raise awareness and build capacities of all the strata of the society to address climate change issues in the country. In this context, various types of awareness creations and knowledge products are made. Among them, general awareness for school children, subject specific awareness for vulnerable communities, adaptation measures for practitioners including farmers, planters, architectures, hoteliers, industrialists etc,. and mitigation options among the energy developers, transport operators, waste managers, industrialists and livestock practitioners. Further, awareness materials like leaflets, story boards, broachers, posters, video clips, documentaries and short films are perpetually produced to make aware the general public through electronic, printed and social medias.

The Department of Coastal Conservation and Coastal Resource Management creates awareness in coastal conservation with the participation of beach-users with distribution of leaflets, booklets, holding debates among groups of school children etc. The Central Environmental Authority focussed largely on changing attitudes, improving knowledge and enhancing skills of citizens to face climate change.

The Disaster Management Centre (DMC) also conducted awareness workshops among school children and communities on how to face post disaster situations. The Forest Conservation Department conducts pilot projects to assess the emissions reduction impact on forest-based livelihood development activities with the involvement of local stakeholders. Further, DoM and NBRO conduct awareness programmes for different stakeholders on climate forecasting and land slide risks including early warnings.

A wide cross section of NGOs promotes public awareness on climate change through research, advocacy, education, training and media coverage at community level. The Centre for Environmental Justice advocates a “Civil Action Plan” for cooperation of all civil society organizations to reduce disaster risks. The Green Movement of Sri Lanka working with grass-root level communities propagate sector-wise best practices in building disaster and climate resilience at rural level.

Further, several awareness creational events are organized by the SLYCAN Trust with special reference to youth engagement, gender involvement, loss and damage, local and provincial engagement on climate change. Janathakshan (Gte) Ltd also conducts awareness programmes on resilience building of vulnerable communities to meet the adverse impacts of climate change and potential GHG emission reductions through innovative and indigenous technologies.

5.4 Capacity building on climate change

In order to address climate change issues at grass root level effectively, in vast scaled capacity buildings on adaptation measures for communities have to be conducted while the field level officials and officials who are working at district, provincial and national level government institutions should be empowered with required knowledge and climate smart technologies. At present, capacity buildings on climate change are taken place in ad hoc manner. However, the major role is presently played by the government and semi government institutions. Infrastructure development and distribution of equipment where the vulnerability to climate change adverse impacts are being provided by the government and such grass-root level activities have been gradually increased to build resilience in most vulnerable communities, sectors and areas.

The CCS of the Ministry of Environment has taken the leadership in the country for building capacities of different stakeholders to address climate change issues. In this context, various kinds of capacity building programmes for different stakeholders are conducted by the CCS specially related on calculation of GHGs emissions and removals, vulnerability assessment and adaptation measures, technology assessment needs, carbon market mechanisms, identification of research needs, nationally determined contributions and its emission reductions targets, preparation of project proposals for funding, calculation of carbon footprints, preparation of national communications and Biennial Updated Reports etc,..

Further, as it was expected to incorporate provincial data and information into this communication, the stakeholder consultations were conducted for all Provincial Councils of the country to make them well aware of on-going climate change programmes and activities for obtaining their inputs and increase capacities for addressing climate change issues in the respective Province with the intension of establishing a Provincial Climate Data Portal for future communication purposes.

Furthermore, capacity building programmes were conducted to establish the development of provincial climate institutional set up for the preparation of Provincial Adaptation Plan (PAP) for each Province focusing on provincial vulnerability and resilience building needs and climate data collection mechanism. Establishment of a Climate Cell under the purview of the Chief Secretary would enable the Government of Sri Lanka to accurately and timely contribute their situations in the national communications reporting.

The capacity building programmes were successfully held to enhance the capacities of the stakeholders who involve in the national communication preparation process to effectively contribute for climate change reporting.

Education, training, public awareness creation and capacity building play very pertinent roles in building resilience to meet the adverse of climate change and the minimization of its consequential losses, and reduce potential GHGs emissions and increase removals.

CHAPTER SIX

Technology Transfer, Research and Systematic Observations

CHAPTER SIX

Technology Transfer, Research and Systematic Observations

6.0 Introduction

This chapter presents activities or steps taken to integrate climate change considerations into relevant social, economic and environmental policies and actions in accordance with Article 4, paragraph 1 (f), of the Convention. The developed country parties to the UNFCCC are required, as per articles 4.3 and 4.5 of the Convention, to promote, facilitate and finance the transfer of, or access to, environmental sound technologies and know how to developing country parties, to enable them to implement the provisions of the Convention. Further, it is encouraged to provide information on climate change research and systematic observations, including their participation in and contribution to activities and programmes, as appropriate, of national, regional and global research network and observing systems. Non-Annex I parties to the Convention are encouraged to provide information on research related to programmes containing measures to mitigate climate change; programmes containing to measures to facilitate adequate adaptation to climate change; and the development of emission factors and activity data. This chapter describes activities carried out in the last decade in compliance with these requirements on technology transfer, research and systematic observations.

6.1 Technology transfer

Technology has been defined by Inter-governmental Panel on Climate Change (IPCC) in its Special Report on Methodological and Technological Issues in Technology Transfer (IPCC, 2000) as "a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change". Further, it highlights technology transfer as a process of learning to understand, utilize and replicate the technology, including the capacity to choose it and adapt it to local conditions and integrate it with indigenous technologies.

Article 4.5 of the UNFCCC states that developed countries "shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country parties, to enable them to implement the provisions of the Convention". Pursuant to decision 4/CP.7, its annex, and the implementation of Article 4, paragraph 5, of the Convention, Non-Annex I Parties such as Sri Lanka, are encouraged, in the light of their social and economic conditions, to provide information on activities relating to the transfer of, and access to, environmentally sound technologies and know-how, the development and enhancement of endogenous capacities and measures relating to enhancing the enabling environment for development and transfer of technologies.

Sri Lanka was able to leverage bilateral, regional and multilateral cooperation, including development banks, UNFCCC related funds, and the UN system for technology transfer related to climate change adaptation and mitigation.

The UNEP Risø supported Sri Lanka to carry out a "Technology Needs Assessment" (TNA) in 2014 using the UNFCCC and UNDP handbooks on conducting TNA. The TNA was conducted to identify and assess environmentally sound technologies that can help to reduce the impacts of climate change and the rate of GHG emissions. Specifically, the TNA helps to identify barriers for deployment and diffusion of technologies and address policy and legal gaps to enhance the overall enabling environment, increase the capacity of local institutions and experts, and raise public awareness of climate change issues. The TNA identified climate change adaptation needs in five sectors; food security (agriculture, livestock, fisheries), water, health and coastal, and biodiversity, and for mitigation in three sectors; energy, transport and industry. Following the assessment, a Technology Action Plan for each sector were developed in 2014.

Further, Climate Technology Centre and Network (CTCN) provided technical assistance in 2018 to commence Climate Smart City Programme for Kurunegala City by identifying the adaptation measures and later on potential mitigation actions (2019) to be implemented through a roadmap.

The South Asian Association for Regional Cooperation (SAARC), to which Sri Lanka is a member country, provides a platform for setting the regional policy agenda, and promoting regional cooperation, including on climate change, disaster management, and environmental protection, among other development issues.

SAARC has adopted several frameworks and action plans, including on climate change, Comprehensive Framework on Disaster Management (2006-2015), and adopted the Thimphu Statement on Climate Change in 2010. The latter calls on member states to undertake advocacy and awareness programmes on climate change, to promote the use of green technology, and best practices to promote climate resilient and low-carbon, sustainable and inclusive development of the region.

Sri Lanka is also a member of another sub-regional body – the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC). BIMSTEC's Centre for Weather and Climate was established following the signing of a Memorandum of Association (MoA) in 2014 among the BIMSTEC member countries. The purpose of this Centre is to build capacity of member countries, enhance observation capability, and encourage cooperation between BIMSTEC member countries for weather and climate prediction especially to develop an early warning system for weather and climate related disasters.

Sri Lanka shares knowledge as well as benefits from expertise and experience sharing through the Asian Disaster Preparedness Centre (ADPC), a regional body that brings together the national disaster management organisations of member countries to facilitate the implementation of disaster and climate risk management. Key institutions of Government of Sri Lanka such as the DoM, Disaster Management Centre, National Building Research Organization, are currently technical partners of the ADPC.

Sri Lanka is also a member of the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia, which was established in 2005 as a Tsunami early warning system in a multi-hazard framework for Southeast Asia and the Indian Ocean. Along with Bangladesh and the Maldives, Sri Lanka adopted a regional programme to establish and operate the early warning system. At present, Sri Lanka National Centre for Climate Applications (SNCCA), inaugurated in 2019, serves the South Asian region as the RIMES Sub-Regional Hub for Climate Applications. SNCCA shares technical, institutional, and policy pathways to integrate climate risk management into risk reduction and development processes.

On enhancing endogenous capacities, technologies and know-how, and measures relating to enhancing the enabling environment for development and transfer of technologies, the country has implemented several projects. One of the major projects by the Government of Sri Lanka (GoSL) is the "Rooftop Solar PV Power Generation Project", which provides electricity consumers with long-term debt financing for installation of rooftop solar photovoltaic power generation systems, and also allows private consumer to sell excess energy to the grid (from 2016 onwards).

6.1.1 Technology transfer for addressing climate change

Main requirement is the educational and outreach activities in order to change management practices suited to an ever-changing dynamic climate is the main factor one should consider before implementing the new technologies to fulfil the gap of knowledge. Technology is required to introduce interactive tools and simulation models in local languages to practice and develop the methods in day to day activities.

Agro-forestry is an integrated approach to the production of trees and of non-tree crops or animals on the same piece of land. An alternative is to extend agro-forestry in the country to increase climate resiliency, provide different sources of income, and reduce land erosion. Tools required to identify physical characteristics (including altitude, rainfall, slopes, water supplies, soil condition, visible erosion, relative humidity) for building resilience of agriculture. Ecological Pest Management is one of the technological approaches for increasing the strengths of natural systems to reinforce the natural processes of pest regulation and improve agricultural production.

Diversification of income generation to reduce vulnerability and enhance resilience could be obtained by mixed farming. Technologies need to identify the suitable mixing varieties and implement the suitable farming practices.

Then agricultural officials should identify appropriate species for plants taken into account physical characteristics. Measurements should be taken to calculate the inputs and outputs of the agriculture system (including yields of trees and crops, and labour requirements). Surveys should be carried out for land use planning and land tenure reform and socio-economic benefits assessment in order to sustainable agricultural practices. Crop diversification and introduction of new varieties are the technologies to develop conservation farming. Technology needs required to the development of new and improved crop varieties arise where attractive native species can be used to increase productivity.

Advanced software, tools and models required for effective analysis of long-range weather forecasting for agricultural planning and crop recommendation based on the agro-ecological suitability should be introduced. Also, introduction of effective land and water management techniques for central highlands and other marginal areas to minimize land degradation and to improve land and water productivity due to climate change adverse impacts are recommended. Introduction of crop calendar for timely cultivation of crops, mulch cultivation techniques to reduce the water evaporation, soil testing tool kits for farmers to apply fertilizer based on the soil quality should be introduced.

Introduction of conservation techniques for water and soil is another proposed technology in agricultural field. Technologies are required to enhance irrigation efficiency and/or expand irrigation, development of major and minor tanks, dredging of tanks filled with sediments in order to increase the capacity of tanks. Also, ancient tank cascade system should be improved to save the rainwater and reduce water scarcity in the dry zone. Sealing techniques of irrigation channels to reduce water absorption and increase the vegetation cover to reduce water evaporation are another technology to be applied.

Drip Irrigation is a technology to save water when water is sufficiently unavailable. Drip irrigation involves dripping water into the soil at very low rates (2-20 litres/hour). Sprinkler irrigation system for small and large-scale watering is one of the water efficient and climate smart water management techniques that can be used for sustainable farming where the water scarcity is prevailing. Introduction and promotion of water harvesting techniques such as rooftop rainwater harvesting in dry zone, and technology needs to improved water filtration techniques are encouraged. Aerial surveys and remote sensing technology should be introduced to determine the most vulnerable areas for water scarcity.

Flood-proofing structures needs to be introduced to reduce the impacts of coastal flooding. This may include elevating structures above the floodplain, employing designs and building materials which make structures more resilient to flood damage and preventing floodwaters from entering structures in the flood zone, amongst other measures for mitigating flash floods.

Improving knowledge of agricultural machinery, training and capacity building among farmers are required to promote conservation farming techniques in areas where vulnerable to climate change. Slow-forming terraces are constructed from a combination of infiltration ditches, hedgerows and earth or stone walls to decrease superficial water run-off, increasing water infiltration and intercepting the soil sediment. Conservation tillage is new and developing technology to conserve the soil nutrients and increase the water retention capacity.

Adopting suitable breeding technologies considering the experience and predicted climate change scenarios in different agro climatic regions to achieve sustainable livestock production systems are essential. Technology related to introducing improved breeding under environmental stresses such as extreme droughts and extreme floods is required. Livestock disease management is one of the technological interventions to reduce disease through improved animal husbandry practices.

Technology needs such as establishment of environment friendly sustainable livestock farming practices, introduction of different breeds to different climatic zones in Sri Lanka and introduction of genetically modified rumen bacteria in animal farming are required. Feed optimization in animal farming, introduce specific agents and dietary additives, instead of C-3 and C-4 grasses and adaptation of temperature and fire tolerance grass (Eg: Gini grass) for the foods of the animals are also required.

In order to minimize the impacts of landslides, settlements and land use changes in landslide-prone and other vulnerable areas are discouraged.

Bio technology for new rubber varieties could be developed to withstand extreme climate and to reduce the loss of tapping days. Further, rain guards to overcome the dampness of the tapping panel should be used and thereby reduce the loss of tapping days in the wet zone.

In the coastal sector, beach nourishment, flood hazard mapping, flood-proofing and ecological barriers are some of technologies that can be applied to minimize the coastal ecosystem degradation. Beach nourishment, which refers to the artificial addition of sediment of suitable quality to a beach area that has a sediment deficit is the main option to reduce coastal erosion. Reduces the detrimental impacts of coastal erosion, provide a buffer to protect coastal infrastructure and other assets from the effects of coastal erosion and storm damage and help retain the natural landscape of the beach are the advantages of beach nourishment.

Artificial sand dunes and dune rehabilitation, storm surge barriers and closure dams, use of Sea Dikes are encouraged to protect low-lying areas against inundation. Land claims and seawalls are hard engineered structures with a primary function to prevent further erosion of the shoreline.

Technology needs to reduce the distribution and transmission losses addressing line losses together reduce both capacity and energy requirements which will eventually reduce the electricity generated. There are some challenges in improving distribution network such as efficient grid infrastructure challenge and high maintenance cost for modifications in the system. Already in the TNA (2014) it has identified three common barriers which are likely to impact upon successful transfer and diffusion of the prioritized technologies in the energy sector. These include (i) High capital cost and difficulties to access finance (ii) Economic feasibility either not examined or relevant information not available (iii) Technology either not established at the desired scale or not fully developed.

Further, it is recommended some measures to overcome these barriers such as fiscal policy reforms aiming at reducing costs of Renewable Energy and Energy Efficient project related fabrications and constructions; Activate the provisions in the Sri Lanka Sustainable Energy Authority Act to create a fund to support Renewable Energy and Energy Efficient projects by imposing a cess on all imported fossil fuels; Assign a multidisciplinary team of experts including economists and engineers to conduct economic feasibility studies and disseminate study results; Commercialize the production and marketing of "Gliricidia Sepium" leaves through supporting R&D.

Amongst the barriers identified for technology transfer in industry sector are high capital costs, lack of adequate financial resources and incentives, insufficient regulatory framework and inadequate enforcement, lack of and limited capacity in existing institutions, lack of skilled personnel for technology implementation and inadequate training for maintenance, poor operations and maintenance facilities, absence of standards, codes and certification, inadequate information, awareness, feedback and difficulties in comprehending technical contents. The measures recommended to overcome these barriers are government tax policy reforms as appropriate to enable reducing capital costs for high efficient and sustainable technologies; appropriate financial instruments and credit facilities, tax concessions and subsidies; provide green credit facilities on concessionary terms for greening the industry. streamline biomass supply process; technical education and awareness creation, training and skills development; avail service of international certification agencies to set up local standards; energy labelling and setting standards, and promoting climate smart technology through Energy Associations, Industry Associations and industrialists.

In order to minimize GHG emission in waste sector, innovative technologies for sanitary land fillings, waste to energy projects, waste segregations, waste recycling, organic fertilizer production, waste water treatment plants should be introduced. Incineration is the main technology that uses in Sri Lanka for clinical waste management. Waste segregation techniques and assessment of waste parameters and introducing the pyrolytic incinerators are the technologies to be introduced.

Water and environmental sustainability are considered as key factors for food security and the main focus at that time was to store water within reach of the people for cultivation and drinking. In this respect, rehabilitation of ancient tank cascade system in the country blending traditional knowledge with modern technology to ensure water availability in a drought period for agriculture and rainwater harvesting on rooftops for drinking and household uses are recommended.

Human settlement could be categorized as urban settlements, rural settlements and estate housing which need separate technology interventions for separate settlement category. Vulnerability risk maps using Remote Sensing and Aerial Photogrammetry technologies should be prepared to identify the suitable areas for settlements, identify suitable construction methodology such as food proofing technology to elevate structures above the floodplain, employing designs and building materials which make structures more resilient to floods. Decentralised Community-run Early Warning Systems are a set of coordinated procedures through which information on foreseeable hazards is collected and processed to warn the possible occurrence of a natural phenomenon that could cause disasters.

Energy efficiency and renewable energy technology related applications in the tourism sector are praiseworthy. Nature based solutions for tourist destinations and accommodations would be encouraged.

6.2 Research on climate change

A seminal piece of research carried on climate change risks faced by the country is the study that conducted by the Climate Change Secretariat with the technical assistance of the Asian Development Bank. The study, 'Climate Change Risks in Sri Lanka 2018', was conducted at the Divisional Secretariat level (or in other words sub-district level) and covered the entire country. The study's methodology identified 31 variables and four main hazards to assess the climate change impacts on hazards and key economic sectors. The study assessed the exposure, vulnerability and risk of each sector to four main hazards (drought, flood, landslide and sea-level rise) and provided the generated values for each component of the vulnerability. The findings of the study, along with the vulnerability assessments carried for the Chapter Three of Third National Communication, can help in developing national, provincial and also local level strategies for climate change adaptation.

Several universities and research institutions in the country conduct special courses on climate change. Further, many research symposiums on climate change are organized by different institutions in the country. There is a growing interest on climate change research among students and academia.

Further, sector-specific research on the impact of climate change is promoted by the private sector, especially in the tea sector. Localized research on climate change are conducted for Sri Lanka's tea and other export crops with useful data on climate change trends. The Dilmah Conservation Group has established the 'Dilmah Conservation Centre for Climate Change Research and Adaptation' (for more information please refer Section 5.3 of Chapter Five). The Centre provides the space for researchers, policy makers, planters, farmers and civil society organizations to collaborate and conduct research and studies for minimizing the adverse impacts of climate change in order for ensuring both quality and yield of tea.

6.2.1 Research needs for addressing climate change

A wide range of research on adaptation measures to meet the adverse effects of climate change have already been conducted within the realm of agriculture. However, extensive research should be carried out to obtain a comprehensive picture before implementing adaptation and mitigation actions including technology transfer for agriculture. Research needs in paddy cultivation are cost benefit analysis of local species to propagate local varieties among the local communities, physiological responses against with the changing climate parameters such as growth, yield, nodulation patterns, hard seed formation, and screening of existing traditional varieties. Comparable productivity study on Alternate Wetting and Drying (AWD) and traditional methods of paddy cultivation of Sri Lanka are also vital. Further, research on suitable measures to manage excess water in paddy fields for minimizing methane emission are required.

Identification of appropriate crop and tree species for vulnerable areas to adverse impacts of climate change which can be used for agroforestry and to identify the input and output of agroforestry systems, and development of models to investigate socio economic benefits in agroforestry practices are essential for research in agriculture. Identification of appropriate drought resistance species for vegetation cover in tea plantations is needed. Research on new rubber varieties which can sustain for extreme climates and identify suitable land and climatic areas (less affected with rain) that are compatible with new rubber varieties are required.

In the livestock sector, disease management using traditional methods and the variance of pest growth against climatic parameters are needed to be studied. Further, research in this sector should be conducted to identify and develop high resistant varieties for biotic and abiotic stresses, heat stress, droughts, floods, salt water intrusion and pest diseases.

Research needs in water sector are establishment of systematic observations for climatic variables, surface and ground water quality surveillance, salinity intrusion, efficient rainwater harvesting methods, extent of lands affected by sea level rise and river flow regimes. Further, finding the ways and means of motivating people for rainwater usage is another research area in the water sector. Research should be conducted on climate change concerns on wetland rehabilitation, restoration, conservation of coral reefs, sea grass beds, mangroves and sand dunes in coastal areas. Also, research on promotion of bio char as a stimulant to organic fertilizer to ensure water retention capacity increased are to be conducted.

Research and piloting on soil conservation techniques that can be reduced the land degradation in central highlands, traditional knowledge and practices of sustainable farming that can be coped up with adverse impacts of climate change, and identifying tolerable crop varieties which can withstand to climate change for different agro-ecological regions should be conducted. Study the applicability of conservation tillage technology is required to promote the tillage practices among the farmers.

Research on assessing and preparing for the increased health risks due to climate induced vector borne and zoonotic diseases are urgent need to address adverse impacts on human health. Further, research on current extent of waste production and types of health-care waste, estimated future waste production and waste handling are required to identify the potential of GHG emission reduction. For the waste water treatment, new biological technologies such as aerobic biological treatment methods; SBR (Sequencing Batch Reactor) and MBBR (Moving Bed Bio Reactor) and developed anaerobic biological treatment methods should be used in future applications are to be researched. Utilize composting (Aerobic waste treatment), especially in regions with a demand for soil conditioners and vermicomposting are other research areas in composting. Research on low / zero emitting composting techniques for municipal solid waste are essential. Research on organic fertilizer production process and usage in relation to standard, quality, crop productivity, nutrition content/ration, efficiency, compositions etc are also essential.

Research should be conducted to identify most efficient building materials for construction of housing and other infrastructure in line with Green Building Guidelines.

Research on improvement of energy efficiency transport modes, sustainable fuels as biofuel and vehicle technology for reducing greenhouse gas emission in the transport sector should be conducted. Studies on different traffic management practices, alternative fuels, fuel quality standards, passengers' behaviours, use of information and communications technology (ICT) as an alternative to travel for employments and personal matters as an effective demand management instrument in urban transport are timely. Further, country specific emission factors for vehicle types and models, and emission controllable instruments should be identified. Furthermore, research on country specific emission factors to calculate greenhouse gas emissions in energy, industry, waste, forestry, agriculture and livestock sectors should be conducted.

Research on efficiency and further expansion of renewable energy sources (solar, wind, biomass, biogas, tidal waves, etc..) and grid connectivity are essential for reducing greenhouse gas emission in energy sector.

Research on fuel switching to sustainable biomass energy and improve user efficiency by increasing feedstock quality, operation and maintenance practices, system design and automation in industry sector are the research to be carried out in the future. Carry out rapid assessments of tri-generation potential for replacing fossil fuels in industrial parks are also needed.

6.3 Systematic observations on climate change

Sri Lanka has the infrastructure to carryout systematic observations and provide data for weather forecasting. The country has 37 automatic weather systems deployed at regional meteorological stations and collaborative stations. Parameters are measured at every minute and data is sent to the Head Office of DoM in Colombo at every 10 minutes via INSAT 3-E satellite.[2] In addition, there are also two Automated Weather Observing Systems. There are 487 rain gauge stations across the country. Data is regularly obtained from 410 stations. These stations are maintained by the DoM in collaboration with government institutions, non-governmental organizations, and voluntary observers. In addition, 40 agrometeorological centres, with limited hardware, technical, advisory support from the DoM, have been established and managed by various institutions. These centres collect weather related data, as well as obtain measurements on evaporation and collect data from different depths below the surface. These data are primarily utilized for agro meteorological purposes.

2 Department of Meteorology, Sri Lanka, 'The General Structure of Real-Time Weather Forecasting System' https://www.meteo.gov.lk/index.php?option=com_phocadownload&view=category&download=3:booklet&id=1:astronomy&lang=en

Department of Meteorology consists of 20 meteorological stations representing all districts of Sri Lanka. Each station observes meteorological parameters such as temperature, humidity, atmospheric pressure etc. Meteorological measurements of all these parameters are taken eight times per day for three-hour period starting from 0000GMT according to the standards of World Meteorological Organization (WMO). The DoM has a better spatial distribution of rainfall measurement with about 350 rainfall stations installed throughout the country. Rainfall data are recorded every day at 0830 am.

Automatic Weather System (AWS) after the Tsunami has been established under the supervision of DoM to mitigate natural disasters. The department exchanges meteorological data at some stations (three-hour basis) with the other countries through GTS (Global Telecommunication System) via New Delhi. These data and data from selected meteorological stations directly go to the Global Climate Observing System (GCOS).

Agro-meteorological network started in 1976 for agricultural development purposes. The Department of Agriculture collects weather data in agro-climatic zones continuously and shares with the DoM. 42 agro-meteorological (agromet) stations to collect data on sunshine hours, evaporation, soil temperature at various depths and solar radiation have been established and recorded twice a day at 0830 in the morning and 1630 in the evening. The weekly summary of the Agromet data are available to the public in the website of the DoM.

National Aquatic Resources Research and Development Agency (NARA) is the top national institute assigned with the responsibility of carrying out and coordinating research, development and management activities on the subject of aquatic resources in Sri Lanka. NARA has established island wide systematic information centers. Temperature sensors are located in Pigeon Island and Bar Reef Sanctuary and 1-hour interval data are recorded.

Further, tidal stations are located in Colombo, Kirinda, Mirissa, Trincomalee to measure the sea level. Wind data are recorded at Mirissa and experimental level data are recorded at Kirinda. Wave rider buoys are used to collect the Wave Height. Nutrients and plankton types are analyzed in every visit to the ocean (Nearly Once a month) (NO_3, NO_2 as nutrients). Further, sediment analyses are carried out and Current Speed is recorded using Recording Current Meters.

The research areas covered by NARA are ocean warming, ocean acidification and sea level rising. Ocean acidification research carried out in 2018, identified that oxygen minimum zones are spreading and estimated the rate of acidification.

Further, Department of Irrigation in Sri Lanka measures the reservoir status, river water level and rainfall. Observations are mainly focused on forecasting agricultural patterns.

NBRO is the premier research & development institute established in 1984. NBRO also functions as the national focal point for landslide risk management including landslide investigation and risk assessment, preparation of hazard zoning maps, monitoring rainfall and ground movements and issuing landslide early warning.

6.3.1 Systematic Observations for addressing climate change

Systematic observations required for assessing the vulnerability and determining adaptation measures are; continuously measuring and monitoring of climate change related parameters such as rainfall, temperature changes, wind patterns, moisture content, water evaporation, evapotranspiration, water quality and ground water level, and sea level rise by local weather and monitoring stations.

Analysing, monitoring, and modelling of metrological data for long time horizons related to agriculture and sustainable land management to identify most suitable areas for new cultivations. Continuous monitoring of nitrogen content in soil in different climatic zones in order to determine the fertilizer quantity to be applied. Monitoring of climate parameters to identify heat stress and extreme climatic conditions affecting livestock in localized environment should be systematically observed.

Systematic Observations on sea-level rise and wave surges are required to monitor continuously for building resilience of coastal resources and issuing alerts and warnings to the coastal community. Shoreline monitoring, exploration of coastal processes and erosion risks, formulation and design of shoreline stabilization, and project development in coastal areas are some of systematic observations needed.

CHAPTER SEVEN

Constraints, Gaps and Needs

CHAPTER SEVEN

Constraints, Gaps and Needs

7.0 Introduction

This chapter identifies the existing gaps and constraints for the preparation of national communications, and implementation of climate change actions. It also proposes actions to be implemented to address these gaps and constraints.

The guidelines provide that in accordance with national circumstances and development priorities, it is needed to describe any constraints and gaps, and related financial, technical and capacity needs, as well as proposed and/or implemented activities for overcoming the gaps and constraints, associated with the implementation of activities, measures and programmes envisaged under the Convention, and with the preparation and improvement of national communications on a continuous basis.

The methodology used for the preparation of this chapter has been through desk research, expert consultations, sectoral and national level stakeholder consultations for data collection, and national level consultation for validation of the findings. Through these activities, the stakeholders and experts contributing to the information and data collection have highlighted gaps in institutional structure, and coordination among different entities working on fulfilling obligations related to climate change activities; gaps in laws, policies, and regulations pertaining to adaptation and mitigation actions; gaps and lack of availability of data for adaptation and mitigation measures that focus on climate change impacts in Sir Lanka; gaps in capacity building and research; gaps in financial resources available and the amount needed to implement the activities related to climate change in the country.

Further, the activities conducted for the preparation of the TNC have identified gaps in data for the preparation of the chapters of the TNC, including adaptation and mitigation related data; constraints in accessing data exist nonetheless available for the preparation of the TNC; constraints in accessing findings of research on climate change conducted by different researchers, gaps in information related to climate finance, and constraints in accessing climate finance data and information.

Based on these gaps and constraints, the chapter proposes activities needed to address them. Activities that are highlighted among other are amending policies and regulations and development of a law for implementing activities related to climate change in Sri Lanka; capacity building activities on climate change for stakeholders; development of coordination and institutional structures for effective and efficient implementation of climate action; mobilizing climate finance to address support needs.

7.1 Gaps and Constraints under the Second National Communication

The Second National Communication (SNC) of Sri Lanka to the UNFCCC submitted in 2012 provides input on different gaps and constraints that exist in different sectors. Among those are:

i. Data gaps existing in different sectors which impact the preparation of the GHG inventory.

ii. Lack of quantifiable assessment of vulnerabilities in the report, which is difficult to be provided based on the findings of SNC.

iii. Lack of technology and technical capacity is indicated as a constraint that is existing in Sri Lanka which hinders the performance of obligations under the UNFCCC.

iv. Financial constraints for the implementation of climate change related activities for fulfilling the obligations under the UNFCCC.

These gaps and constraints have been studied in the preparation of the TNC, and additional gaps and constraints have been identified where relevant to provide a comprehensive overview of the existing gaps and constraints for the preparation of NCs and implementation of climate actions in Sri Lanka.

7.2 Gaps and constraints under the Third National Communication

This chapter has different data collection methods for gaining information on the existing gaps and constraints for climate action in Sri Lanka. This includes desk research, as well as a multi-stakeholder process which includes consultations with experts and multiple stakeholders as appropriate.

The key gaps and constraints identified in Sri Lanka for addressing climate change impacts, and fulfilling the obligations under the UNFCCC are described below from 7.2.1 to 7.2.12.

7.2.1 Institutional structure and coordination

There are multiple policies and plans related to climate change in Sri Lanka. Among these are the National Climate Change Policy of Sri Lanka, Nationally Determined Contributions (NDC) of Sri Lanka, National Adaptation Plan for Climate Change Impacts of Sri Lanka (NAP). They focus on adaptation, mitigation, and loss and damage, and other related obligations to which Sri Lanka has committed related to climate change.

However, a key gap that has been identified is an effective mechanism to communicate and coordinate among the different entities (government, private, civil society, academia and media) at national as well as provincial level. To ensure effective and efficient coordination for climate action among key stakeholders, it is important to;

i. Develop a clear mandate for improving the long-term coordination for inter-ministry and inter-institutional coordination on climate change including the roles and functions of each stakeholder in climate action, including and not limited to implementation of laws and policies relevant to climate change, activities under sectoral processes, as well as national, provincial and district level activities.

ii. Develop a coordination system for the preparation of NCs through a multi-sectoral approach, and with coordination between national and provincial levels.

iii. A coordination mechanism between national, provincial and district level for data sharing on climate change, and for the preparation of NCs as well as for other climate related activities.

7.2.2 Policies, laws and regulations pertaining to climate change

It has been identified that there are gaps and constraints in policies, laws and regulations for effective implementation to address climate change. In this respect, followings are important to be carried out;

i. Updating existing National Climate Change Policy of Sri Lanka addressing emerging climate change related concerns such as MRV, carbon trading and offsetting, data management, climate finance, etc..

ii. Enacting a law on climate change for Sri Lanka. It is important to note that Climate Change Commission Act for Sri Lanka is being drafted at present. It will be crucial for Act to have a clear mandate and powers vested in it empower effective ground level climate actions.

iii. Establishing a coordination mechanism under the proposed Act for the implementation of laws and policies that are related to climate change with robust actions against those violating the provisions of the Act.

7.2.3 Capacity Building and Research

There are gaps and constraints in capacity and technical skills on climate change related knowledge among the line ministries, departments and institutions. This prevents productive actions to be taken at sectoral levels, as well as reduces the effective engagement by stakeholders from these groups to engage in the national communication preparation. To address these gaps and constraints, it is required to;

i. Build capacity of stakeholders in the government sector, engaging in climate change related activities on the technical aspects relevant to climate change, as well as the preparation of NCs. This includes capacity building among stakeholders on, country specific emission factors, sectoral and provincial level GHG inventories which provides input to the national GHG inventory which is maintained by the Climate Change Secretariat (CCS) of the Ministry of Environment.

ii. Conduct training and capacity building workshops on the general overview of the UNFCCC process, as well as emerging concepts under the UNFCCC process such as concepts of loss and damage and the Warsaw International Mechanism (WIM,) measurement, reporting and verification (MRV), climate finance, implementation of the Paris Agreement and others as deemed appropriate.

iii. Capacity building of stakeholders on new findings of climate science and research such as the findings of the Inter-governmental Panel on Climate Change (IPCC) among others through consultations, briefing, sharing of knowledge products, etc.

iv. Capacity building workshops and sessions on how to address research and knowledge gaps on climate change, and development of a National Climate Change Research Strategy which will contribute to addressing gaps and constraints relevant to research on climate change in Sri Lanka. Among key sectors needing capacity building on research needs and support for research includes agriculture, fisheries, livestock, coastal and marine, biodiversity, water, health, human settlements, tourism, energy, industry, transport, waste, forestry etc..

v. Conducting capacity building activities related to economic diversification, integration of climate action into activities related to national development and planning, mainstreaming climate change into provincial development planning.

7.2.4 Data sufficiency for determining climate change actions

During the preparation of the TNC, it has been identified gaps in data for estimating greenhouse gas emissions for the Inventory and determining mitigation options, vulnerability and adaptation measures as well as loss and damage due to climate induced disasters. For GHG emission reduction, there has been several deficiencies which highlighted the need for accurate data in agriculture and waste sectors.

Further, it has been highlighted that there is insufficient of data for weather forecasting and developing scenarios, assessing climate change impacts, risks and vulnerabilities. In addition to this, other sectors have also highlighted the data gaps in health sector which was unable to provide data on deaths due to climate change impacts and in costal and marine sector which was unable to identify the existing impacts on coastal ecosystems.

Furthermore, it was also demonstrated that there exists gaps and constraints on inter-sectoral data sharing and coordination mechanism to share data. To address these gaps and constraints, it is required to:

i. Develop a data management and sharing policy, and a national data sharing mechanism including a mandate for sharing and ability to access data related to climate change.

ii. Develop a mechanism for data management and sharing through an inter-sectoral coordination and collaboration.

iii. Strengthen capacities for data collection, management and sharing among key stakeholders working on climate change, especially among key sectors highlighted through NDCs and NAP in Sri Lanka. The activities to be conducted are workshops on data collection processes, management and sharing; short courses on effective data management for climate change; selection of a designated officer in each line ministry, department or relevant institution for implementing climate change related commitments, and capacity building of the officials responsible for data collection, management and sharing.

iv. Make available competence human resources and required equipment, accessories, software and servers for data collection, management and sharing in each climate change related sector.

7.2.5 Technology and technical knowhow availability

There are different existing technical expertise for developing solutions to address climate change in Sri Lanka. This includes gaps in technical expertise for developing adaptation measures for vulnerable sectors, identifying appropriate mitigation options for potential sectors, as well as identifying co-benefits in between adaptation and mitigation actions and cost analysis of adaptation needs and mitigation actions. Activities proposed to address these gaps are:

i. Conduct regular sector-wise technology needs assessments through enhanced technology and technical knowhow.

ii. Inclusion of identified technology to address climate change adaptation, mitigation and loss and damage to annual budgets of relevant ministries to mobilise funding.

iii. Obtain technical assistance from external resources to develop innovative climate smart technology and demonstration.

iv. Empower human resources to gain expertise on climate smart technologies and access to technical knowhow for addressing the identified technology gaps to address climate change issues at sectoral level.

7.2.6 Climate finance need assessments

Costing climate actions and financial need assessments for implementing climate change related activities in Sri Lanka are the main gaps in climate financing. At present, there is no such an estimation made on the financial needs for addressing climate change in Sri Lanka. Although, there are activities that are conducted in ad hoc manner to address climate change adaptation, mitigation, and loss and damage, an overall financial needs assessment have not been conducted.

In addition to these gaps, there is a need to mobilize financial resources required to implement climate actions, comprehensively and holistically, and annual budget allocations are determined accordingly. For this purpose, it is important to address gaps in climate finance mobilization such as lack of engagement of private sector in climate financing, lack of capacity for mobilizing climate finance by the government, lack of national accredited entities to access multi-lateral climate finance, lack of technical capacity for developing project proposals to harness climate finance, etc.. To address these gaps, it is required to:

i. Identify and assess the climate finance needs for addressing climate change issues in Sri Lanka. As part of this exercise, key priority actions should be identified for vulnerability and adaptation need in each sector, based on which climate finance requirement should be assessed.

ii. Identify potential funding sources for particular climate action, and mobilise climate finance needed for Sri Lanka such as the Green Climate Fund (GCF), Global Environment Facility (GEF), Adaptation Fund, NAMA Facility, bilateral donors, private sector partnerships and other potential donors.

iii. Develop a multi-stakeholder driven climate finance coordination mechanism which identifies key climate finance needs, with the representation of key institutions that require climate finance including other key stakeholders.

iv. Build capacity of different stakeholders, especially private sector, to access the available funding sources through bankable climate change related proposals, and conduct trainings on developing project proposals targeting different key donors, and effective ways of mobilizing climate finance to Sri Lanka.

v. Facilitate the engagement of multiples stakeholders in mobilizing climate finance for climate actions, especially private sector for implementing climate change related activities through supporting the accreditation process of financial institutions such as the GCF, and engagement in accessing finance through processes such as the Private Sector Facility under the GCF, readiness support funding for National Implementing Entities under the Adaptation Fund.

vi. Conduct outreach activities, and mobilise private public partnerships for identified climate financial needs for Sri Lanka.

7.2.7 Climate change communication, awareness and climate literacy

Climate change communication, awareness, and climate literacy play a key role in addressing climate change. There are several gaps and constraints exist for climate change communication, awareness, and climate literacy in Sri Lanka. Among these are lack of climate change knowledge products in local languages; lack of capacity for Information Communication Technology (ICT) on climate change; gaps in technical capacity and climate literacy of communicators; gaps in science based evidence on climate change for communication. To address these gaps and constraints, it is required to;

i. Develop a comprehensive Climate Change Communication Strategy for Sri Lanka in a participatory and multi-stakeholder driven process.

ii. Conduct trainings and workshops for capacity building of key stakeholders on climate change for communication.

iii. Develop climate change awareness and educational material in local languages to facilitate increased engagement of the general public on climate change related issues.

iv. Create a network of climate change communicators, and key stakeholders who produce publications on climate change, sharing of updated scientific information and findings among the communicators in Sri Lanka.

v. Conduct climate change awareness programmes through trainings, seminars and workshops for multiple stakeholders including youth, school and university students at national, provincial and district level.

vi. Incorporate climate change into the school, university and tertiary education curriculars.

vii. Establish a technical team in the national focal point to the UNFCCC for promoting and facilitating climate change communication and awareness raising activities in Sri Lanka.

7.2.8 Stakeholder responsibility and effective participation, and focus on vulnerable groups in climate change implementation

While there are many stakeholders undertake climate change related activities in Sri Lanka, several gaps and constraints are in ensuring the representation of all sectors and groups of stakeholders in implementation of climate actions. Further, there is no strategy for engagement of vulnerable communities, a mapping of key stakeholders for climate change actions in Sri Lanka. There are also gaps and constraints in guidelines for stakeholder extended responsibility depicted for addressing climate change issues in their respective mandates.

However, committees such as steering committees, expert committees and cells have been established under thematic areas of climate change adaptation, mitigation and project wise. To improve stakeholder responsibility and effective participation, and focus on vulnerable groups in climate change implementation in Sri Lanka, the following actions are proposed to;

i. Develop a stakeholder engagement strategy for climate change activities in Sri Lanka.

ii. Conduct outreach and networking events to create awareness among stakeholders on ongoing climate change related activities, and foster partnerships for activities that are being conducted.

iii. Develop activities for specific stakeholders that have lower representation in the climate change related activities i.e. youth, women, children, vulnerable communities.

iv. Develop a set of guidelines for establishing a multi-stakeholder process for climate change related activities in Sri Lanka.

v. Develop activities annually for stakeholder engagement, and inclusion in decision making process and implementation, regular updating of activities and progress made in different climate change related projects.

vi. Mobilise funding for activities to promote stakeholder partnerships, networking, and outreach to different stakeholders in the climate change processes at national, regional and global level.

7.2.9 Making thematic submissions to the UNFCCC and country position on matters related to the UNFCCC negotiation process

The UNFCCC process regularly calls for inputs and submissions under its different thematic areas for countries to make their submissions. Sri Lanka faces constraints in making submissions for all calls which interlinks with the gaps in human resources in different institutions relevant to developing the submissions. This also interlinks with the gaps previously highlighted in technical expertise and the capacity building gaps on the UNFCCC process. To address this gap, it is required to;

i. Identify key technical experts on different thematic issues of the UNFCCC process.

ii. Conduct group meetings for thematic discussions, based on a mapping of submissions for the year.

iii. Develop regular thematic positions for Sri Lanka considering national policy directives and developmental priorities, and incorporate the existing country positions for each thematic issue when submissions are called for under the UNFCCC process.

iv. Conduct capacity building sessions for thematic experts and key stakeholders related to climate change and the UNFCCC process in order to develop country positions for issues related to the UNFCCC negotiation process.

7.2.10 Knowledge management

It has been recognized that difficulties for identifying knowledge products in a one-stop platform relevant to climate change impacts, vulnerabilities, actions and scientific findings in Sri Lanka, that there is a gap in a centralized, or publicly available portal for climate change knowledge management. Research findings, knowledge products are in different platforms, and constraints existing in accessing them when reporting climate change circumstances in the country. Further, there are gaps in coordination for accessing knowledge products that are available on climate change as they are insufficiently publicly available or published, or has restricted access due to improved technology unavailability and mechanisms which prevent them from being shared. To address these gaps and constraints, it is proposed to;

i. Function effectively the climate change research and knowledge repository that recently developed which allows generators of knowledge products to share their products which are accessible to those who are in search of climate change information.
ii. Develop a system of documenting climate change activities, and developing knowledge products as outputs of the activities conducted under the relevant authorities for sharing with other stakeholders.
iii. Mobilise and allocate climate finance for knowledge management related activities on climate change, for sectoral agencies through different financial flows in annual budgets, annual plans, project budgets.
iv. Identify and engage knowledge management experts to provide support for developing knowledge products on climate change.
v. Build capacity of key stakeholders for developing climate change related knowledge products, and developing a custom of knowledge management at national, provincial and district level, as well as through key stakeholders engaged in climate change related activities.

7.2.11 Monitoring and evaluation climate actions continuously

Considerable gaps and constraints exist in monitoring and evaluation (M&E) of climate actions in Sri Lanka. This is due to a lack of centralized mechanism/ coordinated system which is focused on climate change M&E. This process related to different aspects, which could be related to measurement, reporting and verification (MRV) process under the UNFCCC, where impacts of climate actions, allocation of climate finance for different climate related activities need to be monitored and evaluated in the performance based on the impacts of such initiatives. For Sri Lanka, at present MRV and M&E processes for climate actions are at an early stage and are being established under ongoing projects. To address the gaps and constraints under monitoring and evaluation process of climate actions identified are as follows;

i. Develop a MRV framework for climate actions in the country.
ii. Develop a climate financial flow targeting immediate and prioritized climate change actions for both adaptation and mitigation activities in Sri Lanka.
iii. Establish a multi-stakeholder MRV system for climate action which should be coordinated by the national focal point to the UNFCCC.
iv. Develop an inclusive mechanism of both MRV and M&E into the national reporting and communication system under the UNFCCC process.

7.2.12 Gender responsive climate actions

Gender consideration in policies and actions on climate change exists a gap in addressing gender responsiveness of climate change related activities in Sri Lanka. This is an element that has not been addressed through both NDCs in 2016 and NAP of Sri Lanka. Having identified this need, the Climate Change Secretariat of the Ministry of Environment has taken steps to develop a Gender Action Plan for Climate Change in Sri Lanka, which will be an overarching plan to ensure gender inclusiveness in climate actions. In order to ensure that these actions are effectively implemented, it is needed to;

i. Develop and finalize the Gender Action Plan for Climate Change in Sri Lanka.
ii. Establish a M&E system for gender-based participation for events and activities related to climate change.
iii. Ensure gender balance in project beneficiaries, and in decision making processes.
iv. Conduct capacity building and training workshops on the importance of gender responsiveness for climate change activities.
v. Conduct research on gender and climate change in order to integrate gender as a change agent for climate change intervention.

REFERENCES

1. ADB, 2012: *The Asian Development Bank's Support for the Transport Sector in Sri Lanka,* Ref No: SAP: SRI 2012-06.

2. Adegboye, O.A. and M. Adegboye, 2017: *Spatially correlated time series and ecological niche analysis of cutaneous leishmaniasis in Afghanistan.* International Journal of Environmental Research and Public Health, 14(3), 309 pp.

3. Adesiji, G.B. and S.T. Baba, 2013: *Effects of climate change on poultry production in Ondo State, Nigeria,* Russian Journal of Agriculture and socio-economic sciences, 2(14), 55-60 pp.

4. Ahmed, M. and S. Suphachalasai, 2014: *Assessing the Costs of Climate Change and Adaptation in South Asia.* Asian Development Bank, Manila, Philippines.

5. AIT, 2014: *Municipal Solid Waste Management in Asia: Asian Regional Research Program on Environmental Technology (ARRPET)*, Asian Institute of Technology, Thailand.

6. Alexander, L.V., X. Zhang, T.C. Peterson, J. Caesar, B. Gleason, A.M.G. Klein Tank, M. Haylock, D. Collins, B. Trewin, F. Rahimzadeh, and A. Tagipour, 2006: *Global observed changes in daily climate extremes of temperature and precipitation*, Journal of Geophysical Research: Atmospheres, 111(D5).

7. Amarasinghe, U.A., L. Mutuwatta and R. Sakthivadivel, 1999: Water Scarcity Variations Within a Country: A Case of Sri Lanka. *Research Report 32*. IWMI, Colombo, Sri Lanka.

8. Ariyadasa, K.P. 2002: The Forest Fire Situation in Sri Lanka. http://www.fire.uni-freiburg.de/iffn/country/lk/lk_2.htm

9. Arulananthan, K., 2016: Climate change impact on coastal fisheries and aquaculture in Sri Lanka, Giri, S.S ed., Climate change impact on coastal fisheries and aquaculture in South Asia. SAARC Agriculture Centre., Dhaka, Bangladesh.

10. Basnayake, B.R.S.B., 2007: Climate Change in Sri Lanka: Impacts, Adaptation and Mitigation. *Proceedings of the national conference of climate change held in Kukuleganga, Sri Lanka on 16-17 March, 2007,* Department of Meteorology, Sri Lanka, 15-22 pp.

11. Basnayake, B.R.S.B., 2007: Climate Change. *The National Atlas of Sri Lanka.* Survey Department of Sri Lanka, 54-55 pp.

12. Basnayake, S., 2007: *Future Climate Scenarios of Rainfall and Temperature for Sri Lanka.* Paper presented at the 209th meeting of the E&E forum of the Tea Research Institute of Sri Lanka.

13. Berundharshani, T. and D.S. Munasinghe, 2015: *Drought Resilient Farming System through Crop Diversification:* The Case of Huruluwewa Proc. from the 6th Annual National Building Research Organization Symposium. on Innovations for Resilient Environment, Sri Lanka, 35-40 pp.

14. CBSL, 2018: *Annual Report 2018*, Central Bank of Sri Lanka

15. CBSL, 2019: *Annual Report 2019*, Central Bank of Sri Lanka

16. CDC, 2017: *Natural Disasters and Severe Weather*, Center for Disease Control. https://www.cdc.gov/disasters/extremeheat/heat_guide.html

17. CEA, 2006: *National Wetland Directory of Sri Lanka*, Central Environment Authority, Sri Lanka.

18. CEB, 2013: *Long Term Generation Expansion Plan 2013-2032*, Public Utility Commission of Sri Lanka.

19. CEB, 2015: *Long Term Generation Expansion Plan 2015-2034*, Public Utility Commission of Sri Lanka.

20. Chandrapala, L., 1996: *Calculation of areal precipitation of Sri Lanka on district basis using Voronoi Tessalation Method*. Proceedings of National Symposium on Climate Change, Central Environmental Authority, Sri Lanka.

21. Chandrapala, L., 2007: *Temperature*. The National Atlas of Sri Lanka, Survey Department of Sri Lanka, 56-57 pp.

22. DAPH, 2015: *Livestock Statistical Bulletin 2015*, Department of Animal Production and Health, Sri Lanka.

23. Darshika, D.W.T.T., I.M.S.P. Jayawardane and D.M.S.C. Disanayake, 2018: *Multi Model Ensemble climate change projections for annual and seasonal rainfall in Sri Lanka*, Sri Lanka Journal of Meteorology (3), 19-27 pp.

24. DCS, 2015: *Household Income and Expenditure Survey 2012/13*, Department of Census and Statistics, Sri Lanka.

25. DCS, 2016: *Statistical Abstracts*, Department of Census and Statistics, Sri Lanka.

26. De Zoysa, M. and M. Inoue, 2014: *Climate Change Impacts, Agroforestry Adaptation and Policy Environment in Sri Lanka*, Open Journal of Forestry 4, 439-456 pp.

27. DMC, 2012: *Hazard Profiles of Sri Lanka*, Disaster Management Centre, Sri Lanka.

28. DoE, 2008, 2009, 2010: *Annual Reports*, Department of Excise, Sri Lanka.

29. DWC, 2016: Annual Performance Report, Department of Wildlife Conservation, Sri Lanka.

30. Easterling, D., L. Alexander, A.Mokssit, and V. Detemmerman, 2003: *CCI/CLIVAR Workshop to Develop Priority Climate Indices*, Bulletin of the American Meteorological Society, 84(10), 1403-1407 pp.

31. Easterling, D.R., B. Horton, P.D. Jones, T.C. Peterson, T.R. Karl, D.E. Parker, M.J. Salinger, V. Razuvayev, N. Plummer, P. Jamason, and C.K. Folland, 1997: *Maximum and minimum temperature trends for the globe*, Science, 277 (5324), 364-367 pp.

32. Elith J, S.J. Phillips, T. Hastie, M. Dudík, Y.E. Chee, C.J. Yates, 2011: *A statistical explanation of MaxEnt for ecologists*, Diversity and Distributions, 17, 43-57 pp.

33. EMEP/CORINAIR, 2006: *EMEP/CORINAIR Emission Inventory Guidebook*, European Environment Agency, https://www.eea.europa.eu/publications/EMEPCORINAIR4

34. Eriyagama, N., V. Smakhtin, L. Chandrapala and K. Fernando, 2010: *Impacts of Climate Change on Water Resources and Agriculture in Sri Lanka, A Review and Preliminary Vulnerability Mapping*, IWMI Research Report 135. International Water Management Institute, Sri Lanka.

35. FD, 2010: *National Forest Cover Assessment*, Forest Department, Sri Lanka.

36. FD, 2015: *National Forest Inventory*, Forest Department, Sri Lanka.

37. Fernando, S., A. Senaratna, N. Pallewatta, E. Lokupitiya, L. Manawadu, U. Imbulana, I. De Silva, and S. Ranwala, 2015: *Assessment of key policies and measures to address the drivers of deforestation and forest degradation in Sri Lanka*, Final report of a consultancy to the Colombo Science and Technology Cell in the Faculty of Science, University of Colombo awarded by UNDP for the Sri Lanka UN-REDD Programme.

38. GIZ and EURAC, 2017: *Risk Supplement to the Vulnerability Sourcebook. Guidance on how to apply the Vulnerability Sourcebook's approach with the new IPCC AR5 concept of climate risk*. Bonn: GIZ

39. Gunathilaka, N., W. Abeyewickreme, M. Hapugoda, and R. Wickremasinhe, 2016: Species composition, breeding habitat diversity and habitat characterization of malaria vector breeding habitats in Trincomalee District of Sri Lanka. Biomed Research International, 1-10 pp.

40. Gunatilleke, N., R. Pethiyagoda, and S. Gunatilleke, 2017: *Biodiversity of Sri Lanka*. Journal of the National Science Foundation of Sri Lanka, 36, 25-61 pp. http://doi.org/10.4038/jnsfsr.v36i0.8047

41. Herbert, R., D.F. Ball, J.W. Rodrigo, and E.P. Wright, 1988: *The Rregolith Acquifer of Hard Rock Areas with Special Reference to Sri Lanka*, Journal of Geological Society of Sri Lanka 1, 64-72 pp.

42. IEA, 2019: https://www.iea.org/reports/sdg7-data-and-projections/energy-intensity, International Energy Agency

43. Imbulana, K.A.U.S, N.T.S. Wijesekara, B.R. Neupane, 2006: *Sri Lanka Water Development Report*, UNESCO and Ministry of Irrigation and Water Resources Mangement, Sri Lanka.

44. IPCC, 1996: *Climate Change 1995*, Second Assessment Report of Intergovernmental Panel on Climate Change.

45. IPCC, 1997a: Houghton, J.T., L.G. Meira Filho, B. Lim, K. Tréanton, I. Mamaty., Y. Bonduki, D.J. Griggs, and B.A. Callander (ed.) *Revised 1996 IPCC-GLs for National Greenhouse Gas Inventories: Reporting Instructions (Volume1)*. Intergovernmental Panel on Climate Change.

46. IPCC, 1997b: Houghton, J.T., L.G. Meira Filho, B. Lim, K. Tréanton, I. Mamaty., Y. Bonduki, D.J. Griggs, and B.A. Callander (ed.) *Revised 1996 IPCC-GLs for National Greenhouse Gas Inventories: Reporting Instructions (Volume 2)*. Intergovernmental Panel on Climate Change.

47. IPCC, 1997c: Houghton, J.T., L.G. Meira Filho, B. Lim, K. Tréanton, I. Mamaty., Y. Bonduki, D.J. Griggs, and B.A. Callander (ed.) *Revised 1996 IPCC-GLs for National Greenhouse Gas Inventories: Reporting Instructions (Volume 3)*, Intergovernmental Panel on Climate Change.

48. IPCC, 2003: *Good Practice Guidance for Land use, land use change and forestry*. IPCC/IGES, Hayama, Japan.

49. IPCC, 2006: Eggleston, H.S., L. Buendia, K. Miwa, T. Ngara and K. Tanabe (ed.) *IPCC-GLs for National Greenhouse Gas Inventories*, National Greenhouse Gas Inventories Programme. IPCC/IGES, Hayama, Japan.

50. Jayasekara, K. B., P. N. Kulasooriya, K. N. Wijayasiri, E.D. Rajapakse, D.S. Dulshika, P. Bandara, and S.M. Albert, 2019: *Relevance of heat stress and dehydration to chronic kidney disease (CKDu) in Sri Lanka*. Preventive Medicine Report.

51. Jayatillake, H. M. and P. Droogers, 2004: *Will there be Sufficient Water under Internal and External Changes?* Walawe Basin (Sri Lanka), Climate Change in Contrasting River Basins, eds. J.C.J.H. Aerts and P. Droogers. UK: CABI.

52. Jayatillake, H.M., L. Chandrapala, B.R.S.B. Basnayake, and G.H.P. Dharmaratne, 2005: *Water Resources and Climate Change. in (ed.) S. Wijesekara, K.A.U.S. Imbulana and Bhanu Neupane*, Proceedings of the preparatory workshop on Sri Lanka national water development report. Ministry of Irrigation, Mahaweli and Rajarata Development, Sri Lanka, 62-87 pp.

53. Jayawardena, I.M.S.P., D.W.T.T. Darshika, and H.M.R.C. Herath, 2018: *Recent Trends in Climate Extreme Indices over Sri Lanka*. American Journal of Climate Change 7, 586-599 pp. https://doi.org/10.4236/ajcc.2018.74036

54. Katupotha, J. 2015: *A Comparative Study of Sea Level Change in Maldives and Sri Lanka during the Holocene Period*, Journal Geological Society of Sri Lanka 17: 75-86 pp.

55. Keith, F., and J. Broadhead, 2011: *Forests and landslides-the role of trees and forests in the prevention of landslides and rehabilitation of landslide-affected areas in Asia*, Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific.

56. Kjellstrom T., S. Gabrysch, B. Lemke, 2009: *The 'Hothaps' programme for assessing climate change impacts on occupational health and productivity: an invitation to carry out field studies*. Glob Health Action, Article 2082.

57. Levett, P.N., 2003: *Usefulness of serologic analysis as a predictor of the infecting serovar in patients with severe leptospirosis*. Clin Infect Dis 36, 447-452 pp.

58. Lokuptiya, E., 2016: *Country Specific Emission Factors for Methane emission from enteric fermentation: case study from a Non-Annex I country*. Journal of the National Science Foundation in Sri Lanka, 44(2), 137-144 pp.

59. Mader, T.L., M.S. Davis, and T. Brown-Brandl, 2006: *Environmental factors influencing heat stress in feedlot cattle 12*. Journal of Animal Science 84(3), 712-719 pp.

60. MALF, 1995: *Sri Lanka Forestry Sector Master Plan*. Forestry Planning Unit, Ministry of Agriculture, Land and Forestry, Sri Lanka.

61. Manawadu, L. and N. Liyanage, 2008: *Identifying Surface Temperature Patten of City of Colombo*, Engineer 41(5), 133-140 pp.

62. Manisha, R.B., D.C. Collatto, D.P. Lacedra, M.I.W.M. Morandi, and F.S. Piran, 2019: *Environmental Externalities in Broiler production: An analysis based on system dynamics*, Journal of Cleaner Production 209, 190-199 pp.

63. Martinez-Austria, P.F. and E.R.Bandala, 2018: *Heat Waves: Health Effects, Observed Trends and Climate Change*, Intechopen Publishers.

64. MENR, 2005: *Databases of Municipal Solid Waste in Sri Lanka*, Ministry of Environment and Natural Resources, Sri Lanka

65. MERE, 2011: *Climate Change Vulnerability Data Book*, Climate Change Secretariat, Ministry of Environment and Renewable Energy, Sri Lanka.

66. MFARD, 2018: http://www.fisheries.gov.lk/statistics.php, accessed on 08 Jun 2018, Ministry of Fisheries and Aquatic Resources Development, Sri Lanka.

67. MoE, 2010: National Climate Change Adaptation Strategy for Sri Lanka, Ministry of Environment, Sri Lanka.

68. MoE, 2011: *Second National Communication on Climate Change*, Ministry of Environment, Sri Lanka.

69. MoE, 2012: *The National Climate Change Policy of Sri Lanka*, Ministry of Environment, Sri Lanka.

70. MoE, 2018: *Climate Risks Assessment* with the Technical Assistant (TA-8572 REG) of ADB (yet to be finalized), Ministry of Environment, Sri Lanka.

71. MRI, 2009: *Nutrition and Food Security Assessment in Sri Lanka*, Sri Lanka Nutrition and Food Security Survey Report. Medical Research Institute in collaboration with UNICEF and WFP.

72. Mutuwatte, L.P and P.K.N.C. Liyanage, 2013: *Impacts of Climate Change on Agro-Ecological Regions of Sri Lanka*. In H.P.M. Gunasena, H.A.J. Gunatilake, J.M.D.T. Everard, C.S. Ransinghe and A.D. Nainanayake (Eds.) Proceedings of the International Conference on Climate Change Impacts and Adaptations for Food and Environmental Security, Coconut Research Institute, Sri Lanka.

73. NAP-LD, 2014: *National Action Programme for Combating Land Degradation (NAP-LD) in Sri Lanka (2015-2024)*, Ministry of Environment and Renewable Energy, Sri Lanka.

74. NARA, 2016: *Fisheries Industry Outlook 2016*, National Aquatic Resources Research and Development Agency (NARA), Sri Lanka.

75. Nayanananda, O.K., 2007: *The Study of Economic Significance of Coastal Region of Sri Lanka in the Context of Environmental Changes of Pre and Post Tsunami*, Ministry of Environment and Natural Resources and Department of Coast Conservation, 68 pp.

76. Nissanka, S.P., B.V.R. Punyawardena, K.H.M.S Premalal and R.O. Thattil, 2011: *Recent trends in annual and growing seasons' rainfall of Sri Lanka*, Proceedings of the International Conference on the Impact of Climate Change in Agriculture, Faculty of Agriculture, University of Ruhuna, Sri Lanka, 249-263 pp.

77. Panabokke, C.R., 2008: *Groundwater Conditions in Sri Lanka: A geomorphic perspective*, National Science Foundation, Sri Lanka.

78. Phillips, S.J. and M. Dudík, 2008: *Modeling of species distributions with MaxEnt: new extensions and a comprehensive evaluation*, Ecography 31: 161-175 pp.

79. Phillips, S.J., M. Dudik and R.E. Schapire, 2004: *A maximum entropy approach to species distribution modelling*. In: Proceedings of the 21st International Conference on Machine Learning, ACM Press, New York, 655-662 pp.

80. Phillips, S.J., R.P. Andersonb and R.E. Schapired, 2006: *Maximum entropy modeling of species geographic distributions*, Ecological Modelling 190, 231-259 pp.

81. Premalal, 2018: *A study of the changes in south west monsoon wind pattern using two major study areas located on Bay of Bengal and Arabian Sea 1937-2017*, Department of Meteorology, Sri Lanka.

82. Premalal, K.H.M.S., 2009: *Weather and climate trends, climate controls and risks in Sri Lanka*, Presentation made at the Sri Lanka Monsoon Forum, Department of Meteorology, Sri Lanka.

83. Punyawardena, B.V.R. and K.H.M.S. Premalal, 2013: *Do trends in extreme positive rainfall anomalies in the Central highlands of Sri Lanka exist?* Annals of the Sri Lanka Department of Agriculture 15, 1-12 pp.

84. Rajasuriya, A., 2010: *Survey Report on Marine Biodiversity of Shell Bay, Trincomalee*, National Aquatic Resources Research and Development Agency, Sri Lanka.

85. Ratnayake, U. and G. Herath, 2005: *Changes in Water Cycle: Effect on Natural Disasters and Ecosystems*. In S. Wijesekara, K.A.U.S. Imbulana, B. Neupane (Eds.), Proceedings of the Preparatory Workshop on Sri Lanka National Water Development Report, World Water Assessment Programme, France, 192-205 pp.

86. Ruwanpathirana, N., 2011: *Timber Utilization in Sri Lanka*, paper presented at the Silver Jubilee Conference to Commemorate 25 years of Forestry Education at the University of Sri Jayewardenepura. Sri Lanka.

87. Sachitra, V. and S. Chong, 2015: *Enhancing Competitive Advantage of Sri Lankan Minor Export Crops*, Journal of Global Economics, Management and Business Research 4(4), 185-194 pp.

88. Samarasinghe, G.B., 2009: *Long Ranged Forecast of Climate Change for Sri Lanka*, Paper presented at the National Workshop on 'Mainstreaming Climate Change for Sustainable Development in Sri Lanka' in Dambulla from 19th - 21st August, 2009 organized by the Institute of Policy Studies in collaboration with the Ministry of Environment and Natural Resources.

89. Silva, G.L.L.P, L.T. Thuy, N.D. Abeykoon, N.T.H. Bett, M. Okeyo, and M.N.M. Ibrahim, 2016: *Comparative study of Indigenous pig production in Vietnam and Sri Lanka*, International Journal of Livestock Production, 83-93 pp.

90. Simac J.N., S. Badar, J.A. Farber, M.Y. Brako, R.A. Giudice-Jimenez, S.S. Raspa, 2017: *Malaria elimination in Sri Lanka*, J Health Spec 5.

91. Siriwardhana E.A., P.A. Perera, R. Sivakanesan, T. Abeysekara, D.B Nugegoda, J.A. Jayaweera, 2015: *Dehydration and malaria augment the risk of developing chronic kidney disease in Sri Lanka*, Indian J. Nephrol 25, 146-151 pp.

92. SLCZCRMP, 2018: *Sri Lanka Coastal Zone and Coastal Resource Management Plan - 2018*, Prepared under Section 12(1) of the Coast Conservation and Coastal Resource Management Act, No. 57 of 1981, Gazette Extraordinary of the Democratic Socialist Republic of Sri Lanka, No 2072/58, 141 p.

93. SLSEA, 2000-2010: National Energy Balance Statements of Sri Lanka, Sri Lanka Sustainable Energy Authority (SLSEA).

94. SLSEA, 2015: *Sri Lanka Energy Balance 2015*, Sri Lanka Sustainable Energy Authority (SLSEA), Sri Lanka.

95. SLSEA, 2017: *Sri Lanka Energy Balance 2017*, Sri Lanka Sustainable Energy Authority (SLSEA), Sri Lanka.

96. SLTDA, 2017: *Annual Statistical Report 2017*, Sri Lanka Tourism Development Authority (SLTDA), Sri Lanka.

97. Somarathne, E.A.S.K. and E. Lokupitiya, 2018: *Impacts of climate change on paddy yields and fate of rice residues in different climatic zones*, Abstract book, 2nd International Conference on Climate Change, The International Institute of Knowledge Management, 27 p.

98. Survey Department of Sri Lanka, 2007: *National Atlas of Sri Lanka*, Colombo, Sri Lanka, 58-59 pp.

99. Survey Department, 2007: *The National Atlas of Sri Lanka*. Survey Department of Sri Lanka, Sri Lanka.

100. Thushyanthy, M. and C.S. De Silva, 2012: *Assessment of Groundwater in Jaffna Limestone Aquifer*, Tropical Agricultural Research 23 (2), 177-185 pp.

101. UNEP, 1994: *Assessment and Monitoring of Climate Change Impacts on Mangrove Ecosystems*, UNEP Regional Seas Reports and Studies No. 154 Regional Seas Programme, Nairobi, Kenya.

102. UNREDD, 2017: *Sri Lanka's Forest Reference Level submission to the UNFCCC*, Forest Department, Sri Lanka.

103. Vidanage, S.P. and P. Abeygunawardane, 1994: *An economic assessment of global warming on agriculture: the case of paddy production in Sri Lanka*, Marga 13(1), 33-44 pp.

104. Villholth, K.G. and L.D. Rajasooriya, 2010: *Groundwater Resources and Management Challenges in Sri Lanka*, An Overview. Water Resources Management 24: 1489-1513 pp.

105. WB and EU, 2017: *Sri Lanka Rapid Post Disaster Needs Assessment Floods and Landslides*, World Bank and European Union, ISBN 978-955-0897-05-6 Published by the Ministry of Disaster Management & Ministry of National Policy and Economic Affairs in collaboration with the United Nations.

106. Weerakoon D., 2012: *A Brief Overview of the Biodiversity of Sri Lanka*, Sri Lanka Red List, IUCN Sri Lanka and Ministry of Environment and Renewable Energy, Sri Lanka.

107. WHO, 2012: *Country statistics and global health estimates by WHO and UN partners - Sri Lanka*, http://www.who.int/gho/countries/lka.pdf?ua=1.

108. WHO, 2015: *Review of climate change and health activities in Sri Lanka*, World Health Organization.

109. Wijayatunga, P.D.C, W.J.L.S. Fernando and R.M. Shrestha, 2006: *Greenhouse Gas Emission Mitigation: Sri Lanka Electricity Sector*, ENGINEER Vol. XXXIX.

110. Wijayawardhana, L.M.J.R. and N.C. Kumarasinghe, 2011: *Effect of Climatic Conditions on Sugarcane Cultivation Systems in Sri Lanka*, International Conference on the Impact of Climate Change on Agriculture.

111. Wijeratne, M.A. A. Anandacoomaraswamy, M.K.S.L.D. Amarathunga, J. Ratnasiri, B.R.S.B. Basnayake, and N. Kalra, 2007: *Assessment of impact of climate change on productivity of tea (Camellia sinensis L.) plantations in Sri Lanka*, Journal of National Science Foundation Sri Lanka 35(2), 119-126 pp.

112. World Bank, 2015: *Climate-smart agriculture in Sri Lanka*, CSA country profiles for Africa, Asia, and Latin America and the Caribbean series. Washington D.C., The World Bank Group.

113. World Bank, 2017: *Sri Lanka Education Sector Assessment Achievements, Challenges, and Policy Options*, International Bank for Reconstruction and Development / The World Bank, 1818 H Street NW, Washington, DC 20433

114. WPWMA, 2019: *Strategic Action Plan (Road Map) to Sustainable Waste Management in the Western Province of Sri. Lanka 2019 to 2023*, Western Province Waste Management Authority, Sri Lanka.

115. WTTC, 2017: World Travel & Tourism Council (WTTC) (https://wttc.org/).

116. Yogaratnam, N., 2011: *Global warming threat to natural rubber*, Daily News, The Associated Newspapers of Ceylon Ltd (http://archives.dailynews.lk/2011/01/19/bus20.asp).

117. Zhao, D. and Y. Li, 2015: *Climate Change and Sugarcane Production: Potential Impact and Mitigation Strategies*, International Journal of Agronomy.

118. Zubair, L., J. Hansen, J. Chandimala, M.R.A. Siraj, M. Siriwardhana, K. Ariyaratne, I. Bandara, H. Bulathsinghala, T. Abeyratne, T.D.M.A. Samuel, 2005: *Current climate and climate change assessments for coconut and tea plantations in Sri Lanka*. IRI, FECT, NRMS and UoP Contribution to AS12 Project Report to be submitted to START, Washington, DC., USA.

Climate Change Secretariat
Ministry of Environment

"Sobadam Piyasa" , No 416/C/1, Robert Gunawardana Mawatha
Battaramulla, Sri Lanka
Tel/Fax: +94 112034198 / +94 112879978
Email: climatesec@gmail.com
Web Site: www.climatechange.lk