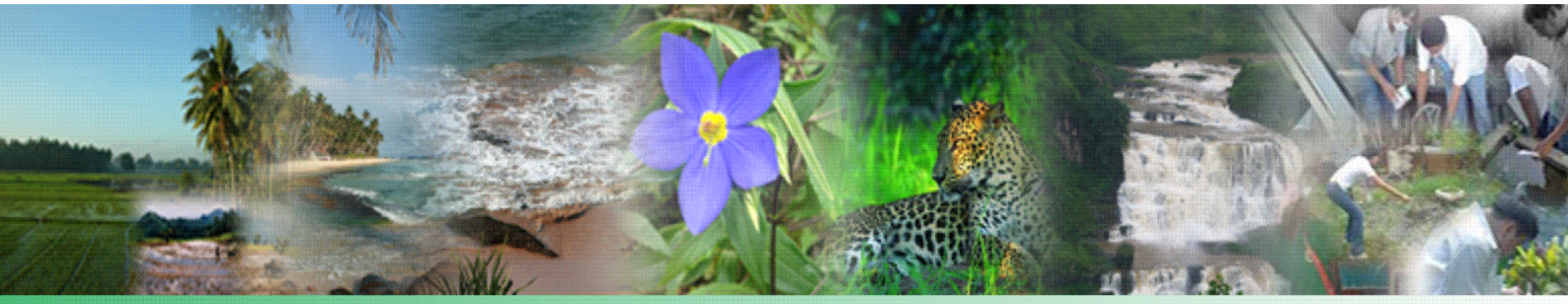
Ministry of Environment and
Renewable Energy
Sri Lanka



Technology Needs Assessment And Technology Action Plans For Climate Change Adaptation

Project Ideas Report

2012

Supported by

UNEP

gef

UNEP RISØ CENTRE

ASIAN INSTITUTE OF TECHNOLOGY 1959

CLIMATE CHANGE SECRETARIAT Sri Lanka

FORWARD

Sri Lanka being an island nation subjected to tropical climatic influences is highly vulnerable to climate change impacts. We are already experiencing significant climatic imbalances manifested through increasing average temperatures, drastic variations in rainfall patterns and extreme climatic events such as heavy rainstorms, flash floods, and extended droughts and weather related natural disasters in various forms and severity. These extreme and sometimes unseasonal events affect not only the human lives and properties but also have long term impacts on the ecosystems as well.

"*Mahinda Chinthana* – Vision for the Future", the Government of Sri Lanka's Ten Year Development Policy Framework assigns a very high priority to the management of the environment and the natural resources sector including addressing climate change impacts. In keeping with the Government's overall vision on tackling climate change impacts, the "National Climate Change Policy (NCCP) for Sri Lanka" identifies the paramount need of undertaking appropriate actions for climate change adaptation in order to build resilience of the country to face the adverse impacts of climate change. The NCCP emphasizes the importance of exploring technologies and best practices already available in the country and globally, and select nationally appropriate innovative technologies, disseminating, and implementation to the extent possible with sound monitoring mechanisms.

The Government and my Ministry in particular recognizes that the Technology Needs Assessment (TNA) Project implemented in collaboration with Global Environment Facility (GEF), United Nations Environment Programme (UNEP), UNEP-Risoe Center (URC) and the Asian Institute for Technology (AIT),as the first comprehensive national exercise undertaken towards addressing our climate change concerns. Thus, the TNA Report provides an assessment of the priority technology requirements and action plans for climate change adaptation activities in food, water, coastal, health and biodiversity sectors. I am convinced that this exercise has been a nationally driven process involving local expertise and knowledge supplemented by international experiences.

In fulfillment of the Government's firm commitment towards taking appropriate national actions for tackling climate change related issues and also collaborative obligations to the international community in this context, I have great pleasure in presenting the **Sri Lanka's National Report on Technology Needs Assessment and Technology Action Plans for Climate Change Adaptation** to the policy makers, potential investors, technology developers, scientists and all other stakeholders who are actively participating in sustainable development efforts of the country. I also recommend this report for consideration and emulation of the world community and invite them to be partners in achieving our economic, environmental and social development goals.

Susil Premajayantha, MP

Minster of Environment and Renewable Energy

Government of Sri Lanka

PREFACE

Sri Lanka ratified the United Nations Framework Convention on Climate Change (UNFCCC) in November 1993 and acceded its Kyoto Protocol in September 2002. In keeping with the obligations of the UNFCCC, the Government of Sri Lanka submitted its Initial National Communication in 2000 and submitted the Second National Communication in 2012. Over the last two decades, Sri Lanka has made a significant progress towards improving the national policy framework and strengthening the legal and institutional capabilities to facilitate implementation of obligations under the UNFCCC and Kyoto Protocol. These timely actions demonstrate the Government's firm commitment in addressing country's environmental and climate change related issues.

Although Sri Lanka is a low greenhouse gases emitter, it is highly vulnerable to adverse impact of climate change. Analysis of past records suggests that air temperature throughout the island has been on a rising trend during the last century. The future scenarios predict higher levels of emissions and possibility of adverse climate change impacts, if no mitigatory and adaptation actions are undertaken now.

The TNA explores country needs for the reduction of greenhouse gas emissions and adaptation technologies. It also re-affirms the will of the Government along with the international community to contribute to the joint efforts in addressing the climate change threat. It is envisaged that this process will open up access to funds, create an enabling environment for the transfer of priority technologies which will improve the climate resilience of the most vulnerable sectors in the country.

I would like to take this opportunity to extent my gratitude to the Global Environment Facility (GEF) for funding and the United Nations Environment Programme (UNEP) and the UNEP Risoe Center (URC) for implementing this project in collaboration with the Asian Institute of Technology (AIT). A record of appreciation is also extended to the members of the TNA committee, Sectoral working Groups and all other experts who have contributed to this national exercise.

B.M.U.D Basnayake
Secretary
Ministry of Environment and Renewable Energy

ACKNOWLEDGMENTS

This report on Technology Needs Assessment and Technology Action Plans for Climate Change Adaptation was the outcome of the project on Technology Needs Assessment (TNA) on Climate Change Adaptation and Mitigation for Sri Lanka conducted by the Climate Change Division of the Ministry of Environment and Renewable Energy from June 2011 to April 2013.

The TNA project in Sri Lanka was funded by the Global Environment Facility (GEF) and technically supported by United Nations Environment Programme (UNEP) and the UNEP Risoe Center (URC) in collaboration with the Asian Institute of Technology (AIT). First and foremost, my appreciation goes to the GEF, UNEP, URC and AIT for their financial and technical supports.

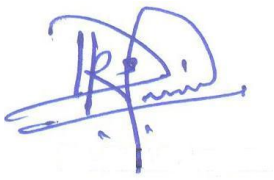
I wish to take this opportunity to express my sincere gratitude to Hon. Susil Premajayantha, Minister of Environment and Renewable Energy, Hon. Anura Priyadarshana Yapa, Former Minister of Environment, Mr. B.M.U.D. Basnayake, Secretary, Ministry of Environment and Renewable Energy and Mr. Gamini Gamage, Additional Secretary (Environment and Policy) of the Ministry of Environment and Renewable Energy for their leadership, directions and guidance provided to conduct this project successfully.

My appreciation is extended to the members of the TNA committee, sectoral working groups and all other experts who contributed to this project. I am grateful to the various governmental, non-governmental and private sector personnel who took time out of their busy schedules to meet with our consultants and to provide data and information.

I am thankful to all the consultants of the TNA project, namely Mr. H.M. Bandaratillake, Team Leader and sector experts Dr. (Mrs.) S.M. Wijesundara (Food Sector), Dr. N.P. Sumanaweera (Health Sector), Prof. (Ms.) Hema M.K.K. Pathirana (Water Sector), Prof. (Ms.) P.R.T. Cumaranatunga (Coastal Sector), and Mr. Shamen Vidanage and Ms. Manishka De Mel representing International Union for Conservation of Nature (IUCN) (Biodiversity Sector).

My special thanks is also extended to the staff of the Climate Change Division of the Ministry of Environment and Renewable Energy, particularly to Ms. Anoja Herath, Coordinator of the TNA project, Ms. Nirosha Kumari and Ms. Surani Pathirana, Environment Management Officers of the Ministry of Environment and Renewable Energy.

Finally, on behalf of the Ministry of Environment and Renewable Energy I would like to thank all those who contributed to make this project realistic. Without their supports this project would never be success.



Dr. R.D.S.Jayathunga
Director, Climate Change Division
Ministry of Environment and Renewable Energy

Contributors

Ministry of Environment and Renewable Energy

Mr. B.M.U.D Basnayake	: Secretary, Ministry of Environment and Renewable Energy
Mr. Gamini Gamage	: Addl. Secretary (Environment & Policy)
Dr. R.D.S. Jayathunga	: Director, Climate Change Division
Ms. Anoja Herath	: Assistant Director, Climate Change Division, (National Project Coordinator)
Ms. Nirosha Kumari	: Environment Management Officer, Climate Change Division
Ms. Surani Pathirana	: Environment Management Officer, Climate Change Division

Consultancy of the TNA Project

Prof.(Ms.) Hema M.K.K. Pathirana	: Water Sector Expert(Prof. In Chemistry Department of Chemistry, Faculty of Sciences, University of Ruhuna)
Prof.(Ms.) P.R.T. Cumaranatunga	: Coastal Sector Expert (Senior Prof. of Fisheries Biology, Department of Fisheries & Aquaculture, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna)
Dr.(Mrs.) S.M. Wijesundara	: Food Sector Expert [Former Director (Natural Resource Management), Ministry of Agriculture and Agrarian Services]
Dr. N.P. Sumanaweera	: Health Sector Expert (Former Health Planning Officer, Ministry of Health)
Mr. Shamen Vidanage	: Biodiversity Sector Expert (Acting Country Representative, IUCN)
Ms. Manishka De Mel	: Biodiversity Sector Expert (Senior Programme Officer, IUCN)

Editor

Mr. W.R.M.S Wickramasinghe	: Former Addl. Secretary (Environment and Policy) Ministry of Environment

Stakeholder Participation

TNA Committee	– Annex A1
Workshop Participants	– Annex A2

This document is an output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) and the UNEP- Risoe Centre (URC) in collaboration with the Asian Institute for Technology (AIT), for the benefit of the participating countries. The present report is the output of a fully country-led process and the views and information contained herein are a product of the National TNA team, led by the Secretary, Ministry of Environment and Renewable Energy, Government of Sri Lanka.

TABLE OF CONTENTS

ABREVIATIONS

ADB	Asian Development Bank
CBD	Convention of Biological Diversity
CBO	Community Based Organization
CBSL	Central Bank of Sri Lanka
CC	Climate Change
CCD	Coast Conservation Department
CD & PF	Crop Diversification and Precision Farming
CEA	Central Environmental Authority
CH_4	Methane
CIDA	Canadian International Development Agency
CMA	Colombo Metropolitan Area
CZMP	Coastal Zone Management Plan
D	Domestic
DAD	Department of Agrarian Development
DC&S	Department of Census and Statistics
DOA	Department of Agriculture
DOF&ARD	Department of Fisheries & Aquatic Resource Development
DWLC	Department of Wildlife Conservation
DZ	Dry Zone
EIA	Environmental Impact Assessment
EWS	Early Warning Systems
FAO	Food and Agriculture Organization of United Nations
FO	Farmer Organization
FSL	Full supply level
FYM	Farm Yard Manure
GCE O/L	General Certificate of Education, Ordinary/Level
GDP	Gross Domestic Production
GHG	Green House Gases
GIS	Geographic Information System
GTZ	Germen Technical Cooperation
HWCM	Health Waste Care Management
I	International
ICTAD	Institute of Construction Training
IEE	Initial Environment Examination
INGO	International Non Governmental Organisation
IUCN	International Union for Conservation of Nature
LFM	Logical Framework Matrix

LRWHF	Lanka Rainwater Harvesting Forum
M	Millions
M&E	Monitoring and Evaluation
M/A	Ministry of Agriculture
M/DM	Ministry of Disaster Management
M/Env.	Ministry of Environment
M/I & WRM	Ministry of Irrigation and Water Resource Management
M/L & LD	Ministry of Land and Land Development
M/LD	Ministry of Livestock Development
M/Plantation Inds	Ministry of Plantation Industries
M/Tech&Res	Ministry of Technology and Research
M/TI&SE	Ministry of Traditional Industry & Small Enterprise Development
MCDA	Multi Criteria Decision Analysis
MDG	Millennium Development Goal
MEPA	Marine Environment Protection Authority
MF&ARD	Ministry of Fisheries and Aquatic Resources Development
MoH	Ministry of Health
MSL	Mean Sea Level
NAQDA	National Aquaculture Development Authority
NARA	National Aquatic Research & Development Agency
NBRO	National Building Research Organisation
NDMC	National Disaster Management Centre
NEP	National Environmental Policy
NFP	National Forestry Policy
NGO	Non-Governmental Organization
NRMC	Natural Resource Management Centre
NSF	National Science Foundation
NWSDB	National Water Supply & Drainage Board
O & M	Operation and Maintenance
PAs	Protected Areas
PCs	Provincial Councils
PMF	Performance Measurement Framework
PS	Private Sector
R&D	Research and Development
RWH	Rooftop Rainwater Harvesting
SALT	Sloping agricultural land technology
SCBF	Sustainable Culture Based Fishery
SICBF	Sustainable Inland Culture Based Fishery
SLLRDC	Sri Lanka Land Reclamation and Development Corporation
SLM	Sustainable land management

SLR	Sea Level Rise
SLSI	Sri Lanka Standard Institute
SME	Small and Medium Scale Enterprise
SVP	Sector Vulnerability Profile
TAP	Technology Action Plan
TNA	Technology Needs Assessment
TOR	Terms of Reference
TT & D	Technology Transfer and Diffusion
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
US $	United States Dollar
USAID	United States Agency for International Development
WHO	World Health Organization
WRB	Water Resources Board
WZ	Wet Zone

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The Technology Needs Assessment (TNA) for Climate Change in Sri Lanka was carried out during the 3rd and 4th quarters of 2011. The priority sectors identified for adaptation were Food, Health, Water Coastal and Biodiversity. Then after following an extensive consultative process with sectoral stakeholder working groups, a potential list of technologies for each sector were identified, and prioritized by using the Multi Criteria Decision Analysis (MCDA) process. Three technologies were prioritized for each sector except for the Biodiversity sector. For the Biodiversity sector, five technologies were prioritized based on the suggestions made by the stakeholders of this sector. Then the barrier analysis was carried out through stakeholder consultations during the 2nd and 3rd quarters of 2012, and enabling framework was identified for each technology, in order to overcome the anticipated barriers for fulfilling the objectives of technology transfer and diffusion. Subsequently, the Technology Action Plans (TAP) and Project Ideas (PI) were developed for each technology under the prioritized sectors.

The PI report presents proposed project ideas based on each of the prioritized technologies. For each project idea, an introduction and background, project objectives, outputs of the proposed project, relationship country's sustainable development priorities, project deliverables, project scope and possible implementation, project activities, timeline for proposed activities, budget & resource requirements, measurement & evaluation, possible complications & challenges, and responsibilities & coordination arrangements are presented.

A summary of Project Ideas (PI) developed for each adaptation sector are briefly described below.

Food Sector:

Based on the MCDA process with stakeholder consultation, the following three technologies were identified as the most promising technologies in the food sector to face the challenge of climate change. This section outlines the proposals of project ideas developed based on the three prioritized technologies for the food sector.

Project Idea for technology 1 (Sustainable Inland Culture Based Fisheries): ***Development of Inland Culture Based Fisheries (ICBF) for enhancing livelihood and food security of communities vulnerable to climate change in the dry zone of Sri Lanka.***

The primary objectives of the project is (i) to increase the livelihoods of 30,000 beneficiaries engaged in the production of inland culture-based fishery in 3,000 minor perennial small non perennial reservoirs in the selected districts in the dry zone of Sri Lanka; (ii) To increase annual household incomes of beneficiaries by 100%; and (iii) To reduce pressure on land and introduce CBF as an alternative and supplementary source of income in the targeted rural communities.

The proposed project is scheduled to be implemented for a period of ten years with a total budget of US $ 54 million.

Project Idea for technology 2 (Sustainable Land Management): ***Restoration and preservation of highland productivity using Sustainable Land Management practices to increase climate change adaptability.***

Objectives of the project is (i) to restore the fertility and productivity levels of agricultural land already deteriorated due to poor management and other natural and anthropocentric parameters; (ii) the secondary objective is to prevent degradation of land with good fertility status. It also involves maintaining the present fertility status of an unspecified area of non-degraded land allocated to food production by promoting good land management practices as the common standard and setting up the institutional structure necessary to ensure it.

The proposed project is scheduled to be implemented for a period of ten years with a total budget of US $ 68 million.

Project Idea for technology 3 (Crop Diversification & Precision Farming): ***Crop diversification and precision farming in dry zone of Sri Lanka for managing climate change vulnerabilities, livelihood sustainability and food security***

The proposed project will aim to convert about half of the available land, i.e. 40,000 ha of the marginal rice lands and 50,000 ha of the area facing water shortage, to other food crop cultivation including both seasonal crops and perennials. The diversified area will also include crops adopting precision farming techniques such as drip irrigation, micro-sprinklers, and other automated systems for the cultivation of high-value crops.

The proposed project is scheduled to be implemented for a period of ten years with a total budget of US $ 60 million.

Health Sector:

This section outlines the proposals of project ideas developed based on the three prioritized technologies for the Health sector.

Project Idea for technology 1 (Technology for Early Warning Systems and networking for information exchange on Extreme Weather events and other climate change related events): ***Strengthening the existing health sector Early Warning Systems through networking and linking with other sectors and training of health personnel on EWS to adapt to adverse health effects of climate change.***

Objectives of the proposed project is (i) To establish a network in the health sector and between other sectors for information sharing within three years covering 70% of districts and all other sectors at the central level; (ii) To provide training, enhance knowledge and skills to health personnel for the purpose of proper functioning of EWS to 60 % health workers in eight years; (iii) To promote R & D to ensure sustainability of aforesaid objectives in three years.

The proposed project is scheduled to be implemented for a period of eight years with a total budget of US $ 117,150.

Project Idea for technology 2 (Transfer of knowledge and skills to Health Personnel): ***Capacity building of health personnel to improve performance with regard to climate change related adverse health effects.***

Objectives of the proposed project is (i) To enhance capacity of health personnel and institutions to ensure all levels of health personal are equipped with required skills to face the challenges of adaptation to climate change; (ii) To establish and strengthen a training coordination unit in the Ministry of Health; (iii) To monitor the progress of activities.
The proposed project is scheduled to be implemented for a period of ten years with a total budget of US $ 374,000.

Project Idea for technology 3 (Technology for management of Healthcare Waste): ***Improvement of Health Care Waste Management in all health institutions to minimize the effects of climate change related adverse health effects.***
Objectives of the proposed project is (i) To identify and implement lasting (HCWM) technologies in the health care institutions; (ii) To create awareness on benefits of proper HCWM among health personnel; (iii) To expand health information system to include HCWM activities; (iv) To install clinical (HCWM) systems in the major hospitals; (v) To improve inter-sectoral coordination for proper HCWM.
The proposed project is scheduled to be implemented for a period of four years with a total budget of US $ 2,279,200.

Water Sector:
The project ideas report for the water sector includes one project idea for each technology identified and a project idea developed by combining the three technologies identified.

Project Idea for technology 1 (Restoration/ Rehabilitation of Minor Tank net works): ***Rehabilitation/Restoration and maintenance of minor tank network (cascade) systems in the dry zone of Sri Lanka as an adaptation strategy for climate change.***
The main objective of this project is to provide water throughout/most of the year (80%), for farmers in selected vulnerable areas in the dry zone, through properly maintained ten minor tank network systems.
The proposed project is scheduled to be implemented for a period of ten years with a total budget of US $ 44.3 million.

Project Idea for technology 2 (Rainwater harvesting from rooftops for drinking and household uses): ***Promote roof top rainwater harvesting technology, as an adaptation measure for climate change.***
The main objective of the proposed project is to provide water for drinking and household uses as a short term security against dry period (40%) for selected areas in the dry zone and as a flash-flood mitigation strategy for urban areas (e.g. Colombo) through quality controlled roof top rainwater harvesting systems.
The proposed project is scheduled to be implemented for a period of seven years with a total budget of US $ 65.3 million.

Project Idea for technology 3 (Boreholes/tube wells as a drought intervention for domestic water supply): ***Promote measures for sustainability of boreholes as an adaptation method for climate change.***

The main objective of the of the proposed project is to provide potable water throughout the year (100%) for 20% of households and general public in selected vulnerable rural areas having hydrogeologically suitable sites in the dry zone by promoting sustainability of boreholes. 50 boreholes will be installed for this purpose.

The proposed project is scheduled to be implemented for a period of eight years with a total budget of US $ 27.5 million.

Project Idea for Multiple technologies: ***Improve availability of drinking and irrigation water for the dry zone of Sri Lanka as an adaptation measure for climate change.***

The main objective of this project is to provide water throughout/most of the year (100%), in the North Central Province in the dry zone for agricultural and drinking purposes through properly maintained ten minor tank network systems, 100 quality controlled roof top rain water harvesting systems and 25 sustainable boreholes.

The proposed project is scheduled to be implemented for a period of ten years with a total budget of US $ 71.2 million.

Coastal Sector:

The project ideas report for the coastal sector includes one project idea for each technology identified.

Project Idea for technology 1 (Restoration of Sand dunes): ***Rehabilitation and restoration of sand dunes in North Western, Southern & Eastern Provinces of Sri Lanka as a soft barrier against sea level rise, while improving socioeconomic status of coastal communities.***

The objectives of the proposed project are (i) Restoration of sand dunes and its vegetation subjected to anthropogenic destructions to develop soft barriers against SLR, storm surges, inundation, etc. and as wind belts where ever it is applicable; (ii) Conserve natural sand dunes and turtle nesting sites in their vicinity; (iii) Reduce unemployment among coastal communities depend on dune resources and improve their socioeconomic status through sustainable management of sand dunes and their resources; (iv) Uplift the country's economy through eco-friendly tourism within coastal belts with sand dunes.

The proposed project is scheduled to be implemented for a period of seven years with a total budget of US $ 2.63 million.

Project Idea for technology 2 (Rehabilitation of Mangroves): ***Rehabilitation of mangroves as soft barriers against sea level rise in the North Western, Eastern and Southern coastal belts of Sri Lanka, while maintaining the ecological balance and sustainability of socioeconomic activities.***

The objectives of the proposed project are (i) Restoration of mangroves and its vegetation, to develop soft barriers against SLR, storm surges, inundation, etc. and as wind belts where ever it is applicable; (ii) Conservation of natural sand dunes and turtle nesting sites in their vicinity to promote eco-tourism; (iii) Reduce unemployment & to uplift socioeconomic status of coastal communities; (iv) Explore the

possibilities of introducing economically important exotic species of mangrove plant species (e.g *Rhyzophora mangle*) to Sri Lanka and also the possibilities of using other Rhyzophora spp available in Sri Lanka for such small-scale industries; (v) Uplift the economy of the country, through development of eco-friendly within coastal belts with mangroves.
The proposed project is scheduled to be implemented for a period of five years with a total budget of US 767,800.

Project Idea for technology 3 (Restoration of Coral Reefs): ***Restoration of coral reefs of southern and south-western coastal belt of Sri Lanka, as a soft barrier against sea level rise and coastal erosion and as a tourist attraction to promote eco-friendly tourism.***
The objectives of the proposed project are (i) Restoration of coral reefs as soft coastal barriers against SLR; (ii) Reduce the impact of anthropogenic activities on the reef ecosystems; (iii) Provision of eco-friendly alternative employment opportunities to coastal communities to reduce destructive socioeconomic activities and unemployment problem among coastal communities through SMEs and promotion of ecotourism through community-based organisations.
The proposed project is scheduled to be implemented for a period of seven years with a total budget of US 2.678 million.

Biodiversity Sector:
The project ideas report for the biodiversity sector includes one project idea for each technology, and an additional project idea covering multiple technologies.

Project Idea for technology 1 (Restoration of degraded areas inside and outside the protected area network to enhance resilience): ***Study on identifying and prioritizing critical areas for restoration.***
The objectives of the proposed project are (i) To identify and prioritize critical areas for rehabilitation and restoration; (ii) Demonstration of rehabilitation and restoration through pilot interventions.
The proposed project is scheduled to be implemented for a period of three years with a total budget of US 2 million.

Project Idea for technology 2 (Increasing connectivity through corridors, landscape/matrix improvement and management): ***Identification of critical areas to be connected and prioritization of required corridors.***
The objectives of the proposed project are (i) To identify and prioritize critical areas to be connected in light of climate change impacts; (ii) To facilitate the inclusion of four critical areas in the protected area network.
The proposed project is scheduled to be implemented for a period of three years with a total budget of US 1.85 million.

Project Idea for technology 3 (Improve management, and possibly increase extent of protected areas, buffer zones and create new areas in vulnerable zones): ***Awareness programme, capacity building and development of materials to promote coexistence with biodiversity.***

The objectives of the proposed project are (i) To create awareness promoting coexistence with biodiversity; (ii) To build capacity to promote coexistence with biodiversity; (iii) To provide materials necessary to promote coexistence with biodiversity.
The proposed project is scheduled to be implemented for a period of one year with a total budget of US 275, 000.

Project Idea for technology 4 (Focus on conservation of resources and carryout special management for restricted range, highly threatened species and ecosystems): ***Awareness programme on point endemics and critically endangered species, and the importance of their conservation.***
The objective of the proposed project is to create awareness of the importance of point endemic species and their conservation through preparation of awareness materials and disseminating them.
The proposed project is scheduled to be implemented for a period of one year with a total budget of US 270, 000.

Project Idea for technology 5 (Ex-situ conservation for highly threatened species and possible reintroduction): ***Studies to identify and prioritize species for ex-situ conservation, and climate change modeling to identify species vulnerable to climate change.***
The objectives of the proposed project are (i) To identify and prioritize species for ex-situ conservation; (ii) To identify species vulnerable to climate change through climate change modeling.
The proposed project is scheduled to be implemented for a period of three years with a total budget of US 2 million.

Project Idea for Multiple Technologies: ***Climate change adaptation for biodiversity: a ridge to reef approach in building climate resilience along the Mahaweli River.***
The objective of the proposed project is to increase the resilience of biodiversity for climate change adaptation, by taking a ridge to reef approach in building resilience.
The proposed project is scheduled to be implemented for a period of three years with a total budget of US 475, 000.

CHAPTER 1

Project Ideas for Food Sector

1.1 Brief summary of the Project Ideas for Food Sector

The analysis of technology options for climate change adaptation in the food sector in Sri Lanka was carried out through an extensive consultative process, by compiling a list of all potent technologies available in the food sector to face the challenge of climate change. A prioritization process utilizing the Multi-Criteria Decision Analysis (MCDA) approach was used to rank the various technologies identified as potential means to increase adaptation to climate change impacts. Based on this process, the following three technologies were identified as the most promising technologies in the food sector to face the challenge of climate change.

This chapter outlines the proposals for the three project ideas developed based on the 3 prioritized technologies for the food sector.

The table 1.1 shows proposed projects for each of the three prioritized technologies.

Table 1.1: Proposed projects for prioritized technologies in the Food Sector

Technology	Project Idea
1. Sustainable Inland Culture Based Fisheries	Development of Inland Culture Based Fisheries for Enhancing Livelihood and Food Security of Communities Vulnerable to Climate Change in the Dry Zone of Sri Lanka
2. Sustainable Land Management	Restoration and preservation of Highland Productivity Using Sustainable Land Management Practices to Increase Climate Change Adaptability
3. Crop Diversification & Precision Farming	Crop Diversification and Precision Farming in Dry Zone of Sri Lanka for Managing Climate Change Vulnerabilities, Livelihood Sustainability and Food Security

1.2 Project Idea for Technology 1: Sustainable Inland Culture Based Fisheries (SICF)

Development of Inland Culture Based Fisheries (ICBF) for Enhancing Livelihood and Food Security of Communities Vulnerable to Climate Change in the Dry Zone of Sri Lanka

1.2.1 Introduction and Background

National Food Security Survey of 2009[1] indicates that only 36.4% of households in the poorest quintile reported having had adequate food supply for every day in the past 12 months compared to 91.4% of the richest quintile. Increasing population pressure, decreasing arable agricultural land and poverty are the main challenging issues that render achieving the national level food and nutrition security in Sri Lanka. In spite of these issues rural agriculture sector which holds majority of the poor has been suffering from vulnerable effects of climate change vagaries. Hence, the impending vagaries of CC further accentuate food and nutritional security and trim down agricultural development such as raising agriculture's contribution to economic growth, incomes and living standards of farming community, consumer welfare, and agriculture's sustainability.

In Sri Lanka, 189,941 ha of natural and quasi-natural inland waters are existing including large, medium, minor irrigation reservoirs, non perennial small reservoirs, Mahaweli reservoirs, upland hydroelectric reservoirs and floodplain lakes.[2] Approximately 12,000 perennial, large reservoirs (<100 ha in surface area) and non-perennial small reservoirs, locally referred to as seasonal tanks, often <20 ha at full supply level (FSL), are mostly located in the dry zone (<187 cm annual rainfall) of the country. These reservoirs, fill during the north-east monsoonal period in October to December and almost completely dry up for 2–3 months (July – September) of the year which could have the potential for development of Inland Culture Based Fisheries without causing impediment on their primary use which is irrigating paddy fields and other uses of bathing cattle and domestic uses. Hence, Inland culture based fisheries have a potential as a non-competitive, complimentary resource to maximize the benefits from freshwater resources and enhances food security for the practitioners and the nation as a whole.

In many Asian countries, fish is one of the most important good quality animal protein food sources and a very good source of long-chain polyunsaturated fatty acids available for human consumption. In Sri Lanka up to 80% of the total animal protein requirement is met by fish products with per capita fish consumption

[1] National Food Security Survey, 2009

[2] Anon, 2006

increased by 38% in the last two years (Figure 1.1). Statistics also indicate that with the development of inland fishery, per-capita fish consumption in the land-locked regions such as Anuradhapura and Polonnaruwa districts has exceeded the average national per-capita fish consumption.

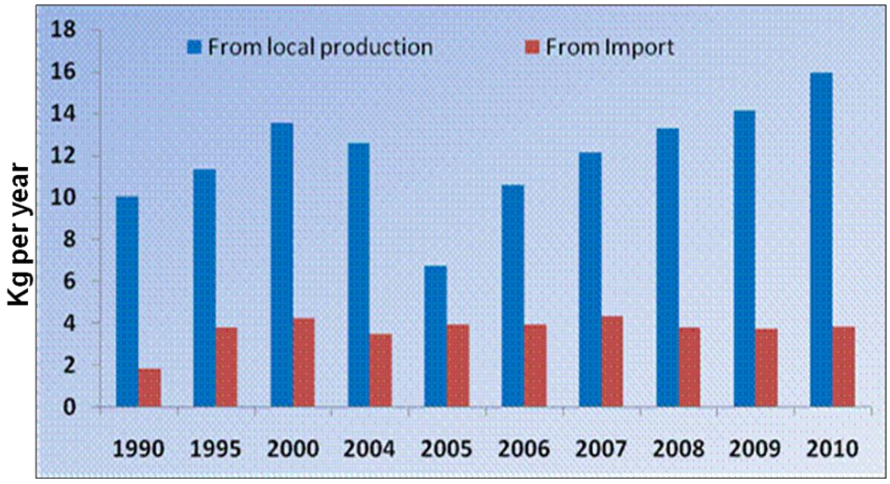


Figure 1.1: Fish Consumption Pattern of Sri Lanka from 1990 - 2010

In Sri Lanka, reservoir fishery as the main aquaculture activity practiced currently provides significant contribution to food and nutritional security especially of the rural areas in the interior regions of the country and has other benefits such as providing supplementary income for farmers by creating new job opportunities in the rural communities, and making available animal protein at affordable prices to avert malnutrition problem in the country.

Sustainable Inland Culture-Based Fisheries technology was favored by the MCDA process and ranked as the most promising adaptation options for Sri Lanka. This technology has been around for long periods and cost less to implement, but have not been fully utilized due to various constraints that exist in the operational/institutional area.

1.2.2 Objectives

- The primary objective of the project is to increase the livelihoods of 30,000 beneficiaries engaged in the production of inland culture-based fishery in 3,000 minor perennial (<100 ha at FSL) and small non perennial reservoirs (<20 ha at FSL) in the Monaragala, Hammbanthota, Anuradapura, Kurunegala, Vavuniya and Kilinochchi districts in the dry zone of Sri Lanka.
- To increase annual household incomes of beneficiaries by 100%
- To reduce pressure on land and introduce CBF as an alternative and supplementary source of income in the targeted rural communities.

1.2.3 Outputs of the proposed project

To achieve the targeted increase in production, the project will set up the following infrastructure:

- Five fish breeding farms with 2,000 m^2 tank area
- Ten hatcheries with 20,000 m^2 fry to fingerling raising operations
- Supply of 200 fishing vessels
- Provided fishing gear for CBF communities
- Improved marketing networks of inland fisheries

It will also produce the following;

- Manual of operations with guidelines on codes, standards and procedures
- Training manual on best hatchery management practices and fry to fingerling production
- Make available of extension materials for farmers and hatchery owners
- Status reports

1.2.4 Relationship to the country's sustainable development priorities

Mahinda Chinthana – Vision for the New Future is the Government of Sri Lanka's Ten Year Development Policy Framework[3]. The plan for the Fisheries and Aquatic Resources Sector 2007–2016 places high priority on inland fisheries and aquaculture production. It proposes to increase aquaculture production from 36,530 mt in 2006 to 74,450 mt in 2016, an increase of 104%.

The plan identifies the following strategies to develop culture-based fisheries in inland waters and to achieve this targeted increase in production:

- Increase fish production in minor perennial reservoirs and seasonal tanks through
- culture based fisheries;
- Increase Indian carp production through stock enhancement programmes in major and medium perennial reservoirs

Fish is the primary source of animal protein consumed in the country. The per capita fish consumption increased from 11.4 kg in 2009 to 15.7 kg within two years. The Ministry of Fisheries and Aquatic Resources Development expect to increase the per capita fish consumption to 22 kg by 2016 to eliminate malnutrition from the country.

As such, the project is in line with national interests and development priorities.

1.2.5 Project Deliverables

- The project will increase the production of culture-based fishery from the current level of about 5,400 mt to 9,000 mt in 10 years (by 2023)
- Culture based fishery will be introduced to 3,000 seasonal and minor perennial reservoirs with a cumulative surface area of 30,000 ha in the country
- To increase fish breeding centers and hatcheries and produce 75 million fingerlings within 10 years. (2013 -2023).
- Create 10 – 12,000 livelihoods in fish marketing.

[3] Mahinda Chinthana Policy Framework, 2005.

The main beneficiaries of the project will comprise of farmers who hold land and cultivate them under the minor irrigation reservoirs selected for project interventions. The village fishing communities, fish vendors will be the primary beneficiaries while those participants in the value chain such as transporters, ice suppliers, other service providers and retailers will also benefit from increased production.

Much of the project beneficiaries will come from very poor background as those who depend on seasonal minor tanks for a livelihood are among the poorest in the country. They farm very small holdings of rice and other food crop land and often subjected to vagaries of weather due to climate change and depletion of catchment forests due to clearing for other economic uses. Village women will have opportunities to increase their incomes by engaging in post-harvest activities such as fish drying and Maldives-fish making. Also, some project districts are in the areas where the residents come from ethnic Tamil minority whose livelihoods have been severely disturbed by damage from the Sri Lanka's civil war.

Development of SICBF in seasonal and perennial reservoirs provides job opportunities; ensure availability of fish for affordable prices as a protein source. The employment generated from seasonal village tank fish culture currently estimated to be around 6, 000 of which 13 percent are women (Siriwardena and Jayakody, 2003). Thus SICBF benefit to improve socio economic situation significantly of the poor sectors of the rural community. The project is expected to provide 30 days of additional work per year to 6,000 members from village fishery communities and part-time employment to 200 people in fish marketing and transportation etc.

Furthermore, Rearing of fish will require farmers to work together to make decisions about the fish-rearing calendar, protecting fish, harvesting etc thereby strengthening the collaboration among them. SICBF is an environmentally friendly activity because there is little or no manipulation of the environment due to adoption of SICBF. However, as it will enhance benefits derived by the local communities from village tanks, SICBF can encourage villagers to protect the surrounding forests that serve as catchments for the tanks and conserve water.

1.2.6 Project Scope and Possible Implementation

The CBF project will make use of the extensive network of minor perennial reservoirs and the seasonal (non-perennial) reservoirs in the dry zone currently used for irrigation purposes to increase culture based fish production. The technology has been successfully practiced with many tanks in the dry zone and the expansion is limited by the capacity to produce fingerlings which is addressed by the project.

In the recent decades, variability of the rainfall patterns is increased and as a result, water scarcity and timing have become a recurrent problem for ICBF in Sri Lanka. ICBF can be impacted by the timing of water availability and the issue can be solved if the fingerling production is coincided when the water is available for stocking.

1.2.7 Project Activities

Project activities are organized under 4 main components of actions, i.e. Expanding capacity, improving investments, marketing improvement and creating an enabling environment, and under each component activities are listed below.

A) Expanding Capacity:

1. Expand supply of fingerlings
2. Increase R& D and training facilities.
3. Prevent degradation of Water quality

B) Improving investments:

1. Enhance availability of financial resources
2. Improve investment risk insurance

C) **Marketing Improvement:**

1. Improve marketing infrastructure and price
2. Introduce product standards, codes and certification
3. Improve consumer preferences and overcoming social biases

D) Creating an Enabling Environment:

1. Improve Policy Coordination
2. Facilitate stakeholder participation in policy making

1.2.8 Timelines for Proposed Activities

The proposed timeline for implementation of proposed activities are provided in table 1.2.

Table 1.2: Proposed Timeline for Implementation of Proposed Activities of Project 1

	1	2	3	4	5	6	7	8	9	10
1. Expand supply of fingerlings										
2. Increase R&D and Training Facilities♣										
3. Prevent degradation of Water quality										
4. Enhance availability of financial resources										
5. Improve investment risk insurance										
6. Improve marketing infrastructure and price										
7. Introduce product standards, codes and certification										
8. Improve consumer preferences and overcoming social biases										
9. Improve Policy Coordination										
10. Facilitate stakeholder participation in policy making										

♣ Research will be undertaken in 2 phases, with the initial exploratory phase followed by a second phase comprising of projects screened for targeted outcomes.

1.2.9 Budget/Resource requirements

Realizing the target set out for the ICBF development requires undertaking a series of activities covering a range of complex activities that needs to be well coordinated. Therefore, the implementation of them has to be designed as a project implemented over a 10-year period. Requirements of technical assistance, physical developments and financing, operational, project management interventions for each of the key project components were estimated and costed individually to develop the budget.

It is envisaged that the Government will seek donor funds to undertake and finance major activities of the project that will be implemented under the Ministry of Fisheries. National and international technical expertise will be engaged to implement activities in which the agency capacity is limited.

The table below (table 1.3) shows the approximate costs of implementation using a project modality as discussed above:

Table 1.3: Approximate Cost for Implementation of the Proposed Activities of Project 1

Activity	Cost US $ million
1. Fingerlings production	10.00
2. R&D and Training Facilities	15.00
3. Financing and risk management	10.00
4. Consumer and producer awareness	3.00
5. Marketing Improvement	10.00
6. Improve Policy Coordination	1.00
7. Project Management	5.00
Total Cost	**54.00**

1.2.10 Measurement/Evaluation

The Logical Framework Matrix of the project will contain a detailed Performance Measurement Framework to track implementation progress and monitor and evaluate it during the course of the project life. Such an arrangement will permit identifying problems and undertaking necessary on-course corrections to remedy any problems. The monitoring framework will involve internal monitoring (quarterly) as well as periodic external evaluations (annual or bi-annual) to support the implementation process. End of project result evaluation will be undertaken and incorporated to a Project Completion Report.

1.2.11 Possible Complications/Challenges

Potential challenges to the project implementation will arise from disturbances relating to the natural environment as well as those activities connected to them, which will lower the capacity of the project to reach targets. Identifying such impacts early and undertaking necessary mitigation measures will minimize

disturbances to project implementation. The main anticipated challenges to the project implementation are given below;

a. Water availability: Water levels of minor perennial reservoirs and the seasonal (non-perennial) reservoirs which are used for SICBF depends on the rainfall received from two monsoons and inter-monsoons. Generally, 8-9 months optimum water retention period and 2-2.5 m depth of water at the water body is required for fish to reach marketable size. Unpredictable rainfall changes and changes in rainfall pattern may cause adverse impacts on the availability of water in the reservoirs which may affect on two main sectors of the ICBF; fingerling production and marketing as well as grow out period of the stocked fingerlings in seasonal reservoirs.

b. Scheduling Fingerling production: Climate factors such as temperature, day length modify the growth of fish and thereby can alter the length of the culture period and duration taken for fingerling production. Improved ability to predict changing climate parameters is necessary to understand the nature of such changes and to develop appropriate management techniques to attain improved performance of CBF.

c. Timely Availability of fingerlings: Fish fingerlings have to be made available from fish hatcheries and nurseries in required combination of fish species to stock the tanks at the correct time. Timely availability is critical to ensure right length of growing period to reach the required marketable size. The stocking period arrives soon reservoir is filled from monsoonal rains, and delays can reduce the length of growing period minimizing quality and quantity of harvest.

1.2.12 Responsibilities and Coordination

The Ministry of Fisheries would be the executing agency of the proposed project**. Implementing agency would be the National Aquaculture Development Authority** as the agency directly overseeing the subject and it will host the project. The project management arrangements will have coordination and decision making responsibilities involving all key stakeholders. The establishment of a **Project Steering Committee** under the chairmanship of the Ministry of Fisheries and membership of agency heads of key stakeholder organizations, and a **Project Management Committee** involving staff more closely involved with supervising field monitoring can provide the necessary guidance and troubleshooting.

List of other Stakeholders involved:

a. Ministry of Agriculture
b. Ministry of Agrarian Development
c. Department of Agrarian Development
d. Ministry of Irrigation and Water Resources
e. Farmer Organization
f. Universities – Wayamba, Kelaniya, Ruhuna
g. National Aquatic Research & Development Agency
h. Fisheries Societies

i. Community Based Organization
j. Central Environment Authority
k. Sri Lanka Standard Institute

1.2.13 List of References

1. Amrasinghe, U.S. & Weerakoon, D.E.M. (2008) Present status and future strategies for the management of reservoir fisheries in Sri Lanka. Paper presented at the planning meeting of regional project on Asian reservoir fisheries development and management, 14–16 January 2008, Network of Aquaculture Centres in Asia-Pacific, Bangkok.
2. http://www.naqda.gov.lk/fish_production.php
3. http://www.fisheries.gov.lk/English_link/Idiri%20Dekma_DOC.pdf
4. Siriwardena, P.P.G.S. and Jayakody, D.S. (2003) Aquaculture technologies and fishing practices of Sri Lanka. Report submitted to ICLARM on the Strategies and option for increasing and sustaining fisheries and aquaculture production to benefit poor households in Asia. ADB-RETA 5945 Project. Sri Lanka.
5. The National Fisheries and Aquatic Resources Policy, 2006.

1.3: Project Idea for Technology 2: Sustainable Land Management (SLM)

Restoration and Preservation of Highland Productivity Using Sustainable Land Management Practices to Increase Climate Change Adaptability

1.3.1 Introduction/Background

Land degradation problems of varying intensity are experienced in all 48 agro-ecological zones in Sri Lanka due to a variety of contributing factors. The pressure factors that cause land degradation are high population density (330 persons per km^2), low per capita land availability (0.13 ha arable land per head) and 33% of the labour force engaged in agriculture[4]. About 17% of the land area is comprised of hilly and mountainous terrain having steep slopes and narrow valleys that makes it highly susceptible to land degradation due to high rates of soil loss (over 100 tons/ha/yr in intensively cultivated land)[5]. Being a food deficit country there is a great deal of effort to increase domestic food production and the high dependence of rural populations on agriculture has driven to exploit agricultural land use as means of poverty alleviation.

[4] CBSL, 2011 & DC&S, 2002

[5] Upper watershed Management Project, Final Report, 1997

Land consists of not only the soil but also the associated natural resources such as water, vegetation, landscape, and microclimate that are components of a larger ecosystem. As the land is interconnected with other natural resources such as the air, water, fauna and flora, managing land well, in addition to guaranteeing food supplies, poverty reduction and socio-economic development it helps to protect environment and natural resources and facilitate to continue to accomplish ecological functions and services in a sustainable manner.

Land degradation is recognized as one of the most serious environmental problems in the country and occurs in all forty eight agro-ecological regions at different intensities. Degradation of land is a major cause of declining productivity and thereby lowering farmer incomes. Based on the information available from various sources, the degraded land are can be estimated to be over 240,000 ha of lowland cultivated to rice, about 100,000 ha of highland cultivated to other food crops and about 75,000 ha of plantation crop lands. It has been recognized that climate change will worsen the incidence of land degradation further threatening the stability of food supplies and viability of farming.

Sustainable land management (SLM) is identified as a climate change (CC) adaptation technology in the food sector because of the importance of sustaining healthy soil, habitat conservation and restoring degraded land in the country. Productivity of land is a key determinant in ensuring food security, alleviating rural poverty and hunger. Land degradation has already taken place to various degrees and the objective of sustainable land management should necessarily consider restoring such degraded lands while preventing further degradation of any non-degraded land to ensure continued ecosystem health and functions. SLM is not limited to engagement of appropriate technology in crop or animal husbandry, given that a host social and economic parameters influence the actual practice of good management. Therefore, prescribed SLM practices involve many institutional, knowledge building, coordination, legal, research and enforcement mechanisms.

1.3.2 Objectives

- Sustainable Land management Project will primarily aim to restore the fertility and productivity levels of agricultural land already deteriorated due to poor management and other natural and anthropocentric parameters. The specific target of the project is the restoration of the fertility status of 25,000 ha of highlands cultivated to other food crops and 15,000 ha of plantation crop lands from the stock of 175,000 ha from the two land categories of which the fertility status is deemed to have declined.
- The secondary objective would be to prevent degradation of land with good fertility status. It also involves maintaining the present fertility status of an unspecified area of non-degraded land allocated to food production by promoting good land management practices as the common standard and setting up the institutional structure necessary to ensure it.

1.3.3 Outputs of the Proposed Project

The key outputs of the proposed project will comprise of the following:

a) Training 25,000 farmers on SLM practices
b) Adoption of on-farm soil conservation, sloping agricultural land technology (SALT) etc in 35,000 ha
c) Issue grants, subsidies and other direct and indirect assistance to adopting selected SLM
d) Establish 5,000 ha of forest plantations in heavily degraded hilly areas
e) Promotion of crop-livestock integration and non- and off-farm enterprises for income generation
f) Arrange for granting of titles or long leases to land to those in the project area
g) Develop capabilities (GIS, databases etc) to provide information for planning and managing watersheds
h) Monitor sedimentation of reservoirs in the project area
i) Revise National land use Policy and Agricultural policy to include SLM
j) Set up District and sub-district SLM Coordination Committees

Relationship to the country's sustainable development priorities

Land degradation is one of the most critical problems affecting the economic development of Sri Lanka. The high demand has increased pressures on land resources and has resulted in a high level of degradation. It had been estimated that nearly one third of the land in Sri Lanka is subjected to soil erosion, the erodible proportion ranging from less than 10% in some districts to over 50% in others. Severe erosion takes place in the hill country on sloping lands under cash crops like potatoes, tobacco, vegetables, poorly managed seedling tea and chena cultivation[6].

Soil and water conservation and land productivity improvement are recognized as important policy priorities for Sri Lanka under various strategies for national and sectoral development. The National Agriculture Policy (2007) of the Ministry of Agriculture lists 3 areas relating to sustainable land management, i.e. Irrigation and water management, Land use and Soil conservation among the 22 Policy Statements and recommends specific actions relating to conservation and judicious use of land and water resources to translate policy in to implementation. Sri Lanka's Ten Year Development Policy Framework, the "Mahinda Chinthana – Vision for the Future", recognizes land productivity improvement as a key strategy for agricultural development and poverty alleviation. A "National Land Use Policy" was introduced by the Ministry of Lands and Land Development in 2007 that recommends stronger efforts to protect and improve land productivity.

The project contributes to the national goal to make progress on the national priority to improve productivity of agricultural land to improve food security for the nation and eliminate poverty, which remains a relatively difficult problem to solve in the rural areas where agriculture dominates.

[6] The State of the Environment, 2010

1.3.4. Project Deliverables

a) **Improved land productivity:** Improved land productivity leading to greater crop yields and production, increased opportunities for employment for farmers and agricultural labourers in the area. It will lead to declined poverty among farmers and improved growth in the local economy.

b) **Employment generation:** It is estimated that undertaking land improvements activities in farm such as removal of rocks and moving soil, cutting contour drains, leveling and grading, constructing stone terraces, planting live fences and cover crops, and the maintenance of conservation works will create substantial amount of employment for the farmer and family.

The women will be particularly benefitted by the creation of work opportunities in the own farm and the immediate neighborhood.

The plantation workers from the ethnic minority will benefit by finding additional employment opportunities created in the area. As many of them are engaged in home gardening and small scale cash crop production they will benefit both directly and indirectly.

c) **Reduction of GHG emissions:** SLM mitigates GHG emission contribution and increased carbon sequestration through reduction of fertilizer use by Site specific fertilizer programs, better management of farm yard manure combined with integrated plant nutrient management practices increase use efficiency of fertilizer and thereby increasing organic carbon content in soil and soil fertility. Best management agriculture practices provide the opportunity for carbon trading, and this can be used for income generation.

d) **Develop biogas for light and cooking in households:** .Enteric fermentation (bio digesters) of animal wastes to reduce CH_4 emissions and develop biogas for light and cooking in households. Strong social benefits here, also, due to lessened smoke inhalation in households, and cleaner living conditions.

(e) **Introduction of organic Agriculture:** Introduction of organic Agriculture for the fragile eco systems supplies safety food and encouraged green economy.

1.3.6 Project Scope and Possible Implementation

There have been a number of land and soil conservation projects targeting various regions in the upcountry funded by various donors such as the USAID, GTZ, ADB, FAO/UNDP and the World Bank[7]. Yet, the seriousness of the issue and the area under consideration is so large previous efforts and investments have not been sufficient to fully address the problem. There is a wealth of information about the appropriateness of various practices and the viability of different conservation measures which will serve to improve the knowledge base in quickly getting the project off to a good start.

The proposed project place a great deal of emphasis on building up to the learning from the previous experiences and also on institutionalizing the learning by adopting a strong participatory approach to implementation at the ground level and supporting mechanisms to internalize land management within the respective state and community organizations. Through this approach it is envisaged that the interventions

[7] Jayakody, et al. 2007, Gunawardena, 1998

introduced by the project will find greater ownership within the communities and institutions and continued beyond project period.

1.3.7 Project activities

The main activities of the project comprise of direct actions that assist in the implementation of the sustainable land management measures at the farm level and capacity building and coordination measures that support ownership creation and internalizing the project within the key responsible Ministries and Departments. The selected activities are listed below under associated key components of the project.

A) Increase Awareness and Priority for Sustainable Land Management

1) Raise awareness and knowledge on appropriate land management techniques
2) Develop land management methods for larger units
3) Introduce organic agricultural practices for the fragile eco systems
4) Promote land conservation as a national priority in agric and non-agric land uses

B) Improve Affordability of Adopting Sustainable Land Management

1) Introduce grants, subsidies, loans and other forms of assistance to practice SLM
2) Raise public and private investment on SLM research and development
3) Securing Land Ownership rights

Proposed Timelines for Implementation of Proposed Activities are given in the table 1.4 below.

4) Develop model SLM packages for diverse land, weather, soil, terrain, size and land formation classes
5) Introduce alternative livelihoods to reduce pressure on land

C) Build Institutional Capacity for Effective Enforcement of Land Management

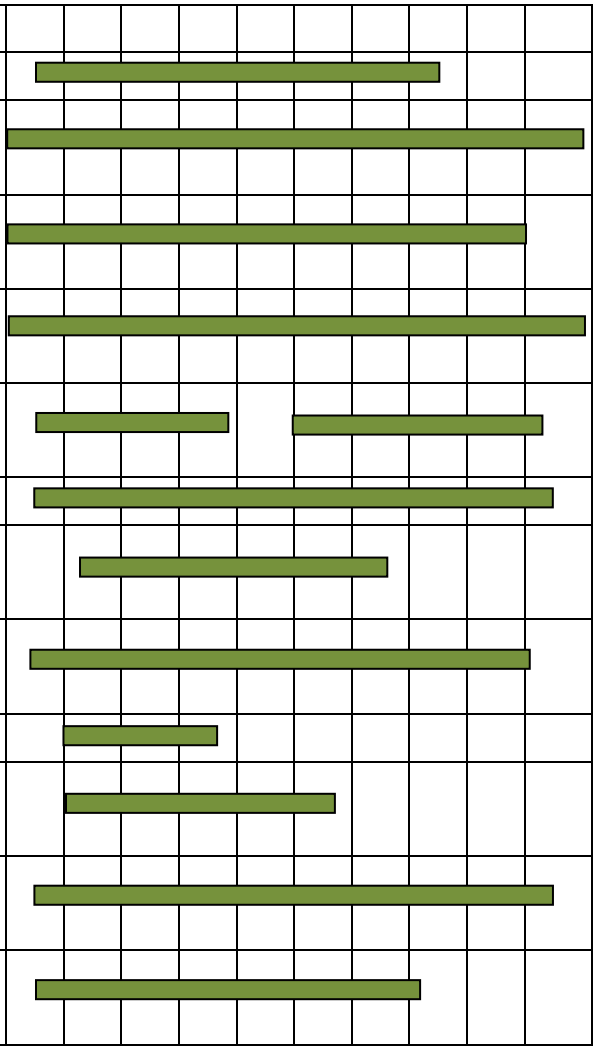
1) Review and update National Policies (National Land Use & National Agriculture Policy) to accommodate climate change aspects
2) Support to enforcement of land management policies, laws and regulations
3) Set up land use planning and independent system monitoring enforcement
4) Improve coordination among stakeholder organizations

1.3.8 Timelines for Proposed Activities

The proposed timeline for implementation of proposed activities are provided in table 1.3.

Table 1.3: Proposed Timeline for Implementation of Proposed Activities for Technology 2.

Activities	Year									
	1	2	3	4	5	6	7	8	9	10
1.Raise awareness and knowledge on appropriate										

land management	
2.Develop land management methods for larger units	
3. Introduce organic agricultural practices for the fragile eco systems	
4.Promote land conservation as a national priority in agric and non-agric land uses	
5. Introduce grants, subsidies, loans and other forms of assistance to practice SLM	
6. Raise public and private investment on SLM research and development	
7. Securing Land Ownership rights	
8. Develop model SLM packages for diverse land classes	
9. Introduce alternative livelihoods to reduce pressure on land	
10. Update land use policy and legislation	
11. Support to enforcement of land management policies, laws and regulations	
12. Set up land use planning and independent monitoring system	
13. Improve coordination among stakeholder organizations	

1.3.9 Budget/Resource requirements

The SLM in the upcountry project will be operated over a 7-year period introducing many of the support measures targeting beneficiaries from the first year. The returns to the project are slow and it is necessary to launch interventions and monitor implementation over a longer duration to derive the best outcome. The project is estimated to cost US $70 Million with most of the expenses incurred in supporting beneficiaries to implement interventions through a variety of financing mechanisms. It will be necessary for the Government to obtain development assistance as grants or loans to implement the project. The approximate budget estimate for the main project components of the proposed project is given in table 1.5 below;

Table 1.5: Approximate Budget Estimate for the Proposed Project 2

Main Activitiy	Sub Activities	Estimated Budget (US $ million)
1.Raise knowledge on SLM	Raise awareness and knowledge on appropriate land management techniques	3.00
	Develop land management methods for larger units	3.00
	Introduce organic agricultural practices for the fragile eco systems	2.50
	Promote land conservation as a national priority in agric and non-agric land uses	1.50
	Total	**10.00**
2.Increase affordability of SLM	Introduce grants, subsidies, loans and other forms of assistance to practice SLM	15.00
	Raise public and private investment on SLM research and development	10.00
	Securing Land Ownership rights	2.00
	Develop model SLM packages for diverse land, weather, soil, terrain, size and land formation classes	5.00
	Introduce alternative livelihoods to reduce pressure on land	8.00
	Total	**40.00**
3.Build capacity for SLM application	Review and update National Policies (National Land Use & National Agriculture Policy)—to accommodate climate change aspects	0.50
	Support to enforcement of land management policies, laws and regulations	4.50
	Set up land use planning and independent system monitoring enforcement	5.00
	Improve coordination among stakeholder organizations	1.00
	Total	**11.00**
1. Project Management		7.00
Total Cost		**68.00**

The project should target to develop co-financing opportunities locally through the commercial banks by making funds available for the implementation of the SLM interventions at the farm level. The sustainability of the project will depend on continued assistance through the availability of funds from the financial institutions for the farmers to introduce new measures or for the rehabilitation of aging structures. Co-financing models developed and implemented during the project will permit the financing institutions to develop capacity for internalizing assistance programs.

1.3.10 Measurement/Evaluation

The project specific Logical Framework Matrix (LFM) and the Performance Measurement Framework (PMF) will be used to oversee progress of implementation, monitor and evaluate it during the course of the project life. The project LFM and PMF permit identifying problems and undertaking necessary on-course corrections to rectify any problems experienced during the implementation phase. The monitoring framework will have scheduled internal monitoring events (quarterly) as well as periodic external evaluations (annually or bi-annually) to support the implementation process. End of project result evaluation will be undertaken and incorporated to a Project Completion Report.

1.3.11 Possible Complications/Challenges

There are potential difficulties to achieving project targets due to factors that are not well within the project's ability to influence. Two of the important issues relate to the fertilizer subsidy programme implemented by the government and the prices of agricultural commodities which may not provide predictability and guarantee remunerative prices to producers.

Fertilizer subsidy – The subsidy given to fertilizer has encouraged farmers to rely solely on inorganic fertilizers to obtain higher yields. This has also led to unbalanced use of nutrients with higher application of nitrogenous fertilizer. More disturbing is the fact that this has dissociated farmers from applying organic fertilizers such as FYM manure and compost which are important in improving the soil properties that reduce erosion and nutrient depletion. Thus, the fertilizer subsidy has operated in a manner detrimental to adoption of some of the important soil conservation measures. Continued provision of fertilizer at the current subsidized rate will make it harder to encourage application of organic fertilizer of which the importance in protecting and improving soil productivity as or more important than nutrient supply. Educating farmers to adopt balanced fertilizer and add organic material to retain long term productivity of soil has been a challenge.

Low and unstable agricultural prices – Returns to undertaking soil conservation measures depend on crop prices as reasonable return on investment is necessary to encourage continued adoption of conservation measures and sustainable practices. However, declining and variable prices of agricultural commodities is a challenge to make farmers think of the long term. Due to unsteady trade and marketing policies and poor

production coordination prices of many agricultural commodities that bring a higher income to farmers such as onion, potato, chilli, and even rice have been too volatile to give farmers a good income.

Slow Progress in Policy Reform – The project envisages significant reform in policies pertaining to land management and the participation of many agencies in developing and implementing policy. There can always be resistance to reforming policies from institutions who feel that their sphere of influence is diminished by new policy. Such agencies get in the way of reform and delay progress. The project must be aware of the prospect and adopt counter measures to bring all on board with a better understanding and agreement on the purpose.

1.3.12 Responsibilities and Coordination

The **implementing Ministry would be the Ministry of Agriculture,** directly overseeing the subject and will host the project. The project management arrangements will have coordination and decision making responsibilities involving all key stakeholders. The establishment of a **Project Steering Committee** under the chairmanship of Ministry of Agriculture with other key stakeholder organizations would oversee project implementation A **Project Management Committee** involving staff closely involved with supervising implementation and monitoring can provide the necessary guidance and troubleshooting.

List of other Stakeholders:

a) Ministry of Lands and Land Development
b) Ministry of Plantation Industries
c) Ministry of Disaster Management
d) Ministry of Irrigation and Water Resource Management
e) Department of Agriculture
f) Sri Lanka institute of Nano-technologies

1.3.13 List of References

1. Gunawardena, E.R.N.1998. Impacts of land use changes in reservoir catchments on runoff generation: Consultancy report submitted to the International Water Research Institute, Colombo.
2. Jayakody, A.N., Wanigasundara, W.A.D., and Gunawardena, E.R.N. 2007. Monitoring and Evaluation of Soil conservation and Watershed Management Projects. (Ed: J.D. Graff, J. Cameron, S. Sombatpanit, C. Peiri and Wood Hill). Science, Publisher, U.S.A. 163-178.
3. National Land Use Policy in Sri Lanka, 2007.
4. National Agricultural Policy, 2007.

1.4 Project Idea for Technology 3 - Crop Diversification & Precision Farming (CD&PF)

Crop Diversification and Precision Farming in Dry Zone of Sri Lanka for Managing Climate Change Vulnerabilities, Livelihood Sustainability and Food Security

1.4.1 Introduction/Background

Agriculture is the main source of livelihood for more than 70% of the population living in rural areas of the country. Contributing 11.2% to the country's GDP, accounting for 17 % of all export revenue, employing 30% of the total workforce, and supporting 21 million people directly or indirectly, food sector is vital to Sri Lanka's economy and the livelihood of its people[8]. In Sri Lanka, the contribution to the GDP comes from agriculture, predominantly from crop production which accounted for 79% of the 11.2% GDP share in 2011. In comparison, the respective contributions from livestock, and fisheries sectors were 14% and 7%.
The Government of Sri Lanka has placed high priority on achieving self-sufficiency in rice, the staple food. The country has made significant progress towards this goal by increasing domestic rice production. Irrigated areas in the dry zone are the most important source of increase in production. However, this has not necessarily assured food security as rainfall variations have failed to guarantee an adequate stock of water in certain crop seasons to irrigate all the area planted to rice. This requires building system flexibility to be adaptable to change cropping patterns to suit water availability.

Also, attaining food security extends well beyond increasing rice supply. With urbanization and income growth food consumption patterns are shifting from cereal from non-cereal food (pulses, edible oil, fruits, vegetables, dairy and other livestock, and fishery products). Therefore, supply of these commodities which are currently in short supply also helps to address food security and nutritional goals.
Fortunes of the agriculture sector are also tied up with the success of poverty alleviation in Sri Lanka, which remains predominantly a rural phenomenon in regions dominated by agriculture. Majority of the poor are relying on agriculture for an income the level of which cannot be significantly increased due to the small size of the agricultural holding. This requires farmers to look for more remunerative crops other than rice, which can bring a greater income. Crop diversification to introduce in to the crop mix of the farmer more cash crops, for which there is an increasing demand from the consumer, is one option available to increase incomes above poverty levels.

Agricultural production is adversely affected by climate change and the livelihoods of those depend on agriculture will be at risk from it. CC related impacts on food supply will affect food security of even greater number of people. Arable land area is becoming scarcer making it even more difficult to provide adequate

[8] Central Bank of Sri Lanka, 2011

food production for the nation and incomes opportunities for farmers. This has compelled to look for ways of increasing production and incomes from a diminishing natural resource base.

Potential negative consequences from climate change on agricultural production have generated a desire to build resilience into agricultural systems while moving towards goals of food and nutritional security and poverty alleviation. Increased agricultural diversification and precision farming provides a means to achieve both within agriculture, while other options outside agriculture are pursued.

1.4.2 Objectives

The proposed project will aim to convert about half of the available land, i.e. 40,000 ha of the marginal rice lands and 50,000 ha of the area facing water shortage, to other food crop cultivation including both seasonal crops and perennials. The diversified area will also include crops adopting precision farming techniques such as drip irrigation, micro-sprinklers, and other automated systems for the cultivation of high-value crops.

1.4.3 Outputs of the Proposed Project

The outputs of the project will be delivered in the form of commodities, i.e. intermediate goods such as crop varieties and final goods such as crop production, and services such as improved policy, better market data and enhanced coordination. The key outputs are listed below under main types of interventions:

a. Increased Production of Diversified Crop and Livestock products:

- New varieties of crops and cultivation practices- Four drought and flood resistant varieties and four management packages
- New animal breeds and management packages- Two temperature resistant breeds and management packages accordingly
- Irrigation network restructured to favor diversified crops- Irrigation net work restructured to prepare 9000 ha per year for crop diversification and precision farming techniques
- Post harvest and processing infrastructure installed-
  Develop 10 appropriate cold chain and cold storage facilities for 500 mt capacity
  Develop food processing and post harvest technologi es support product promotion
  Establish storage facilities for 30,000 mt of Onion/Grains

b. Institutional Reform:

- Procedures to reduce fragmentation of land holdings- New land titling and tenancy legislation introduce within 5 years to favour land consolidation
- Improved marketing system with increase integration of rural markets- Introduce at 10 locations
- Market information system providing timely and accurate data

c. Improved Policy Coordination:

- Diversification friendly Land tenancy procedures
- More predictable import policy

1.4.4 Relationship to the Country's Sustainable Development Priorities

Increasing domestic food production to achieve high levels of self sufficiency in major food commodities demanded by the consumer is the key strategy adopted by the government. The "Mahinda Chinthana – Vision for the New Future", the Government of Sri Lanka's Ten Year Development Policy Framework assigns very high priority to domestic production as a means of improving national food security.

Number of programmes have been introduced and operated by the Government over the last 6 years to achieve food security through self sufficiency. The "*Api Wawamu, Rata Nagamu* – Let us Cultivate and Uplift the Nation, 2007-2010" was the apex of these efforts with the domestic production accelerated

ahead of the world food crisis of 2008. This has been followed up with the introduction of new initiatives such as "*Divi Neguma",* a special home gardening program. These special programs aim to increase household food production through the distribution of high yielding seeds, training, technical assistance and credit. *Divi Neguma* aims to strengthen economic status of households and food security by minimizing their dependence on the market for food.

1.4.5 Project Deliverables

The benefits of the project will accrue to all citizens in the forms of increased availability of domestic food products at reasonable prices. As the actual extent of different types of crops planted and dairy production undertaken will depend on the market situation it is difficult to quantify production by individual commodity.

Crop and Livestock products:
Increased production of other food crops – Onion, Chilli, Pulses, Feed crops
Animal Products – Milk and milk products, poultry and goat
Processed food products – Ready-to-eat and other value added food

Services:
Fragmentation of land holdings prevented
Improved marketing system
Rural markets better integrated to Regional and Central markets
Improved Market information system
Modified land tenancy procedures
More predictable import policy

The main beneficiaries: The main beneficiaries of the project are farmers in the dry zone whose livelihoods face climate risk in addition to generally depressing economic conditions that has driven many of them to poverty. The low output and volatile market prices was making it quite challenging to lift out of poverty those depend on agriculture-based livelihoods for a major income. The unpredictable weather conditions were making it even more difficult. The Government was resorting to various forms border protection measures to safeguard incomes of domestic producers thus driving prices up, making consumers pay more. Therefore, domestic production bolstered by increased productivity should make prices more affordable to the consumer while guaranteeing a remunerative price to the producer.

The environmental benefits: The environmental benefits of the project will be quite significant as the technologies would permit efficient crop production in areas that may be abandoned in the absence of new technologies raising productivity. The net effect on GHG emissions, contribution to atmospheric warming and increasing system resilience will have favourable environment outcomes.

Employment opportunities: Increased production and value addition through post harvest will expand employment opportunities thus making more remunerative employment available to women and youth. The precision agriculture methods using developments in the high tech agriculture will make appeal to the educated youth encouraging them to engage in agricultural vocations. More youth will also find employment in the service sector, supplying, operating and maintaining farm equipments employing new technology.

Development of partnerships: Precision farming employs new developments in technology that makes it more appealing for the private sector to engage. Most of these innovations reach the market as proprietary products. Thus, the private firms will be keen to support new high-tech crop and livestock research and develop partnerships with significant new funding.

1.4.6 Project Scope and Possible Implementation

Given agriculture's importance in creating rural livelihoods and reducing poverty, the project has widespread national implications. The reduction in rural poverty can reduce pressure for expansion of agriculture into more marginal lands, where such expansion is led by poor or landless migrants. Other strategies of rural poverty alleviation can reduce those types of land degradation that are due to inadequate investment resources or to unsustainable survival strategies of the poor during droughts or other economic downturns. Finally, rural economic diversification can provide alternative livelihood sources, reducing dependence on marginal farmlands or generating resources for investment in land improvements or both.

The sustainability of the project is rated high as it concurrently addresses two key issues; the low income problem in farming adapting to climate change. Also, the project has immediate application to the area facing identical challenges but does not become a part of the project. Therefore, the scaling up potential can be rated high.

1.4.7 Project activities

The main activities of the project comprise of the following:

1. Develop and introduce new varieties of crops and cultivation practices
2. Develop and introduce new animal breeds and management packages
3. Restructuring of irrigation network to favor diversified crops
4. Develop/Improve post harvest and processing infrastructure
5. Modify the legal framework to favour land consolidation
6. Improve marketing system with increase integration of rural markets
7. Develop marketing information and price reporting system

8. Introduce and implement diversification-friendly land tenancy procedures
9. Introduce more predictable import policy

1.4.8 Timelines for the Proposed Activities

The proposed timeline for implementation of proposed activities are provided in table 1.6.

Table 1.6: Proposed Timelines for Implementation of Proposed Activities of Project 3

Activities	Year									
	1	2	3	4	5	6	7	8	9	10
1.New varieties of crops and cultivation practices										
2.New animal breeds and management packages										
3. Restructuring of irrigation network to favor diversified crops										
4.Develop/Improve post harvest and processing infrastructure										
5.Amend the legal framework to reduce fragmentation of land holdings										
6.Improved marketing system with increase integration of rural markets										
7.Market information system providing timely and accurate data										
8.Diversification-friendly Land tenancy procedures										
9.Introduction of more predictable import policy										

1.4.9 Budget/Resource requirements

The project will have a budget of US $ 60 million and will be operated over a 10-year period. The project can get off to a fast start as there already are many technologies that can be introduced quickly. It will make available a variety of financing mechanisms to introduce the new Precision Agriculture technologies to a large group of beneficiaries quickly.

Given the scale of the project it will be necessary for the Government to obtain development assistance as grants or loans to implement the project. The approximate budget estimate of the proposed project is given in table 1.7 below;

Table 1.7: Approximate Budget Estimate for the Proposed Project 3

Main Activitiy	Sub Activities	Estimated Budget (US $ million)
1. **Increased Production of Diversified Crop and Livestock product**	New varieties of crops and cultivation practices	7.00
	New animal breeds and management packages	5.00
	Irrigation network restructured to favor diversified crops	10.00
	Post harvest and processing infrastructure installed	8.00
	Total	**30.00**
2. **Institutional Reform**	Procedures to reduce fragmentation of land holdings	0.50
	Improved marketing system with increase integration of rural markets	10.00
	Market information system providing timely and accurate data	3.50
	Total	**14.00**
3. **Improve Policy Coordination**	Diversification friendly Land tenancy procedures	8.00
	More predictable import policy	2.00
	Total	**10.00**
2. Project Management		6.00
Total Cost		**60.00**

1.4.10 Measurement/Evaluation

The project design will follow a Results-Based-Management framework developing a Logic Framework Matrix (LFM) and a Performance Measurement Framework (PMF) that internalizes tracking implementation progress and monitoring. Such an arrangement will permit identifying problems and undertaking necessary on-course corrections to remedy any problems. The monitoring framework will involve internal monitoring (quarterly) as well as periodic external evaluations (annually or bi-annually) to support the implementation process.

1.4.11 Possible Complications/Challenges

There are areas that may raise challenges to the implementation of the crop diversification and precision farming project. One potential complication is in getting the policies reformed, which is usually an area that see a lot of institutional resistance. The other relate to timely supply of inputs, particularly seed and planting material.

Policy reform: The project proposal envisages reform in institutional arrangements relating to irrigated cropping patterns, trade and marketing and land tenancy that require broad reform in agency policies and practices in these areas. It is very likely that reaching agreement to implement some of these changes will be a difficult task as changing practices held for long years would be resisted. For example land tenancy legislation is archaic to serve purposes of today's agriculture, but held sacrosanct by some elements, who are motivated more by emotions than reality. Similarly, restructuring of the irrigation water delivery systems for greater flexibility requires innovation and boldness that is not witnessed in bureaucracies.

Availability of adequate suitable Seeds and planting materials: Being able to implement the crop diversification assumes availability of a wide range of seeds for the farmer. In the absence of a market-driven seed supply system in the country it is difficult to expect that seed supplies would be met by the market. This requires the project to undertake the responsibility of ensuring supply quality seed of varieties required. This can be a challenge as seed producers may demand numerous guarantees to make the seed available for the initiatives promoted by the project.

1.4.12 Responsibilities and Coordination

The **implementing agency would be the Ministry of Irrigation** as much of the land will be directly under the command of the Ministry. However, the implementation of the project requires close support and collaboration with the Agriculture and Agrarian Development Ministries. A Project **Steering Committee** arrangement with the Secretaries of the 3 Ministries alternatively chairing the PSC would be helpful to ensure ownership and follow up. A **Project Management Committee** involving staff more closely involved with supervising project implementation and monitoring can provide the necessary guidance and troubleshooting.

The responsible agencies will comprise of the following:

1. Ministry of Agriculture
2. Ministry of Agrarian Development
3. Ministry of Fisheries and Aquatic Resources Development
4. Ministry of Irrigation and Water Resource Management
5. Ministry of Co-operatives & Internal Trade
6. Ministry of Livestock Development

7. Ministry of Land and Land Development
8. Ministry of Traditional Industry & Small Enterprise Development
9. Department of Agriculture
10. Department of Agrarian Development
11. Department of Irrigation

1.4.13 List of References

1. Annual Report. (2011). Central Bank of Sri Lanka, Colombo.

CHAPTER 2

Project Ideas for Health Sector

2.1 Brief summary of the Project Ideas for Health Sector

Climate Change and its ill effects on human health are now clearly identified (WHO, WMO, UNEP; 2007). The governments of countries are in the process of planning to implement measures to prevent and minimize the adverse effects of climate change on human health with the assistance of United Nations and other technically conversant agencies. As the health sector does not emit or facilitate sinks of GHGs, only adaptation measures can be identified and implemented. In this endeavour, the Climate Change Secretariat of the Ministry of Environment is providing assistance to projects to be implemented by five sectors in Sri Lanka to adapt to the adverse effects of Climate Change. The process of development of activities related are identified as the TNA (Technology Needs Assessment) which is supported by the UNEP/GEF. Health is one sector considered as a priority in this enterprise.

The Climate Change affects the health of the humans directly as well as indirectly. The common direct health effects are, vector, including rodent and water borne diseases (Malaria, Dengue, Yellow fever, leptospirosis, viral haemorrhagic diseases and diarrheal diseases including Cholera). Then there are conditions associated with extremes of temperature; heat waves and cold spells. The effect of natural disasters and extreme weather events causes many health effects on humans; some are immediate and others late. The immediate health effects are death and injury. Late ones are disability, communicable diseases, psycho-social problems etc. On the other hand, protracted or sudden weather events indirectly affect human health through crop failure, loss of live stock, livelihoods etc. Therefore, it is imperative to identify strategies and to implement suitable technologies to reduce human suffering.
The Project Ideas were developed through the process of discussions with the stakeholder group. Additionally some important individuals were also interviewed and available resources were also referenced.

Chapter 2 of this report outlines the proposals for the three project ideas developed based on the 3 prioritized technologies for the health sector.
The table shows proposed projects for each of the three prioritized technologies:

Technology	Project Idea
1. Technology for Early Warning Systems and networking for information exchange on	Strengthening the existing health sector Early Warning Systems through networking and linking

Extreme Weather events and other climate change related events	with other sectors and training of health personnel on EWS to adapt to adverse health effects of climate change
2. Transfer of knowledge and skills to Health Personnel	Capacity building of health personnel to improve performance with regard to climate change related adverse health effects
3. Technology for management of Healthcare Waste	Improvement of Health Care Waste Management in all health institutions, to minimize the effects of climate change related adverse health effects

2.2 Project Idea for Technology 1: Technology for Early Warning Systems and networking for information exchange on Extreme Weather events and other climate change related events.

The Project Idea:

'Strengthening the existing health sector Early Warning Systems through networking and linking with other sectors and training of health personnel on EWS to adapt to adverse health effects of climate change'

2.2.1 Introduction/Background

The activities of the Project Idea will be implemented in the island nation of Sri Lanka, located in south Asia. The project idea; *'Strengthening the health sector early warning mechanisms through networking with available EWS system, training of health personnel and linking with other sectors*' is a combination of sub-actions recognized in the Technology Action plan for priority Technology-1: '***Technology for Early Warning Systems and networking for information exchange on Extreme Weather events and other climate change related events'***

The Project Idea is for the entire island of Sri Lanka. The Central location will be the Focal Unit of the Ministry of Health and other settings will be at sub-national levels.

An Early Warning System which is in existence in Sri Lanka presently has many lapses. The main agency responsible is the National Disaster Management Centre (NDMC. 2005). Though the Health sector has a dedicated unit for Disaster Preparedness and Response Unit, the linkages with other sectors and intra-sector is poor. Moreover, there is no established links with other relevant sectors e.g. Meteorological Department, Mass Media, Mines Bureau. As a result other sectors do not get the health information in a timely manner and vice-versa. The finances provided for improvement of existing systems of EWS and

establish linkages are also not sufficient and one sub-action of this Project Idea is to explore avenues and to solicit more assistance from the government and other development partners through advocacy.
Though the preventive health workers possess some knowledge and skills, in Early Warning Mechanisms, especially to detect communicable diseases, the concept has to be expanded to non-communicable diseases, injuries, and other important health issues as well.

Next is the knowledge and skills among the health personnel on EWS. This is poor among the hospital care givers compared to preventive health workers. The general understanding is the EWS is only for hydro–meteorological and other disasters or emergencies but not for health. Early detection of cases with communicable diseases, and other impending adverse health events, proper information relaying through existing HIS is essential to control out breaks e.g. Dengue, injuries. Therefore, a sub-action included in this Project Idea to provide necessary knowledge and skills to health people.
Another important aspect is to establish a focal unit and a person in the ministry of health. Additionally focal points shall be identified, trained and positioned down to lowest levels of health institutions and a network shall be established for information exchange to prevent delays.
Furthermore, the proposed Project Idea identifies the need for research and development to discover feasible, appropriate and affordable EWS technologies to be implemented to ensure sustainability over time.

2.2.2 Objectives

- To establish a network in the health sector and between other sectors for information sharing within three years covering 70% of districts and all other sectors at the central level
- To provide training, enhance knowledge and skills to health personnel for the purpose of proper functioning of EWS to 60 % health workers in eight years
- To promote R & D to ensure sustainability of aforesaid objectives in three years

2.2.3 The Measurable outputs

- A functioning network made available at the end of three years, which is an expected output
- A focal point and a unit established in the ministry of health along with focal points at all levels of the health sector, which is a measurable output
- Training curricula developed and implemented.
- Health personnel trained at all levels over a period of eight years.
- R & D activities conducted, number of R & D findings disseminated to all relevant institutions in three years
- Regular policy, legislation and regulations analyses for climate change related Disaster Management is conducted and required adjustments done.

2.2.4 Relationship to the Country's Sustainable Development Priorities

Climate Change affects human health adversely in many ways, which is a well known fact. The early identification of adverse health issues is imperative as a diseases and disability free society is an integral element of healthy nation which is essential for sustainable development. In other words health of a nation is directly proportional to sustainable development.

"*Mahinda Chintana* – Vision for the New Future", the Government of Sri Lanka's Ten Year Development Policy Framework assigns very high priority to health sector. It emphasizes excellence in healthcare to be achieved through the provision of patient-focused, comprehensive and high quality service. Private sector involvement in the healthcare network will be encouraged under a well-regulated system in order to provide high quality and safe healthcare services. Furthermore, in Mahinda Chintana 2010, it is stressed that the necessary policy changes for the Central Environmental Authority to work in collaboration with the Ministry of Health to tackle issues in the spread of diseases due to the increase of environmental pollution and Global Environmental Changes.

Therefore, health of the nation is essential for the development of a country. EWS provides important early signals of impending adverse health effects which helps to prevent mass scale health problems.

2.2.5 Project Deliverables

- A functioning and linkages of EWS with other sectors made available by the end of the project period
- Report on training and skills development needs assessment made available at the end of the initial year
- Training curricula for training and skills development of the health personnel will be made available at the end of the first year
- A national focal point and a unit will be established and focal points in the provinces, districts and divisions will be established at the end of three years,
- R & D reports on feasible, affordable and sustainable reports will be made available at the end of three years
- Health personnel in all districts will be trained by the end of eight years
- Policy, legislation and regulatory dialogue reports will be made available at the end of each project year

2.2.6 Project Scope and Possible Implementation

The scope of the project idea is to strengthen the mechanisms available in the Health Sector to predict and identify impending health emergencies through, training of health personnel of the public health sector

(which include systems practiced in Sri Lanka other than Allopathic medicine) with the aim of preventing and mitigating adverse health effects of Climate Change. The project intends to establish a network to connect different administrative levels of health institutions through feasible, affordable and sustainable mechanisms. Additionally, to link the existing government EWS to health network to share information reliably and timely.

The main concept in this venture is to solicit the support of policy makers through advocacy. The boundary of the proposed project does not go beyond the effects of climate change; the endeavor is strictly a confined one to the EWS linked to Climate Change and related extreme events.

2.2.7 List of Project activities

1. Assessment and implementation of suitable and sustainable networking methods
2. Establish a functioning national focal unit and a linked focal points and functioning network at all administrative levels with instructions to report to the Officer in-Charge (National, Provincial, and District)
3. Research, identification and implementation of appropriate and affordable technologies
4. Train personnel to use the technologies to be used, including training needs assessment, preparation of training modules, pre-testing, identification of health personnel to be trained and trainers
5. Promote R & D in new innovations to be implemented for EWS
6. Carry out an analysis and identify reasons for underutilization of available human and physical resources and find lasting solutions to rectify issues

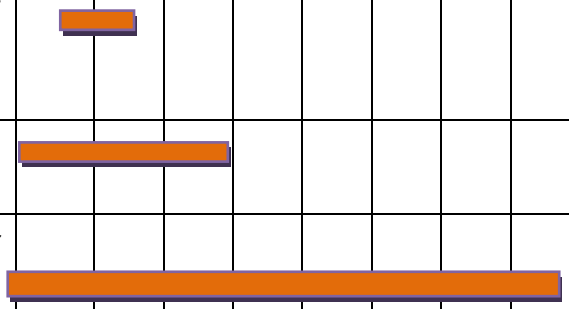
The proposed project is to be completed in 8 years. Some sub-activities will be done concurrently.

2.2.8 Timelines for Activities of the Proposed Project

Table 2.1: Proposed Timelines for Implementation of project activities

Activity	Time in Years							
	1	2	3	4	5	6	7	8
1. Assessment and implementation of suitable and sustainable networking methods								
2. Establish a functioning national focal unit and a linked focal points and functioning network at all administrative levels with instructions to report to the Officer in-Charge (National, Provincial, and District)								
3. Research, identification and implementation of								

appropriate and affordable technologies	
4. Train personnel to use the technologies to be used, including Training needs assessment, preparation of training modules, pre-testing, identification of health personnel to be trained and trainers	
5. Promote R & D in new innovations to be implemented for EWS	
6. Carry out an analysis and identify reasons for underutilization of available human and physical resources and find lasting solutions to rectify issues	



2.2.9 Budget/Resource requirements

Table 2.2: Approximate Budget Estimate for the Proposed Project

Activity	Budget (US$)
1. Assessment and implementation of suitable and sustainable networking methods	10,000
2. Establish a functioning national focal unit and a linked focal points and functioning network at all administrative levels with instructions to report to the Officer in-Charge (National, Provincial, and District)	16,000
3. Research, identification and implementation of appropriate and affordable technologies	10,000
4. Train personnel to use the technologies to be used, including Training needs assessment, preparation of training modules, pre-testing, identification of health personnel to be trained and trainers	28,000
5. Promote R & D in new innovations to be implemented for EWS	40,000
6. Carry out an analysis and identify reasons for underutilization of available human and physical resources and find lasting solutions to rectify issues	2,500
Subtotal: Total cost of project activities	**106,500**
7. Administrative cost	10,650
TOTAL	**117,150**

The required amounts of finances will be obtained through government, other domestic sources and international partners. The activities of the project will be mainly funded by international agencies. The estimated cost of project activities would be $US 106,500. Project management cost will be 10% of the total project cost; $US 10,650. The total cost of the project including the administrative cost will be around

$US 117,150. Co-financing opportunities will be explored with private sector and other interested parties, The EWS in general provide inputs to all aspects of development including industries and services,

2.2.10 Measurement/Evaluation

The progress of activities under the project idea will be monitored quarterly basis by the implementing agencies through the existing monitoring mechanisms. The expert group entrusted with the evaluation (external evaluation) and progress assessment would be carried out at periodic intervals during the project period (annually or bi-annually) and the lessons learnt would be recorded and shared with all relevant parties. The necessary alterations and changes in plan of action will be done accordingly

2.2.11 Possible Complications/Challenge

- EWS may not be an urgently needed project if there are other burning issues. Some other need may become a priority which will decrease the level of interest of the policy makers.
- HRH issues: recruitment, retention, specifically in underserved and geographically vulnerable areas.
- Breakdown of the systems due to unexpected catastrophe may be a complication as well as a challenge

2.2.12 Responsibilities and Coordination

The proposed project activities will be coordinated by the National Focal Unit at the Ministry of Health and the **Ministry of Health will be responsible for the implementation of the Project** activities.

There are twenty five administrative districts in Sri Lanka. In each of this districts there is a coordination committee headed by the Government Agent and supported by a coordinator appointed by the National Disaster Management Center of the Ministry of Disaster Management. All sectors; Health and Hospitals, Education, Telecommunication, Water-supply, Electricity, Military, Police, Fire Department, Social Services, Local Government Agencies, NGOO, UN agencies are represented at their regular meetings. They are inter-linked in many ways; share information, prepare preventive plans, mitigation activities, Emergency Preparedness Plans, prepare contingency plans, sector specific plans and act cohesively in an emergency. They share information with the National authorities when and where necessary. Therefore, it is not only a health specific EWS system but an inter-sectoral link which is necessary to share information for immediate action. There are many short comings in the health sector and the idea of this proposal is to strengthen the EWS in the health sector to overcome the impending issues. Similarly, at the National level the Ministry of Health will have to take the lead in health related EWS activities with the other sector

representatives. The sub-national focal points will be responsible for organization of the implementation activities at their level with the support of the national counterpart.

The National focal point would be coordinating with the other sectors at National level and the sub-national inter-sector coordination to be done by the sub-national focal points.

The National and sub-national coordination will be maintained through the net work established. At all levels the Focal points will report on the progress of activities to their respective heads.

2.2.13 List of References

1. A participatory concept paper for the design of an effective all hazard public warning system, National Early Warning System Sri Lanka, LIRNEasia, March 2005
2. CIA world Fact Book; available online at https://www.cia.gov/library/publications/the-world-factbook/geos/ce.html [Accessed on 25th of November, 2012]
3. Climate Change and Human Health, *Risks and Responses,* Summary: WHO, WMO, UNEP; 2007. (ISBN 92 4 159081 5)
4. Disaster Management Centre, Government of Sri Lanka, *Multi Hazard Early Warning Systems*, Road Map for Disaster Risk Management,2005:24-30 (supported by UNDP)
5. Glantz M.H., Usable Science: Early warning systems: Do's and Don'ts, Report of workshop, 20-23 October, Shangai, China, 2003.
6. Grasso V.F., Beck J.L., Manfredi G., Automated decision procedure for earthquake early warning, Journal of Engineering Structures, 2007, in press.
7. Tubtiang A., ICT in pre-disaster awareness and preparedness, presented at the APT-ITU Joint Meeting for ICT role in disaster management, Bangkok, 28 February, 2005.

2.3 Project Idea for Technology 2: Transfer of knowledge and skills to Health Personnel

The Project Idea: *'Capacity building of health personnel to improve performance with regard to climate change related adverse health effects'*

2.3.1 Introduction/Background

The activities of the Project Idea were developed as the ultimate result of the working-group meetings for health of the TNA Project. Initially the technologies were identified and prioritized. Then the barrier analysis and enabling framework were developed to identify the measures required to overcome the barriers for implementation of technology. Finally Technology Action Plan was developed, which proposed the actions to achieve the objectives of the Technology-2. The Project Idea was a follow up step of the Technology Action Plan. In addition to the deliberations of the working-group, key personnel were interviewed, available scientific materials were referred and inputs from focus group discussions conducted with health personnel and community groups were also considered in developing the Project Idea.

The adverse effects on human health are serious according to the currently available evidence. Some health effects are direct and others are indirect. Some are acute and others are chronic in nature. The theme of the World Health Day of 2008 was 'climate change and its impact on global health'. It emphasizes 'as the threat of climate change poses to health is evident and if current global warming trends remain uncontrolled, humanity will face more injury, disease and death related to natural disasters and heat waves; higher rates of food borne, waterborne, and vector-borne illness; and more premature deaths and disease related to air pollution. Moreover, in many parts of the world, large populations will be displaced by rising sea level and affected by drought and famine.

With this growing impact of climate change, impact on health, the need for increased numbers of skilled, motivated and facilitated health workers is greater than ever. The most urgent need for increased numbers of health workers is in developing countries. Equally, climate change will hit developing countries hardest as high levels of poverty and malnutrition, weak health infrastructures and/or political unrest will be the least able to cope. We must acknowledge the critical role played by health workers in reversing and resolving global health issues. Health workers are the backbone of health systems. Therefore, the Global Health Workforce Alliance calls on governments and partners to ensure health, and the shortage of health workers, are central considerations for any action on climate change. We are all looking to ensuring a

brighter future for our world. In response to climate change, increasing the numbers, quality of training and working conditions of health workers must be seen as a priority to help reduce suffering and save lives[9]. Presently in Sri Lanka, education, training and knowledge transfer is done by state agencies, universities and other academic institutions, private sector including non-governmental agencies supported by donors. The impression given by the stakeholders was to train the health workers according to a plan based on a needs assessment. The current policies need to be reviewed to retain the trained personnel at all times. The different training institutions should be given mandate to train health workers according to an agreed upon training colander. In this technology the 'Health Personnel' means people working in government as well as non-government and in the private sector. In addition, personnel providing promotive curative, preventive, and rehabilitative care are considered.

The activities of the Project Idea will be implemented in the island nation of Democratic Socialist Republic of Sri Lanka which is located in the South Asian region. Initiating from the center and will defuse to the lowest level of health institutions in all twenty five administrative districts. Furthermore, curative, preventive and rehabilitative personnel of all health systems will be included in the process of diffusion of the technology. The private sector will also be included in this endeavour. The ultimate objective is to attend to the needs of the people as well to provide scientifically appropriate by transfer of knowledge and skills to minimize the adverse effects of climate change on human health through any form of adaptation methodology i.e. anticipatory, reactive, private or public through the health personnel of the different health systems existing in Sri Lanka.

2.3.2 Objectives

1. To enhance capacity of health personnel and institutions to ensure all levels of health personal are equipped with required skills to face the challenges of adaptation to climate change.
2. To establish and strengthen a training coordination unit in the Ministry of Health.
3. To monitor the progress of activities

2.3.3 Measurable outputs

1. Functioning training coordination unit established in the Ministry of Health at the end of the first year following the initiation of the project period
2. An annual training calendar is made available every year since the inception of the project
3. Training need assessment is done within the first year of of the project
4. Training methodologies are identified during the first two years of the project

[9] WHO, 2008

5. Master trainers are identified and/or pooled form other sectors during the first two years of implementation of the project
6. 70 % of health personnel at different levels trained in ten years
7. Drills/simulations conducted at least one per district in three years
8. Monitoring of diffusion of the technology is incorporated into the existing monitoring system during the project period and five years after closing the project

2.3.4 Relationship to the country's sustainable development priorities

Adaptation to adverse effects of health needs could be implemented in many different ways. It could be anticipatory /proactive wherein adaptation takes place before impact of climate change are observed. When the health sector is technically prepared the adverse effects can be minimized. An example is when the health personnel are provided with essential training and skills to provide the communities inputs for adaptations it will reduce the impact on human health supporting the ongoing development activities. Skills and knowledge of health personnel is essential to assist the affected populations revert back to normalcy which is essential for sustainable development. Sri Lanka at the moment is undergoing a rapid development in the form of rapid reconstruction and modernization in many sectors. Maintaining good health in general assist the development process by saving scarce funds available to be used in development activities. It is also provides healthy persons to the workforce.

The country's main development policy, the *Mahinda Chintana* the Government of Sri Lanka's Ten Year Development Policy Framework assigns very high priority to health sector, and it states 'understanding good health, preserving and safeguarding of free health services would be ensured, by enhancing the health services qualitatively and quantitatively through increasing budgetary provisions. Both curative and preventive aspects of the health services would be accorded equal priority. Therefore, improvement of the health sector is included as a high priority in the national development plans.

2.3.5 Project deliverables

1. The health personnel trained to provide knowledge and skills to public in order to minimize the adverse effects of health due to climate change
2. Training coordinating unit strengthened and a training coordinator appointed in the first year
3. Training needs assessment conducted and the recommendation made available at the end of first year
4. Training calendars produced annually.
5. Training curricula and methodologies made available at the end of the first year
6. Progress of training Monitoring reports made available (on the progress of diffusion of knowledge and skills) among health personnel

2.3.6 Project Scope & Implementation

Project scope is confined to the healthcare workers. The boundary is the Climate Change related adverse health effects. The activities of the project will transfer the training and skills to the health workers to provide inputs to the communities to adapt to the adverse effects of climate change. This skills development of the healthcare workers ensures the sustainability of the project.

2.3.7 Project activities

1. Strengthening the training coordination unit and appointment of a training coordinator and linking activities in all healthcare institutions
2. Conduct the needs assessment across the sector to identify capacity building and training needs of the health personnel
3. Preparation of training modules and curricula / identification and adaptation of training methodologies
4. Development of annual training programme, and training of master trainers along with pooling of trainers.
5. Training of health personnel in the center, provinces, districts and divisions
6. Conduction of drills and simulations in all districts
7. Continuous Monitoring and Evaluation of progress of diffusion of the technology

2.3.8 Timelines for project Idea activities

Table 2.3: Proposed Timelines for Implementation of project activities

Activity	Time in Years									
	1	2	3	4	5	6	7	8	9	10
1. Strengthening the training coordination unit and appointment of a training coordinator and linking activities in all healthcare institutions										
2. Training needs assessment										
3. Preparation of training modules and curricula / identification and adaptation of training methodologies										
4. Development of annual training programme and training of master trainers										

5. Training of health personnel in the center, provinces, districts and divisions										
6. Drills and simulations in all districts										
7. Continuous Monitoring and Evaluation of progress of diffusion of the technology										

2.3.9 Budget /resource requirements

Table 2.4: Approximate Budget Estimate for the Proposed Project

Activity	Budget (US $)
1. Strengthening the training coordination unit and appointment of a training coordinator and linking activities in all healthcare institutions	25,000
2. Training needs assessment	15,000
3. Preparation of training modules and curricula/ identification and adaptation of training methodologies	30,000
4. Development of annual training calendar and training of master trainers	75,000
5. Training of health personnel in the center, provinces, districts and divisions	75,000
6. Conduction of drills and simulations in all districts	50,000
7. Continuous monitoring and evaluation of progress of diffusion of the technology	70,000
Sub Total - Total cost of activities	**340,000**
8. Administrative cost	34,000
TOTAL	**374,000**

The project staff will be assigned from the Ministry of Health following the process of advertising, short listing, interviewing and the selected shall be appointed with specific TORs for different purposes of the project. The trainers will be selected and trained by training institutes in the county and overseas. The funds for the purposes of the project will be mainly obtained from the government and donor agencies and the private sector. The estimated cost of activities would be about 80,000 $ US. In addition, project administrative cost is 8,000 $ US (approximately 10% of the cost of activities). The total cost would be approximately 88,000 $ US. Partnership with the health institutions of the private sector as a growing industry will be agreed as they also will be benefitted from the project. The proposal is to establish partnerships with NGOO, CBO and other related and interested organizations, as well as individuals to make the projects ownership more extensive which will be a plus point to achieve the goals of the project.

2.3.10 Monitoring and Evaluation

Monitoring is an integral part of the project management. The monitoring plan should be developed when the activity plan is being developed. The center would conduct regular quarterly monitoring activities to learn whether the activities are conducted appropriately and in timely manner, the lessons learned should be recorded and shared with stakeholders and to take corrective measures if necessary. Evaluation of the activities of the project would be given to an independent external entity. Preferably evaluation should be conducted bi-annually and midterm. The impact evaluations need to be carried out at the end of the project and submit reports to the Coordination Unit of the Ministry of Health.

2.3.11 Complications and challenges

Sufficient amount of fund availability for continuation of activities would be a possible challenge. Providing priority for project activities by convincing the relevant authorities would also be a challenge. Making personnel to work together in different settings of the health sector will be a complication. Retaining trainers as well as trained personnel will lead to a serious challenge if proactive measures are not taken by the authorities anticipating such problems.

2.3.12 Responsibilities and coordination

The training coordination unit of the Ministry of Health will be responsible for implementation of overall activities of the project. These responsibilities of implementation of activities would be distributed as appropriate with the Center, Provincial and District authorities. They are primarily responsible for activities of advocacy, preparation off training programme, preparation of curricula, identification of trainers and getting them refresher-training and also related activities. Monitoring is again a responsibility of national as well as sub- national level authorities depending on the activities. Sectoral coordination with sub-national levels is the responsibility of the coordination unit at national level. It also shall coordinate between other sectors at national level.

2.3.13 List of References

1. Annual Health Bulletin, Ministry of Health, 2011
2. Health Master Plan for Sri Lanka, Volume III, Project Profiles, Ministry of Health 2003
3. Heath Master Plan, (HMP) 2007- 2016, Ministry of Health, Sri Lanka. [Available at: http://www.health.gov.lk]
4. Human Resources for Health, Strategic Plan (2009-2018), Ministry of Health, 2009. [Available online: http://www.health.gov.lk]

5. MAHINDA CHINTHANA, *Towards a new Sri Lanka*, 2005 and 2010
6. National Health Policy, Sri Lanka, 1996. [Available online: http://www.health.gov.lk]
7. Strategic Plan for Health Sector Disaster/ Emergency Preparedness, Disaster preparedness and Response Unit, Ministry of Health, 2011
8. Surveillance case definitions for notifiable diseases in Sri Lanka, Epidemiology Unit, Ministry of Health [Available Online at; http://www.health.gov.lk]
9. Transfer and Diffusion of Climate Technologies, [Available online**:** www.tech-action.org **]**
10. WHO, Health workers: *on the frontline protecting health from the climate change*, global health workforce alliance; 2008. [Available online: http://www.who.int/workforcealliance/news/whd2008statement/en/index.html] accessed on 25th may 2012.

2.4 Project Idea for Technology 3: Technology for management of Healthcare Waste

The Project Idea: *'Improvement of Health Care Waste Management in all health institutions to minimize the effects of climate change related adverse health effects'*

2.4.1 Introduction/Background

The activities of the Project Idea will be implemented in the island nation of Sri Lanka located in the South Asian region. The activities of the Project Idea were developed as the ultimate result of the working-group meetings for health of the TNA Project. Initially the Technologies were identified and prioritized based on the stakeholder consultations. Three technologies were prioritized for each sector. The third priority technology identified in the health sector was 'Technology for management of Health Care waste'. Then the barrier analysis and enabling framework were developed to identify and overcome the barriers for implementation of technology. Finally Technology Action Plan was developed, which proposed the actions to achieve the objectives of the Technology-3. The Project Idea was a follow up step of the Technology Action Plan.

The World Health Organization identifies health waste care management as a measure; to reduce the burden of disease, including alternatives to incineration (WHO). Of the total amount of waste generated by health-care activities, about 80% is general waste comparable to domestic waste. The remaining 20% is considered hazardous material that may be infectious, toxic or radioactive which also can pollute water, soil and air under suitable conditions. The major sources of health-care waste include; hospitals and other health-care establishments (Public as well as private sectors); laboratories and research centres; mortuary and autopsy centres; animal research and testing laboratories; blood banks and collection services; nursing homes for the elderly.

Although Sri Lanka has impressive health indicators, the health system has certain shortcomings. A notable example is Health Care Waste Management. Estimated total health care waste produced by listed government hospitals is between 76,623 and 170,789 kg daily. It should be noted that no private sector hospital health care waste generation has been included. Thus it can be assumed that by using high income country data we are compensating for the loss of waste generation from the private sector hospitals to some degree. Using WHO estimates[10] the daily hazardous waste production in the listed government hospitals in Sri Lanka between 7,662 and 42,697 kg daily. The state hospital health care waste produced at present in Sri Lanka is disposed off by the following methods: Collection by local

municipal authority, subsequent dumping and Burning in the health care facility premises, Burying in the health care facility premises, Dumping at a designated site within hospital premises or at a designated dumping site of the local authority. Sri Lanka at present is disposing general health care waste according to WHO recommendations. The point at which Sri Lanka departs from these recommendations is that we dispose hazardous waste along with the general waste into a common disposal system. Hazardous waste is not treated before releasing into the general waste disposal system to render it nonhazardous. Some major hospitals in the island are collecting waste using the internationally accepted colour coded collection system.

The management of health care waste is streamlined by the Ministry of Health by developing a policy on healthcare waste management of which the final stages has to be accomplished. At the moment the Local Government Bodies are disposing the non-clinical waste but still the stages of collection, separation storage, transportation, and disposal is unacceptable in most of the instances. Some private sector agencies also provide services to dispose expired drugs and devices through high temperature burners in cement factories. Still the diffusion of knowledge and practices to the periphery has not taken place and it is imperative to implement projects to begin with for the purpose of addressing the hazards. The Ministry of Health has prepared a policy on Health Care Waste Management (HCWM) and the guidelines to be practiced in disposing HCWM. The policy is yet to be approved by the Cabinet of Ministers.

The identified shortcomings in (HCWM) are, fact that the treatment technologies are expensive, the projects implemented stops at the end of project period due to shortage of funds and human resources, poor awareness among health workers, not being a priority area, shortage of trained personnel to carry-out duties, and poor inter sectoral coordination.
The proposed project for '*Improvement of Health Care Waste Management in all health institutions'* to be implemented to overcome the current issues in health waste care management in the country

2.4.2 Objectives

1. To identify and implement lasting (HCWM) technologies in the health care institutions
2. To create awareness on benefits of proper HCWM among health personnel
3. To expand health information system to include HCWM activities
4. To install clinical (HCWM) systems in the major hospitals
5. To improve inter-sectoral coordination for proper HCWM

2.4.3 Measurable Outputs

1. Number of stakeholders involved in (HCWM) increased and making more resources available
2. Newer, affordable and feasible HCWM technologies identified and implemented with a coverage of 40 % of institutions
3. Awareness created among 70 % of relevant health personnel through project period
4. HCWM information is included into the existing Health Information System (HIS)
5. Installation of Clinical HCWM systems in all districts (one General Hospital in each district)
6. Improved inter-sectoral coordination for HCWM.

2.4.4 Relationship to the country's development priority

The activities of the proposed project are related to the present development priorities of Sri Lanka in many ways. Firstly, it prevents environmental pollution (water, air and soil) by proper disposal of Health Care Waste; which is one target of the sustainable development is to maintain appropriate environmental conditions which are conducive to healthy living. It also prevents possible diseases outbreaks, development of resistant strains of microbes by contamination with water and soil. The proper HCWM will prevent incorporation of nuclear material and heavy metals, which are used in radiotherapy for cancer patients and in X-ray departments in general, in to the environment even in minute amounts preventing adverse health as well as environmental effects. The project activities also minimize the general nuisance created by improper disposal of the hospital waste care. The Policy on Hospital Waste Care Management has been prepared by the Ministry of Health and waiting approval by the Cabinet of Ministers. National Policy Cleaner Production for Health Sector is another step forward taken by the Ministry of Health to prevent environmental pollution due to health activities with definite policy goal to ensure sustainable socio-economic development of Sri Lanka and three others.

The country's main development policy, the *Mahinda Chintana* National Policy Framework states 'understanding good health, preserving and safeguarding of free health services would be ensured, by enhancing the health services qualitatively and quantitatively through increasing budgetary provisions. Both curative and preventive aspects of the health services would be accorded equal priority.

2.4.5 Project deliverables

1. Awareness creation among 60 % of health care personnel
2. Sustainable technologies for HCWM implemented in selected major institutions across the island
3. Information on HCWM incorporated into Health Information System (HIS) and made available to all stakeholders
4. Report on Inter-sectoral coordination

2.4.6 Project Scope & Implementation

The scope of the proposed project is confined to the health care institutions with the aim of minimizing the possibility of adverse health effects to humans through reduction of environment pollution. The activities are confined to the health sector with a special emphasis on prevention of human suffering due to climate change and related extreme events by implementing sound HCWM systems. The overall planning will be the responsibility of the Environmental and Occupational directorate of the Ministry of Health. Implementation is the responsibility of all decentralized units including provinces and the districts.

2.4.7 Project Activities

1. Establishment of a National Information Center to facilitate partnerships and to explore additional funding sources and to provide necessary information.
2. Research study to identify and to implement appropriate, sustainable and affordable technologies for HCWM
3. Awareness creation on HCWM among health workers at all levels (national, provincial, district and divisional).
4. Training of selected health personnel for HCWM activities at all levels
5. Setting up of HCWM systems in general hospitals in each district
6. Networking of health institutions and linking to other sectors for improving inter-sectoral coordination for HCWM purposes

2.4.8 Timelines for the proposed project

Table 2.5: Proposed Timelines for Implementation of project activities

Activities	Time in Years			
	1	2	3	4
1.Establishment of a national Information Center to facilitate partnerships and to explore additional funding sources and to provide necessary information				
2.Research study to identify and to implement appropriate, sustainable and affordable technologies for HCWM				
3.Awareness creation on HCWM among health workers at all levels (national, provincial, district and divisional)				
4.Training of selected health personnel for HCWM activities at all levels				
5. Setting up of HCWM systems in general hospitals in each district				
6.Networking of health institutions and linking to other sectors for improving inter-sectoral coordination for HCWM purposes				

2.4.8 Budget/ Resource requirements

Table 2.6: Approximate Budget Estimate for the Proposed Project

Activity	Budget (US $)
1.Establishment of a national Information Center to facilitate partnerships and to explore additional funding sources to provide necessary information	15,000
2.Research study to identify and to implement appropriate, sustainable and affordable technologies for HCWM	25,000
3.Awareness creation on HCWM among health workers at all levels (national, provincial, district & divisional)	10,000
4.Training of selected health personnel for HCWM activities at all levels	12,000
5. Setting up of HCWM systems in general hospitals in each district	2,000,000
6.Networking of health institutions and linking to other sectors for improving inter-sectoral coordination for HCWM purposes	10.000
Sub-total: Total cost of activities	**2,072,000**
7. Administrative cost	207,200
TOTAL	**2,279,200**

The estimated cost of project activities would be about US $ 2,072,000. The administrative cost will be 10% of the total cost of activities, amounting to US $ 207,200. Total cost of the project including administrative cost would be US $ 2,279,200. This amount will be obtained from the government sources, UN and other supporting donors as well as from the private sector. The project management and overall monitoring will be done by the Environmental & Occupational Health Directorate of the Ministry of Health.

2.4.10 Monitoring & Evaluation

Regular monitoring activities (quarterly) of the project at central level will be done by the Environmental and Occupational Health Directorate of the Ministry of Health. Activities at sub-national levels will be monitored by the staff of the decentralized unit under the supervision of the respective heads. The monitoring reports will be prepared and shared with all stakeholders to make alterations of activities if there is a need. Evaluation will be entrusted to a recognized external entity. It will be done on annual basis, end of the project to assess impact after a pre-determined period of time following the completion of project. Evaluation will be coordinated by the Environmental and Occupational Health Directorate of the Ministry of Health. The evaluation reports will be utilized to further improve or to do away with the project activities.

2.4.11 Complications and Challenges

The concept of HCWM at all health institutions is not a priority at the moment. Moreover, the understanding of the health workers is that they are doing the right thing at present. The cost of technologies is a challenge as well as a complication. Inter-sectoral collaboration, altering the attitudes of health care personnel and general public will be a challenge. Ensuring continuous financial support is also a challenge to continue project activities.

2.4.12 Responsibilities and Coordination

The overall **responsibility for implementation and coordination of project success is with the Environmental & Occupational Health Directorate of the Ministry of Health.** The heads of all decentralized units are responsible for their units. The Environmental & Occupational Directorate is selected for the purpose because, it is their mandate and mission to do the work proposed in this project. Though they are short of staff, the experts in this regard is attached to this Directorate. Additionally, the local government authorities are responsible for management of Non-clinical solid waste. They need to acquire new recruits for the project purposes if there is a real need.

2.4.13 List of References

1. Annual Health Bulletin, Ministry of Health, 2011
2. Haniffa R, Management of Health Care Waste, Ceylon Medical Journal, Vol. 49, No. 3, September 2004
3. Health Master Plan for Sri Lanka, Volume III, Project Profiles, Ministry of Health 2003
4. MAHINDA CHINTHANA, *Towards a new Sri Lanka*, 2005 and 2010
5. Ministry of Health, *National Policy and Strategy on Cleaner Production for health Sector*,:2007
6. Sri Lanka's Second National Communication on Climate Change, Ministry of Environment, 2011.[Available at: http://www.climatechange.lk]
7. Strategic Plan for Health Sector Disaster/ Emergency Preparedness, Disaster preparedness and Response Unit, Ministry of Health, 2011
8. WHO Fact Sheet N 281, October 2011
9. WHO, FACT SHEET NO. 253, November 2011.

CHAPTER 3

Project Ideas for Water Sector

3.1 Brief summary of the Project Ideas for Water Sector

The project ideas report for the water sector includes one project idea for each technology identified and a project developed by combining the three technologies identified. Three project ideas were developed for the water sector covering the three technologies identified. The most important actions identified under each technology were considered for this purpose.
The following table 3.1 shows proposed four project ideas:

Table 3.1: Proposed projects for prioritized technologies in the Water Sector

Technology	Project Idea
1. Restoration/ Rehabilitation of Minor Tank net works	Rehabilitation/Restoration and maintenance of minor tank network (cascade) systems in the dry zone of Sri Lanka as an adaptation strategy for climate change
2. Rainwater harvesting from rooftops for drinking and household uses	Promote roof top rainwater harvesting technology, as an adaptation measure for climate change
3. Boreholes/tube wells as a drought intervention for domestic water supply	Promote measures for sustainability of boreholes as an adaptation method for climate change
4. Multiple technologies	Improve availability of drinking and irrigation water for the dry zone of Sri Lanka as an adaptation measure for climate change

Objective of the project idea 'Rehabilitation/Restoration and maintenance of minor tank network systems in the dry zone of Sri Lanka as an adaptation strategy for climate change' developed for technology 1, is to provide water throughout/most of the year (80%), for farmers in selected vulnerable areas in the dry zone, through properly maintained ten rehabilitated/restored minor tank network systems. Allocated time for the project is ten years.

The objective of the project idea 'Promote roof top rainwater harvesting technology, as an adaptation measure for climate change' developed for technology 2, is to provide good quality water for drinking and household uses as a short term security against dry period (40%) for selected areas in the dry zone and

also as a flash-flood mitigation strategy for Colombo, through quality controlled roof top rainwater harvesting systems. Allocated time for the project is ten years.

The objective of the third project idea 'Promote measures for sustainability of boreholes as an adaptation method for climate change' is to provide potable water throughout the year (100%) for households and general public in selected vulnerable rural areas in the by promoting sustainability of boreholes. Allocated time for the project is eight years.

The objective of the fourth project idea 'Improve availability of drinking and irrigation water for the dry zone of Sri Lanka as an adaptation measure for climate change' is to provide potable and irrigation water throughout the year (100 %) for farmers and villagers in selected vulnerable rural areas in the North Central Province of Sri Lanka. Allocated time for the project is ten years.

Required funds for all four projects will be obtained through local and foreign funding sources. Cost of project management will be borne by the government of Sri Lanka.

3.2 Project Idea for Technology 1: Restoration/ Rehabilitation of Minor Tank net works

Project Idea:

'Rehabilitation/Restoration and maintenance of minor tank network (cascade) systems in the dry zone of Sri Lanka as an adaptation strategy for climate change'

3.2.1 Introduction/Background

This project idea was developed by considering the most important actions identified under the Technology 1: Restoration/ Rehabilitation of Minor Tank net works.

Economy of the dry zone mainly depends on paddy cultivation based on minor tanks network systems. According to climate change projections, water scarcity will be a problem in the dry zone because this region will be more vulnerable to droughts. In addition to that, high temperature and dry winds will increase the evaporation rate and also affect the ground water resource. Increases in high rainfall events during rainy season will increase soil erosion, which in turn accelerates the silting up of these tank systems. In order to mitigate the above problems it is important to maintain sustainability of these minor tank systems as an adaptation strategy through water conservation, storm water control and capture and groundwater recharge. It also enhances access to groundwater and hence the expansion in irrigated area. For this purpose, it is necessary to improve operation and maintenance of tanks, catchment areas and canal systems. i.e. Restoration/rehabilitation of minor tanks involves work such as breach closing, tank bund strengthening, aquatic weeds control and repairs or reconstruction to sluices and weirs. Ten minor tank network systems in the dry zone will be selected for implementation of this project.

Lack of sustainability of minor tank systems is a current problem in the country and this is mainly due to poor operation and management practices. Implementation of Farmer Organisations based mechanisms will be a good way to maintain sustainability of minor tank systems. Farmer Organisations can be strengthened through active involvement of Dept. of Agrarian Services and Provincial Councils. In most of the previous restoration processes, selection of cascade systems/minor tanks has been carried out in a haphazard manner/without any scientific basis and as a result such restorations have failed to maximize benefits/returns. As such, it is important to carry out a survey in a scientific manner for identification of cascade systems/minor tanks for restoration/rehabilitation. Under this survey, it is necessary to collect data on vulnerability to impacts of climate change, hydrology of the cascade system, major rehabilitation work needed, number of beneficiaries from each tank, relocation needs, and amounts of funds available etc. A list can be prepared once required data are available.

It is essential to implement steps to build capacity of Department of Agrarian Development, provincial councils, Dept. of Health, Farmer Organisations and Cascade Management Teams in order to maximize the efficiency and effectiveness of restoration/rehabilitation/maintenance programmes.
Monitoring of water quality of the tanks selected and monitoring of health conditions of people consuming water from above tanks and to study whether there is a relationship between the above two are also needed in order to find a solution for prevailing health problems (i.e. kidney disease) in certain areas in the dry zone.

3.2.2 Objectives

The main objective of this project is to provide water throughout/most of the year (80%), for farmers in selected vulnerable areas in the dry zone, through properly maintained ten minor tank network systems.

3.2.3 Outputs of the Proposed Project

- Availability of a list of minor tank network systems which need rehabilitation/restoration and availability of a data bank (need of water resources, number of beneficiaries, type of restoration/rehabilitation work required, hydrology of the tank systems, amount of funds available, etc.)
- Availability of a collaborative mechanism between Agrarian Service Dept. and Provincial Councils pertaining for restoration/rehabilitation work
- Increased awareness and Capacity of Agrarian Service Department, Provincial councils and Health Department, Farmer Organisations and Cascade Management Teams
- Availability of alternative employments for extended dry seasons due to climate change
- An awards system for Farmer Organisations and Cascade Management Teams who show best tank management practices

- Well maintained 10 minor tanks selected
- Availability of evaluation reports prepared by project management team

3.2.4 Relationship to the country's sustainable development priorities

Importance of restoration/rehabilitation of minor tank systems has been recognized in *Mahinda Chinthanaya* – 'Vision for the New Future' the Government of Sri Lanka's Ten Year Development Policy Framework[11]. In this Policy Framework, under the "*Dahasak Maha Weu* Programme" (Thousand large Tank Programme) it is planned to complete rehabilitation of 10,000 tanks by 2020 with the participation of farmer community. It is also reported that 1000 tanks will be completed every year from 2010 at an annual estimated cost of Rs. 500 M. It is also reported that, for rehabilitation of minor tanks, farmers are expected to make a meaningful contribution in the form of labour, with the major proportion of the finances being provided by the government or other agencies such as NGOs and the private sector. Another aspect reported is that, the private sector investors will be encouraged to invest in fields such as eco-tourism and agri-business, where return on investment is attractive. Thus, the project contributes to national strategy of providing water to the dry zone by restoration/rehabilitation of minor tanks.

3.2.5 Project Deliverables

- Water will be made available for consumers of the ten minor tank networks under the project
- A detailed report on success of the project, by end of year 10.
- A list of minor tank networks which need restoration/rehabilitation
- Increase in rice yield and cropping intensity, cultivation of other field crops such as chilli, mung bean etc. in the dry season resulting 50 % increase in income of farmers
- Increase in employment opportunities by 30% through fishery, bricks etc. and for food security of farmer families depending on the restored cascade systems
- Increase in eco-tourism by 10 %
- Reduction of GHG emissions

3.2.6 Project Scope and Possible Implementation

The project will produce ten well maintained minor tank network systems and the project implemented can be adapted to other minor tank network systems in areas facing water scarcity. The list of minor tank network systems identified can be used for other national programmes on restoration/rehabilitation work. The data bank/website can be updated with new hydrology data of minor tanks. The project will be

[11] Mahinda Chinthana Policy Framework, Department of National Planning; 2010.

sustainable because of the active involvement of Farmer Organisations in operation and management of minor tank systems due to the increased income, alternative employment opportunities and incentives they receive and also due to the priority given by the government. This project is not focused on restoration/rehabilitation of individual tanks, but on networks of minor tanks and therefore it will not be a failure as most of the previous restoration projects

Considering the importance of rural development in the Dry Zone, there have been numerous minor tank rehabilitation projects and therefore this project has links with such projects.

3.2.7 Project activities

1. Carry out a survey to collect necessary data (need of water resources, number of beneficiaries, type of restoration/rehabilitation work required, hydrology of the tank system, amount of funds available, etc.) in order to identify minor tank net works which need restoration/rehabilitation.
2. Develop a collaborative mechanism between Department of Agrarian Development and Provincial Councils pertaining for restoration/rehabilitation work
3. Awareness creation and capacity building of Agrarian Service Department, Provincial councils and Health Department, Farmer Organisations and Cascade Management Teams
4. Introduce alternative employments for extended dry seasons due to climate change
5. Introduce an awards system for Farmer Organisations and Cascade Management Teams showing best tank management practices
6. Restoration/Rehabilitation /Operation and maintenance work of 10 minor tanks selected
7. Promote R & D on Monitoring of water quality, health conditions, cascade hydrology and other relevant issues
8. Project Management

3.2.8 Timelines for the proposed activities

Table 3.2: Proposed Timelines for Implementation of Proposed Activities of Project 1

Activity	Year									
	1	2	3	4	5	6	7	8	9	10
1. Carry out a survey to collect necessary data in order to identify minor tank net works which need restoration/rehabilitation.										
2. Develop a collaborative mechanism between Agrarian Service Dept. and Provincial Councils pertaining to restoration/rehabilitation work										

3. Awareness creation and Capacity building of Agrarian Service Department, Provincial councils and Health Department, Farmer Organisations and Cascade Management Teams										
4.Introduce alternative employments for extended dry seasons due to climate change										
5.Introduce an awards system for Farmer Organisations and Cascacde Management Teams showing best tank management practices										
6.Restoration/Rehabilitation /Operation and maintenance work of 10 minor tanks selected										
7. Promote R & D										
8. Project Management										

3.2.9 Budget/Resource requirements

Table 3.3: Approximate Cost for Implementation of the Proposed Activities of Project 1

Activity	Budget (US$) 000'
1. Carry out a survey to collect necessary data to identify minor tank net works which need restoration/rehabilitation.	7000 (I)
2. Develop a collaborative mechanism between Agrarian Service Dept. and Provincial Councils pertaining to restoration/rehabilitation work	1000 (D)
3. Awareness creation and Capacity building of Agrarian Service Department, Provincial councils and Health Department, Farmer Organisations and Cascade Management Teams	2300 (D)
4. Introduce alternative employments for extended dry seasons due to climate change	2000 (D)
5. Introduce an awards system for Farmer Organisations and Cascade Management Teams showing best tank management practices	1000 (D)
6. Restoration/Rehabilitation /Operation and maintenance work of 10 minor tanks selected	21000 (I)
7. Promote R & D	6,000 (D)
Total for above activities (Approximately)	**40.3 M**
8. Project management (10 % of above cost)	4000 (D)
Total cost (Approximately)	**44.3 M**

(D-Domestic; I-International)

The cost of project activities would be US $ 40.3 million and the project management cost US $ 4.0 million. Estimated total cost of the proposed project including the project management cost would be US $ 44.3 million. Required funds will be obtained through domestic (D, 16.3 million) and international (I, 28.0 million) sources as indicated in the budget estimate.

3.2.10 Measurement/Evaluation

Project specific Logical Framework Matrix (LFM) and Performance Measurement Framework (PMF) will be carried out for monitoring and evaluation of progress of implementation, during the course of the project. This will help to identify problems and to provide solutions to rectify such problems during the implementation phase. A scheduled internal monitoring programme (quarterly) and periodic external evaluation (biannually and mid-term) will be implemented. Quarterly internal monitoring will be carried out by the planning unit of the Ministry of Agrarian Services and Wildlife Conservation. For this purpose indicators at different stages of the project will be monitored and evaluated. External evaluation will be carried out by an independent panel of experts appointed by the line ministry in consultation with the donor agency (Ministry of Agrarian Services and Wildlife Conservation). End of project result evaluation will also be carried out by and independent team appointed by the line Ministry and it will be incorporated to the Project Completion Report.

3.2.11 Possible Complications/Challenges

Potential challenges for achieving project targets are lack of a national water policy for the country, political intervention in decision making, poor enforcement of environmental policies/rules, lack of regular water quality monitoring programmes, absence of principles for sharing water between the upper and lower riparian as well as between drinking and irrigation purposes, allocation of water by large water users to themselves regardless of the needs of others and high cost of heavy machinery and equipment required for heavy rehabilitation processes. Another challenge is that reason(s) for prevailing kidney diseases reported in Anuradhapura, Polonnaruwa etc. are not yet confirmed.

3.2.12 Responsibilities and Coordination

The implementing agency will be the Ministry of Agrarian Services and Wildlife Conservation (M/AS&WC). Implementation of the project requires the support and collaboration from M/Local Government and Provincials, M/Health, M/ Finance and Planning, M/ Fisheries and Aquatic Resources, M/Science & Technology, M/Environment (Climate Change Secretariat), Dept. of Agrarian Development, Provincial Councils, Dept. of Health, NWSDB, local and international NGOs, private sector institutions, Farmer organizations, Cascade Management Teams, Inland fisher communities, Universities, Research Institutes,

A Project steering committee appointed by the M/AS&WC will carry out project coordination and monitoring on bi-annual basis.

3.2.13 List of References

1. Annual Report (2011), Central Bank of Sri Lanka
2. Ariyabandu Rajindra De S and Aheeyar M.M.M., Secure Water Through Demand Responsive Approaches-The Sri Lankan Experience, ISBN 0 85003 7271, Overseas Development Institute, 2004
3. Dayaratne M.H.S.,A Review of Alternative Strategies for Improving Farmer-Managed Irrigation Systems in Sri Lanka IIMI Country Paper-Sri Lanka-No.7 ,1991
4. Impact of Climate Change on Agriculture in Sri Lanka, C. Shanthi de Silva, 2012, http://climatenet.blogspot.com/2012/09/impact-of-climate-change-on-agriculture.html
5. Krishnaveni M, Sankari Silva, Rajeswari A, Rehabilitation of Irrigation Tank Cascade System Using Remote Sensing GIS and GPS, International Journal of Engineering Science and Technology (IJEST)ISSN : 0975-5462, 2011, p.1624
6. Mahinda Chinthanaya - The Department of National Planning; 2010
7. Sri Lanka's second national communication on climate change, Ministry of Environment, 2011

3.3 Project Idea for Technology 2: Rainwater harvesting from rooftops for drinking and household uses

Project Idea:

Promote roof top rainwater harvesting technology, as an adaptation measure for climate change

3.3.1 Introduction/Background

This project idea was developed by considering the most important actions identified under the Technology 2-Rainwater harvesting from rooftops for drinking and household uses.

According to climate change projections, water scarcity will be a problem in the dry zone because this region will be more vulnerable to droughts. Quality of ground water in certain areas in the dry zone is poor. In addition to that certain coastal areas in the dry zone, surface and ground water will be affected by sea level rise. Another problem caused by climate change is flash-floods due to heavy rains within a short period. The Colombo Metropolitan Area (CMA) is one of the Sri Lanka's urban areas most exposed to flash-floods due to climatic and non-climatic factors. Promoting roof top rainwater harvesting technology giving special attention on Quality controlling of the rainwater harvesting system is an adaptation strategy

for above problems, through water conservation and mitigation strategy for flash-floods by capturing storm water. It serves also as a method for groundwater recharge. The proposed project is installation of 400 quality controlled roof top rain water harvesting systems in the dry zone/ urban areas having flash flood problem as a household project or as a community project, in hospitals, schools, housing complexes etc. The three basic elements of a RWH system are roof top (the catchment area), gutters (conveyance system), and storage tank.

Providing adequate funds is necessary to maximize the output of this project. In Sri Lanka, the demand for roof top rainwater harvesting technology is poor. Quite often water quality in storage tanks is poor. i.e. Certain storage tanks have become mosquito breeding sites and/or contaminated with *E Coli,* leaves and other debris. There is also a possibility of using inappropriate roof materials by technology users. To increase the demand, it is necessary to introduce measures to improve the quality of harvested rainwater and therefore quality controlling of the rooftop rain water harvesting system is necessary. e.g. Introduce standards, codes and certification/annual license system for roof top rainwater harvesting systems in Sri Lanka. DIN 1989 is a German compilation of standards and. (Adrienne LaBranche *et al*, Rainwater Harvesting Manual 2007, 2009) it is necessary to explore possibility of applying German standards directly or to modify the German standards according to Sri Lanka's requirements. Training and awareness should be provided on good operation and management practices of RWH systems.

This technology can be popularised by introducing subsidy schemes for storage tanks and water quality analytical services for harvested rain water, offering a tax incentive for individuals and businesses interested in installing rainwater harvesting systems and providing health condition monitoring service for persons who consume harvested rain water.
At present, there is no priority list when selecting the most suitable areas for installing roof top rainwater harvesting systems. As such, it is critical to formulate a clear mechanism for selection and prioritisation of areas for implementation of this technology by giving consideration for factors such as results of climate change modelling, data on needs, rainfall, quality of rain water and air, urgency etc. Priority list can be prepared once a mechanism/protocol and required data are available. It is essential to implement steps to build capacity of Health Department and NWSDB in terms of recruitment of additional staff. Inefficient enforcement of National rainwater policy and strategies is also a problem and strict enforcement of this policy is required.

3.3.2 Objectives

The main objective of the proposed project is to provide water for drinking and household uses as a short term security against dry period (40%) for selected areas in the dry zone and as a flash-flood mitigation strategy for urban areas (e.g. Colombo) through quality controlled roof top rainwater harvesting systems.

3.3.3 Outputs of the Proposed Project

- Accepted standards and an annual license system for roof top rainwater harvesting systems in Sri Lanka as quality controlling methods
- A method to register at National Water Supply & Drainage Board (NWSDB) for roof top rainwater harvesting systems.
- Awareness programmes for consumers on good operation and management practices
- Four hundred (400) Quality controlled RWH systems out of which 300 in the dry zone (60 in schools, 30 in hospitals, 10 in religious places and the remaining 200 for houses) and 100 in flats/condominiums/schools/hospitals in flash flood prone areas in Colombo.
- Availability of demonstration models, audio-visuals, guide books, TV programmes, leaflets and posters on RWH systems; Introduction of this technology in GCE O/L curriculum
- A list of areas for installation of roof top rainwater harvesting systems and availability of data bank (data on needs, amount of rainfall during the past few years, quality of rain water, urgency and results of Climate change modeling etc)
- Capacity of Health Department and NWSDB (80%) to maximize the efficiency and effectiveness of the project.
- Knowledge on water quality of storage tanks and health conditions of people consume water from above tanks.
- Mitigate flash-floods by 25%. This technology divert a portion of local rainfall into collection tanks and prevents flooding due to discharge of rooftop rain water directly to main drainage systems; e.g.Indonesia(http://oasis-rainharvesting.co.uk/, http://www.ngoforum.net/index.php?option=com_docman&task=doc_view&gid=74)
- Reduce water supply costs by 30%.

3.3.4 Relationship to the country's sustainable development priorities

Importance of providing safe water has been recognised in "Mahinda Chintana, National Policy Framework -Vision for the future" and accordingly it is expected to increase safe water coverage by 100% of the population by the year 2020. According to United Nations Millennium Development Goal (MDG) on drinking water, it is targeted to decrease the proportion of people without sustainable access to safe drinking water by 50 % by 2015. The Ministry of Water Supply and Drainage, has assigned high priority for the formulation of policies and programme for Rain Water Harvesting and has received Rs.5 Million through 2011 budget to implement a roof top rain water Harvesting Project. At present there is a World Bank approved project on flood mitigation in Colombo. Thus, the proposed project contributes to national strategy of providing safe water to the dry zone and mitigation of floods in Colombo.

3.3.5 Project Deliverables

- Social development (15%), economic wellbeing (25%) and environmental sustainability (25%) of selected areas in the dry zone (30%) /urban areas (10%).
- 40% of total requirement of Good quality water for consumers in selected areas in 30 % of the dry zone
- A publicly available prioritized list of areas for installation of RWH systems
- A data bank/website providing updated data on needs, rainfall, quality of rain water, air quality, urgency and results of Climate change modeling will be available after the year-1.
- A detailed report on success of the project
- In certain areas (25%), quality of harvested water will be better than water from other sources in those areas
- Ground water recharge
- Saves high-quality drinking water sources
- Convenience for women by having water for drinking and cooking at the doorstep, at least for part of the year
- Increase in employment opportunities by 3%
- Relieves the pressure on sewers and the environment by mitigating floods (10 %), soil erosions and replenishing groundwater levels
- Reduces the potable water consumption and consequently, the volume of generated wastewater.
- Reduction of GHG emissions

3.3.6 Project Scope and Possible Implementation

The project will produce quality controlled and well maintained 400 roof top rainwater harvesting systems and the project implemented can be adapted to other areas in areas facing water scarcity or flash-floods. The mechanism/protocol formulated and the prioritized list prepared can be used for other national programmes on roof top rainwater harvesting systems. The data bank/website can be updated with new data.

The feasibility of the project is high because it uses simple, flexible technologies that are easy to maintain and the system is operated and managed by the owner. Feasibility also depends on amount and intensity of rainfall, quantity and quality of water available from other sources, household size, per capita water requirements and available budget. Sustainability of the project is also high because rainwater is a free source, relatively clean and it can be used as a potable water source with proper treatment, offers potential cost savings especially with rising water costs, low running costs, construction, and operation and maintenance are not labour-intensive. There is no/little need of energy for this technology because capture systems often use low-volume, non-pressurized, gravity fed systems or low power pumps. As the project

will formulate standards for roof top rainwater harvesting systems and a scheme for annual license, operation and management will be improved and as a result sustainability of the systems will be maintained.

This project has links with certain current projects in the country. For example there is an ongoing programme of rooftop rain water harvesting carrying out by the Ministry of Water Supply and Drainage under the funds allocated in 2011 budget for that purpose. In addition to that, the World Bank has approved a project of US $ 213 million for Metro Colombo Urban Development and the majority of the investments will be supporting the government to develop a comprehensive flood mitigation strategy for CMA (http://www.ecapra.org/sri-lanka).

3.3.7 Project activities

1. Carryout a survey to collect necessary data (needs, amount of rainfall during the past few years, quality of rain water, urgency and results of Climate change modeling etc) in order to identify suitable areas in the country for installation of roof top rain water harvesting systems.
2. Capacity building of Health Department, NWSDB and relevant general public.
3. Formulate standards, codes, certification and annual license system for roof top rainwater harvesting systems.
4. Raise awareness on this technology among consumers, policy makers and decision makers etc.
5. Strict enforcement of national rainwater harvesting policy.
6. Install 400 quality controlled RWH systems.
7. Provide necessary equipment at a concessionary rate/ Provide incentives.
8. Promote R & D to improve this technology.
9. Project Management.

3.3.8 Timelines for the proposed activities

Table 3.4: Proposed Timelines for Implementation of Proposed Activities of Project 2

Activity	Year						
	1	2	3	4	5	6	7
1. Carryout a survey to collect necessary data in order to identify suitable areas in the country for installation of roof top rainwater harvesting systems							
2. Capacity building of Health Department,							

NWSDB and relevant general public							
3. Formulate standards, codes, certification and annual license system for roof top rainwater harvesting systems							
4. Raise awareness on this technology							
5. Strict enforcement of national rainwater harvesting policy							
6. Install 400 quality controlled RWH systems,							
7. Provide necessary equipment at a concessionary rate							
8. Promote R & D to improve this technology							
9. Project Management							

The project will be carried out over ten years.

3.3.9 Budget/Resource requirements

Table 3.5: Approximate Budget Estimate for the Proposed Project on Project 2

Activity	Budget (US$) 000'
1. Carryout a survey to collect necessary data in order to identify suitable areas in the country for installation of roof top rainwater harvesting systems	3,000 (D)
2. Capacity building of Health Department, NWSDB and relevant general public	1,200 (D)
3. Formulate standards, codes, certification and annual license system for roof top rainwater harvesting systems	1,100 (D)
4. Raise awareness on this technology	4,000 (I)
5. Strict enforcement of national rainwater harvesting policy	1,000 (D)
6. Install 400 quality controlled RWH systems	33,000 (I)
7. Provide necessary equipment at a concessionary rate	10,000 (I)
8. Promote R & D to improve this technology.	6,000 (D)
Total (approximately)	**59.3 M**
9. Project Management (10% of the total, approximately)	6,000 (D)
Total cost (approximately)	**65.3 M**

The cost of project activities would be US $ 59.3 million and the project management cost US $ 6.0 million. Estimated total cost of the proposed project including the project management cost would be US $ 65.3

million. Required funds would be obtained through domestic (D, 18.3 million) and international (I, 47.0 million) sources as indicated in the budget estimate. Cost of project management would be met by the domestic budget.

3.3.10 Measurement/Evaluation

Project specific Logical Framework Matrix (LFM) and Performance Measurement Framework (PMF) will be used for monitoring and evaluation of progress of implementation, during the course of the project. This will help to identify problems and to provide solutions to rectify such problems during the implementation phase. A scheduled internal monitoring programme (quarterly) and periodic external evaluation (biannually and mid-term) would be implemented. Quarterly internal monitoring will be carried out by the planning unit of the Ministry of Water Supply and Drainage. For this purpose indicators at different stages of the project will be monitored and evaluated. External evaluation will be carried out by an independent panel of experts appointed by the line ministry in consultation with the donor agency (Ministry of Water Supply and Drainage). End of project result evaluation will also be carried out by and independent team appointed by the line Ministry and it will be incorporated to the Project Completion Report.

3.2.14 Possible Complications/Challenges

One of the major problems is high cost for storage tanks, maintenance, pump, pressure controller and fittings and plumber's labour. Another disadvantage of this technology is the limited supply and uncertainty of rainfall. Rainwater is not a reliable water source in times of dry periods or prolonged drought. The first rain drains the dust, bird droppings, leaves, etc. which is found on the roof surface and it may contaminate harvested rain water result in health risks. Other disadvantages include low storage capacity which will limit rainwater harvesting, whereas, increasing the storage capacity will add to the construction and operating costs making the technology less economically feasible. Leakages from cisterns can cause deterioration of load-bearing slopes.

3.2.15 Responsibilities and Coordination

The implementing agency will be the Ministry of Water Supply and Drainage. Implementation of the project requires the support and collaboration from M/Environment (Climate Change Secretariat), M/Health, Ministry of Education, M/Science & Technology, NWSDB, Urban Development Authority, Central Environment Authority, Lanka Rain water Harvesting Forum, Dept. of Health, Component prefabrication companies, Architects, engineers, Universities, Research Institutes, INGOs, NGOs, A Project steering committee appointed by the Ministry of Water Supply and Drainage will carry out project coordination and monitoring on bi-annual basis in addition to planning unit of the line Ministry.

3.3.13 List of references

1. Adrienne LaBranche, Hans-Otto Wack, David Crawford, Ed Crawford, Nickolas J. Sojka, DVM and Cabell BrandVirginia; Rainwater Harvesting Manual 2007, 2009; The Cabell Brand Center
2. Annual Report (2011), Central Bank of Sri Lanka
3. DIN 1989-1. 2002. Rainwater Harvesting Systems – Part 1: Planning, Installation, Operation and Maintenance. German Institute for Standardisation, Berlin, 2002.
4. Rainwater Harvesting Project at the Development Technology Unit of School of Engineering, University of Warwick, UK , http://www.eng.warwick.ac.uk/DTU
5. UNICEF, Evaluation of the Rooftop Rainwater Harvesting Project, Study Abstract 2004
6. http://oasis-rainharvesting.co.uk/
7. http://www.ngoforum.net/index.php?option=com_docman&task=doc_view&gid=74

3.4 Project Idea for Technology 3: Boreholes/tube wells as a drought intervention for domestic water supply

Project Idea:

'Promote measures for sustainability of boreholes as an adaptation method for climate change'

3.4.1 Introduction/Background

This project idea was developed by considering the most important actions identified under the Technology 3: Boreholes/tube wells as a drought intervention for domestic water supply.

One of the main reasons for selecting this technology is that, if surface water is not available/ not sufficient/bad quality, ground water can be abstracted for domestic purposes through tube wells/boreholes. If the underground source is pure, water from boreholes is free of microorganisms and will be a good source of drinking water. Boreholes/Tube wells consist of a narrow, screened tube (casing) driven into a water bearing zone of the subsurface. The borehole efficiency changes with the bedrock geology. The total cost for a borehole increases with the depth. According to climate change projections, water scarcity will be a problem in the dry zone because this region will be more vulnerable to droughts. Borehole technology is an adaptation strategy for surface water scarcity as it provides an alternative water source. Most of the boreholes in the country have become failures and therefore it is necessary to promote the sustainability of boreholes when diffusing this technology. Fifty hand pumped boreholes will be installed in a scientific manner, in households as well as in public places for common use, in rural sector in the dry zone, where hydro-geological conditions are suitable, surface water is scarce and quality of ground water is good.

Ground water through boreholes is currently being used in the dry zone as a drinking water source and also for back-garden agriculture and aquaculture. Most of the boreholes constructed in the country have become failures due to technical reasons, over extraction and/or poor quality of ground water. The main technical reason is installation of boreholes at sites having unsuitable hydro-geological conditions. For the sustainability of boreholes, it is necessary to provide technical assistance to select sites having suitable hydro-geological conditions. A certificate course will be offered by NWSDB/WRB, on construction of successful boreholes, so that qualified borehole constructing organizations will be available in the country.

Certain consumers are not aware of possible negative impacts of over extraction. In addition to that, policies/laws/ by laws/ guidelines are not available for safe and sustainable use of ground water. Therefore to maintain sustainability of ground water resource and to prevent over extraction it is necessary to amend existing laws pertaining to ground water resources in the country. In order to create awareness on sustainable use of ground water it is necessary to conduct awareness programmes annually and also

publish guide books (in Sinhala/English/Tamil), leaflets, posters etc. Lack of /insufficient capacity of relevant institutions/organisations is also a current problem. e.g. lack of trained mechanic for maintenance work, lack of capacity of NWSDB to drill tube wells in sufficient numbers due to old and unserviceable equipment. Private entities who engage in well drilling are small and not capable of undertaking major programmes. Therefore it is necessary to build capacity of NWSDB and WRB to offer an efficient service pertaining to this project.

Providing adequate funds is necessary to maximize the output of this project as cost of implementation of this project is high due to high costs of equipment required and construction and repairing of hand pumps which are non functional. Advantage of boreholes as a water conservation method is not known by certain decision makers and providing awareness to them is necessary. It is important to provide financial incentives through loan schemes/import tax reliefs to tube well constructors.
Another problem is that, lack of/insufficient R & D pertaining to ground water. e.g. regular monitoring of changes in ground water availability/changes in water table/ water quality. Lack of/insufficient R & D to identify exact reason(s) for Chronic kidney disease in the North Central Province and to develop a low-cost water treatment procedure are other important problems which need to be addressed. Targeting above, and many other important matters, it is necessary to promote R & D with respect to Ground water.

3.4.2 Objectives

The main objective of the of the proposed project is to provide potable water throughout the year (100%) for 20% of households and general public in selected vulnerable rural areas having hydrogeologically suitable sites in the dry zone by promoting sustainability of boreholes. 50 boreholes will be installed for this purpose.

3.4.3 Outputs of the Proposed Project

1. Well maintained 50 boreholes installed at hydrogeologically suitable sites in the dry zone.
2. Annual license scheme for boreholes
3. Availability of a list of qualified borehole constructing organizations registered at WRB/NWSDB
4. Guidelines for safe and sustainable use of groundwater
5. A certificate course on construction of successful boreholes offered by NWSDB/WRB
6. Awareness programmes for consumers on this technology
7. Adequate capacity of WRB and NWSDB for successful implementation of the project
8. Availability of a data bank and list of suitable areas where boreholes should be installed.

3.4.4 Relationship to the country's sustainable development priorities

According to Mahinda Chintana National Policy Framework -Vision for the future, it is required to achieve 100% safe drinking water coverage by year 2020, which in turn require 6% and 14% growth in the urban and rural sectors respectively. Considering the country's water resources, it is now recognized that, the rural water supplies will have to depend mainly on the groundwater source[12]. The Ministry of Water Supply and Drainage is responsible for providing safe drinking water and adequate sanitation to all citizens of Sri Lanka and their target is to provide water for all by the year 2025. Thus, the proposed project contributes to national strategy of providing safe water to the rural community of the dry zone.

3.4.5 Project Deliverables

1. Good quality water will be made available throughout the year for consumers through Boreholes in selected areas in the dry zone.
2. A detailed report on the project by end of year 7.
3. Increase in employment opportunities by 30%
4. In certain areas, quality of borehole water will be better than water from other sources in those areas
5. Saves high-quality drinking water sources
6. A publicly available suitable sites for installation of boreholes
7. Convenience for women by having water for drinking and cooking at the doorstep

3.4.6 Project Scope and Possible Implementations

The project will produce 50 sustainable boreholes and the project implemented can be adapted to other areas facing water scarcity. Feasibility of the project is high because a sustainable borehole gives ample amount of water and therefore it is not necessary to depend on rains for drinking and backyard cultivation. Sites identified can be used for other national programmes on installation of borehole technology. Sustainability of a borehole is affected by various factors such as hydro-geological conditions of the site, operation and maintenance, whether drilling has been done during the wet season and continuous usage of rehabilitated boreholes having old parts, during the dry season etc.

This project has links with certain current projects in the country. For example, NWSDB together with UNICEF has launched an accelerated groundwater development program in order to accomplish the expected growth in the rural sector. At present there are about 4000 small piped water supplies for rural areas, most of which use groundwater in the form of bore holes/large dug wells. These are maintained by community-based organisations. Development Working Group involving various governmental and non-

[12] Ferdinando D.N.J, 2011

governmental agencies has been set up in NWSDB to study the respective areas in terms of demography, population densities, available water sources, community needs for improved water services and identify requirements for development of groundwater.

3.4.7 Project activities

1. Carry out a survey to collect necessary data (vulnerable areas for climate change, hydrogeology of the sites, quality of ground water and demand etc.) in order to identify suitable sites
2. Provide necessary equipment at a concessionary rate/ Provide incentives
3. Capacity building of NWSDB/WRB/Health Department
4. A certificate course on construction of successful boreholes offered by NWSDB/WRB
5. Formulate a mechanism by WRB/NWSDB to grant approval for installation of boreholes
6. Awareness programmes on this technology for general public specially for consumers of this technology
7. Guidelines for safe and sustainable use of groundwater
8. Install 50 boreholes at sites selected
9. Promote R &D for further improvement of this technology
10. Introduce a mechanism to prevent/minimise ground water pollution
11. Introduce suitable technologies for ground water recharge
12. Project management

3.4.8 Timelines for the Proposed Activities

Table 3.6: Proposed Timelines for Implementation of Proposed Activities of Project 3

Activity	Years							
	1	2	3	4	5	6	7	8
1. Carry out a survey to collect necessary data in order to identify suitable sites								
2. Provide necessary equipment at a concessionary rate/ Provide incentives								
3. Capacity building of NWSDB/WRB/Health Department								
4. A certificate course on construction of successful boreholes offered by NWSDB/WRB								
5. Formulate a mechanism by WRB/NWSDB to grant approval for installation of boreholes								
6. Awareness programmes on this technology for general								

public								
7. Preparation of guidelines for safe and sustainable use of groundwater								
8. Install 50 boreholes								
9. Promote R &D for further improvement of this technology								
10. Introduce a mechanism to prevent/minimise ground water pollution								
11. Introduce suitable technologies for ground water recharge								
12. Project management								

3.4.9 Budget/Resource requirements

Table 3.7: Approximate Budget Estimate for the Proposed Project of Project 3

1. Carry out a survey to collect necessary data in order to identify suitable sites	1000 (D)
2. Provide necessary equipment at a concessionary rate/ Provide incentives	2000 (I)
3. Capacity building of NWSDB/WRB/Health Department	2000 (D)
4. A certificate course on construction of successful boreholes offered by NWSDB/WRB	4000 (I)
5. Formulate a mechanism by WRB/NWSDB to grant approval for installation of boreholes	1000 (D)
6. Awareness programmes on this technology for general public	2000 (D)
7. Guidelines for safe and sustainable use of groundwater	1000 (D)
8. Install 50 boreholes	8000 (I)
9. Promote R &D for further improvement of this technology	2,000 (I)
10. Introduce a mechanism to prevent/minimise ground water pollution	1000 (D)
11. Introduce suitable technologies for ground water recharge	1000 (I)
Sub-total: Cost of project activities	**25.0 M**
12. Project management (Approximately 10% of the cost of project activities)	2500 (D)
Total cost (approximately)	**27.5 M**

The cost of project activities would be US $ 25.0 million and the project management cost US $ 2.5 million. Estimated total cost of the proposed project including the project management cost would be approximately US $ 27.5 million. Required funds will be obtained through domestic (D, 10.5 million) and international (I, 17.0 million) sources as indicated in the budget estimate.

3.4.10 Measurement/Evaluation

Project specific Logical Framework Matrix (LFM) and Performance Measurement Framework (PMF) will be used for monitoring and evaluation of progress of implementation, during the course of the project. This will help to identify problems and to provide solutions to rectify such problems during the implementation phase. A scheduled internal monitoring programme (quarterly) and periodic external evaluation (biannually and mid-term) would be implemented. Quarterly internal monitoring will be carried out by the planning unit of the Ministry of Irrigation and Water Resources Management. For this purpose indicators at different stages of the project will be monitored and evaluated. External evaluation will be carried out by an independent panel of experts appointed by the line ministry (Ministry of Irrigation and Water Resources Management) in consultation with the donor agency. End of project result evaluation will also be carried out by and independent team appointed by the line Ministry and it will be incorporated to the Project Completion Report.

3.4.11 Possible Complications/Challenges

Poor quality of groundwater in certain areas in the country is a limiting factor for implementation of this project. For example, about 40 % of tube wells constructed in the last decade have been abandoned due to contamination with iron, manganese and fluoride ions. In Jaffna, contamination due to NO3- and E coli has been reported. Salt water intrusion has been reported in Putlam, Manar, Paranthan, Kilinochci and Mulathive. High concentration of F- is reported in eastern and north central regions of the dry zone. High evaporation due to temperature increase would also increase the concentration of soluble minerals in ground water (Ministry of Environment, 2011). Type of bed rock is also a limiting factor when selecting suitable sites for installation of boreholes.

Over extraction is another challenge. In Sri Lanka, a land owner has the right to pump all the water from aquifer underneath his land. This would lower the water table. As a result some aquifers are already being pumped dry by the end of the dry season and some communities have been left without drinking water.
Sustainability of boreholes also can be affected due to poor knowledge in repairing of boreholes and lack of effective operation and maintenance practices. High usage of boreholes during dry season can cause damages to rehabilitated boreholes having old parts. If the drilling is done during the wet season it also can cause failures in boreholes. Lack of proper technical assistance when selecting a suitable site also affects the sustainability of the borehole. Another problem is the high cost. Most donors and politicians prefer to support large scale conventional projects rather than community water supplies. Rural water supplies involve several stakeholders and effective coordination is lacking and need to be addressed[13].

[13] Ferdinando D.N.J, 2011

3.4.12 Responsibilities and Coordination

The implementing agency of the proposed project will be the M/Irrigation and Water Resources Management. Implementation of the project requires the support and collaboration from M/ of Water Supply and Drainage, M/ Finance and Planning, M/Environment and Natural Resources, Climate Change Secretariat, NWSDB**,** WRB, Central Bank, Treasury, Private sector, Registered organizations as tube well constructors, Dept. of Health. A Project steering committee appointed by the M/Irrigation and Water Resources Management will also carry out project coordination and monitoring on bi-annual basis.

3.4.13 List of References

1. Annual Report (2011), Central Bank of Sri Lanka
2. Ferdinando D.N.J., Accelerated Groundwater Development for Rural Water Supplies in Sri Lanka, 6th Rural Water Supply Network Forum, Uganda, http://rwsnforum.files.wordpress.com/2011/11/169-ferdinando-sri-lanka-short-paper.pdf., 2011
3. Ferdinando D.N.J., Rural Water Supply in the 21st Century: Myths of the Past, Visions for the Future**,** http://rwsnforum.files.wordpress.com/2011/11/169-ferdinando-sri-lanka-short-paper.pdf.**,** 2011
4. http://www.ecapra.org/sri-lanka
5. http://www.mwsd.gov.lk/sub_pgs/Performance2011_English.pdf; PERFORMANCE REPORT – 2011, Ministry of Water Supply and Drainage
6. Solutions for issues in construction of borehole wells in Sri Lanka: A hydrogeological and economic approach; Shanuka Palamure *et al.*, 2012

3.5 Project Idea developed by combination of all three technologies

Improve availability of drinking and irrigation water for the dry zone of Sri Lanka as an adaptation measure for climate change

3.5.1 Introduction/Background

According to climate change projections, dry zone of the Sri Lanka will be vulnerable to extended droughts, and as a result people in the dry zone will face problem of water scarcity. Therefore this project idea was developed in order to improve availability of drinking and irrigation water to the dry zone as an adaptation method by giving special attention on water conservation, water management, maintenance of the water

Quality and water Recycling for productive use. The three technologies described in the previous sections were included as sub projects under this project idea and therefore water sources will be rainwater and ground water. The three subprojects are rehabilitation/restoration of 10 minor tank network (cascade) systems to provide water for agricultural purposes, installment of quality controlled 100 roof top rain water harvesting systems and 25 bore holes especially for drinking and household purposes as in houses, temples, hospitals, schools, hotels etc.

This proposed project will be implemented at suitable sites in the North Central Province. Restoration/Rehabilitation of Minor Tank net works is an adaptation strategy for water conservation for droughts, control and capture of storm water to mitigate flooding and recharge of groundwater. Past experiences have shown that single tank rehabilitation approach is a failure and therefore, rehabilitation of the whole cascade system including the watershed area is proposed(1)A survey will be carried out in a scientific manner for identification of cascade systems/minor tanks which need restoration/rehabilitation. For this purpose, data on vulnerability to impacts of climate change, hydrology of the cascade systems, major rehabilitation work, number of beneficiaries from each tank, relocation needs, and amounts of funds available etc will be collected. Rehabilitation work normally involves breach closing, tank bund strengthening, aquatic weeds control and repairs or reconstruction to sluices and weirs etc. in a regular basis.

Lack of sustainability of minor tank systems is a current problem in the country and this is mainly due to poor operation and management practices. Implementation of active Farmer Organisations (FOs) based mechanisms will be a good way to maintain sustainability of minor tank systems. At present farmers participation in FO activities is poor and this due to many reasons. Women's participation in FOs is low and even when women attend for FO meetings, their participation is limited to listening only(2). FOs needs a lot of capacity building in technical and institutional issues to sustain the minor tank network systems. For this purpose, strong linkages between FOs and Dept. of Agrarian Development and Provincial Councils need to be established. It is essential to implement steps to build capacity of Department of Agrarian Development provincial councils, Department of Health, Farmer Organisations and Cascacde Management Teams in order to maximize the efficiency and effectiveness of restoration/rehabilitation/maintenance programmes. Under this, intensive training is needed to relevant officers of Department of Agrarian Development and provincial councils about their roles and functions with respect to farmer organizations and joint management committees, and also about the rights and responsibilities of the FOs. Monitoring of water quality of the tanks selected, health conditions of people consuming water from above tanks will be carried out. It is necessary to study whether there is a relationship between the above two in order to find a solution for prevailing health problems in certain areas in the dry zone.

Use of roof top rainwater harvesting systems is an adaptation strategy through rain water conservation and mitigating flash-floods by capturing storm water. It serves also as a method for groundwater recharge. In Sri Lanka, the demand for roof top rainwater harvesting technology is poor. Quite often water quality in storage tanks is poor due to formation of mosquito breeding sites, presence of *E Coli,* leaves and other debris and use of inappropriate roof materials by technology users. Therefore quality controlling of the rooftop rain water harvesting system is necessary. It is also necessary to explore possibility of applying German standards directly or to modify the German standards according to Sri Lanka's requirements. Training and awareness should be provided on good operation and management practices of RWH systems. By introducing subsidy schemes for storage tanks and water quality analytical services for harvested rain water, offering a tax incentive for individuals and businesses interested in installing rainwater harvesting systems and providing health condition monitoring service for persons who consume harvested rain water it is possible to promote use of roof top rainwater harvesting systems. Necessary data (results of climate change modeling, needs, rainfall, quality of rain water and air, urgency etc.) will be collected to identify suitable areas in the North Central Province to implement this technology. Steps will be implemented to build capacity and awareness of Health Department, NWSDB and general public. Inefficient enforcement of National rainwater policy is also a problem and strict enforcement of this policy is required.

Borehole technology for abstraction of ground water for domestic purposes is an adaptation strategy for surface water scarcity as it provides an alternative source for water. This method can be used if surface water is not available or not sufficient or have a bad quality. Most of the boreholes in the country have become failures and therefore to promote the sustainability of boreholes it is necessary to identify areas where suitable hydro-geological conditions are available and quality of ground water is good. Therefore technical assistance will be provided to select sites having suitable hydro-geological conditions. Arrangements will be made to offer a certificate by NWSDB/WRB, on construction of successful boreholes, so that qualified borehole constructing organizations will be available in the country. In order to maintain sustainability of ground water resource and to prevent over extraction it is necessary to provide guide lines pertaining to use of ground water resources in the country. In order to create awareness on sustainable use of ground water it is necessary to conduct awareness programmes annually and also publish guide books (in Sinhala/English/Tamil), leaflets, posters etc. Lack of /insufficient capacity (e.g. lack of trained mechanic for maintenance work, lack of capacity of NWSDB to drill tube wells in sufficient numbers due to old and unserviceable equipment) of relevant institutions/organisations is also a current problem. Private entities who engage in well drilling are small and not capable of undertaking major programmes. Therefore it is necessary to build capacity of NWSDB and WRB to offer an efficient service pertaining to this project. Providing adequate funds is necessary to maximize the output of this project as cost of implementation of this project is high due to high costs of equipment required and construction and repairing of hand pumps which are non functional. It is important to provide financial incentives through loan schemes/import tax reliefs to tube well constructors. Another problem is that, lack of/insufficient R & D pertaining to ground

water. e.g. regular monitoring of changes in ground water availability/changes in water table/ water quality. Lack of/insufficient R & D to identify exact reason(s) for Chronic kidney disease in the North Central Province and to develop a low-cost water treatment procedure are other important problems which need to be addressed. Targeting above, and many other important matters, it is necessary to promote R & D with respect to Ground water.

3.5.2 Objectives

The main objective of this project is to provide water throughout/most of the year (100%), in the North Central Province in the dry zone for agricultural and drinking purposes through properly maintained ten minor tank network systems, 100 quality controlled roof top rain water harvesting systems and 25 sustainable boreholes.

3.5.3 Outputs of the Proposed Project

- Availability of the following lists for the North Central Province.
  - Minor tank network systems (cascade systems) which need rehabilitation/restoration and availability of relevant data bank
  - Areas for installation of roof top rainwater harvesting systems and boreholes and availability of relevant data banks
- Increased awareness and Capacity of Department of Agrarian Development, Provincial councils and Health Department, Farmer Organisations and Cascacde Management Teams, WRB, NWSDB to maximize the efficiency and effectiveness of the project.
- Well maintained 10 minor tank networks (cascades) selected, 100 Quality controlled RWH systems and 25 boreholes in the North Central Province
- Accepted standards and an annual license system for roof top rainwater harvesting systems and boreholes in Sri Lanka and guidelines for safe and sustainable use of groundwater
- A method to register consumers of roof top rainwater systems and boreholes at NWSDB/WRB
- Awareness programmes for consumers on good operation and management practices
- Mitigate flash-floods by 45 % and reduce water supply costs by 50%.
- A certificate course on construction of successful boreholes offered by NWSDB/WRB and as a result, availability of a list of qualified borehole constructing organizations registered at WRB/NWSDB.

3.5.4 Relationship to the country's sustainable development priorities

Importance of restoration/rehabilitation of minor tank systems and importance of providing safe water have been recognized in *Mahinda Chinthanaya* – 'Vision for the New Future' the Government of Sri Lanka's Ten Year Development Policy Framework[4,5]. It is reported that 1000 minor tanks will be rehabilitated every year from 2010 at an annual estimated cost of Rs. 500 M. It is also expected to increase safe water coverage by 100% of the population by the year 2020. The Ministry of Water Supply and Drainage, has assigned high priority for the formulation of policies and programme for Rain Water Harvesting and has received Rs.5 Million through 2011 budget to implement a roof top rain water Harvesting Project. Considering the country's water resources, it is now recognized that, the rural water supplies will have to depend mainly on the groundwater source. Thus, the proposed project contributes to national strategy of providing water to the dry zone by restoration/rehabilitation of minor tanks.

3.5.5 Project Deliverables

- Availability of water, social development, economic wellbeing and environmental sustainability of selected areas in the North Central Province
- A detailed report on success of the project, by end of year 10.
- A list of minor tank networks (cascades) in the North Central Province in which need restoration/rehabilitation and a publicly available list of areas for installation of RWH systems and boreholes in the same districts and data banks/website providing relevant updated data
- Increase in rice yield and cropping intensity, cultivation of other field crops such as chilli, mung bean etc. in the dry season resulting 50 % increase in income of farmers
- Increase in employment opportunities by 30% through fishery, bricks, construction work related to rooftop rain water harvesting systems and boreholes etc. and food security of farmer families
- Reduction of GHG emissions
- Ground water recharge
- Convenience for women by having water for drinking and cooking at the doorstep, at least for part of the year
- Increase in employment opportunities by 6%

3.5.6 Project Scope and Possible Implementation

The project will produce ten well maintained minor tank network (cascade) systems, 100 quality controlled rooftop rainwater harvesting systems and 25 sustainable boreholes in the North Central Province and the project implemented can be adapted to other areas facing water scarcity and also for other relevant national programmes. The data bank/website can be updated with new data. The project will be

sustainable because of good operation and management practices, availability of standards for roof top rainwater harvesting systems, availability of guidelines for ground water extraction and also due to the priority given by the government.

3.5.7 Project activities

1. **Carry out a survey to collect data** on the following.
   - Urgency and results of Climate change modeling etc., needs, number of beneficiaries in vulnerable areas
   - Type of restoration/rehabilitation work required, hydrology of the tank system, amount of funds available, etc. in order to identify minor tank net works which need restoration/rehabilitation.
   - Amount of rainfall during the past few years, quality of rain water, roof top material etc. in order to identify suitable sites for rooftop rainwater harvesting systems
   - Hydrogeology of the sites, quality of ground water and demand etc. in order to identify suitable sites for boreholes
2. **Increase awareness and build Capacity** - of Department of Agrarian Development, Provincial councils and Health Department, Farmer Organisations and Cascade Management Teams, WRB/NWSDB, consumers
3. **Introduction of standards/Annual license/Guidelines** - Formulate standards and an annual license system for roof top rainwater harvesting systems and annual license for boreholes, guidelines for safe and sustainable use of groundwater
4. **Awareness programmes** - for consumers on good operation and management practices
5. **Strict enforcement of policies/mechanisms** - Strict enforcement of rainwater harvesting policy, mechanism to prevent/minimize ground water pollution
6. **Introduction of strategies to promote the three sub projects** - Introduce alternative employments for extended dry seasons and introduce an awards system for Farmer Organisations and Cascade Management Teams showing best tank management practices, Provide necessary equipment at a concessionary rate/ Provide incentives for installation of rooftop rain water harvesting systems and boreholes.
7. **Introduction of a certificate course** on construction of successful boreholes offered by NWSDB/WRB
8. **Introduction of suitable technologies for ground water recharge**
9. **Strengthen the coordination among relevant institutions** – e.g. Develop a collaborative mechanism between Department of Agrarian Development and Provincial Councils pertaining for restoration/rehabilitation work.
10. **Establish a sound maintenance system** for 10 minor tank network (cascade) systems, 100 quality controlled RWH systems and 25 boreholes in the North Central Province.

11. Promote R &D for further improvement of the project
12. Project Management

3.5.8 Timelines for the proposed activities

Table 3.8: Proposed Timelines for Implementation of Proposed Activities

Activity	Year									
	1	2	3	4	5	6	7	8	8	10
1. Carryout a survey to collect necessary data in order to identify suitable areas/sites										
2. Increase awareness and build Capacity of relevant parties										
3. Introduction of standards/ Annual license/ Guidelines										
4. Awareness programmes for consumers										
5. Strict enforcement of policies/mechanisms										
6. Introduction of strategies to promote the sub projects identified										
7. Introduction of a certificate course on construction of successful boreholes										
8. Introduction of suitable technologies for ground water recharge										
9. Strengthen coordination among relevant institutions										
10. Establish a sound maintenance system for 10 minor tank network systems, 100 quality controlled RWH systems and 25 boreholes										
11. Promote R & D										
12. Project Management										

3.5.9 Budget/Resource requirements

Table 3.9: Approximate Budget Estimate for the Proposed Project

Activity/Sub Activity	Budget (US$) 000'
1. Carryout a survey to collect necessary data in order to identify suitable areas/sites.	5,000 (I)
2. Increase awareness and build Capacity of relevant parties	5,000 (I)
3. Introduction of standards/ Annual license/ Guidelines	1,200 (D)
4. Awareness programmes for consumers	3,000 (D)
5. Strict enforcement of policies/mechanisms	1,000 (D)
6. Introduction of strategies to promote the sub projects identified	2,000 (D)
7. A certificate course on construction of successful boreholes	4,000 (D)
8. Introduce suitable technologies for ground water recharge	2,000 (D)
9. Improve coordination among relevant institutions	2,000 (D)
10. Well maintained 10 minor tank network systems, 100 quality controlled RWH systems and 25 boreholes	30,000 (I)
11. Promote R & D	10,000 (I)
Subtotal: Cost of project activities	**65,200**
12. Project Management	6,000 (D)
Total cost (Approximately)	**71.2 M**

The cost of project activities would be US $ 65.2 million and the project management cost US $ 6.0 million. Estimated total cost of the proposed project including the project management cost would be US $ 71.2 million. Required funds will be obtained through domestic (D, 21.2 million) and international (I, 50.0 million) sources as indicated in the budget estimate.

3.5.10 Measurement/Evaluation

Project specific Logical Framework Matrix (LFM) and Performance Measurement Framework (PMF) will be carried out for monitoring and evaluation of progress of implementation, during the course of the project. This will help to identify problems and to provide solutions to rectify such problems during the implementation phase. A scheduled internal monitoring programme (quarterly) and periodic external evaluation (biannually and mid-term) would be implemented. Quarterly internal monitoring will be carried out jointly by Ministry of Agrarian Services and Wildlife Conservation, Ministry of Irrigation and Water Resources Management and Ministry of Water Supply and Drainage. For this purpose indicators at

different stages of the project will be monitored and evaluated. External evaluation will be carried out by an independent panel of experts appointed by line ministries (Ministry of Agrarian Services and Wildlife Conservation, Ministry of Irrigation and Water Resources Management and Ministry of Water Supply and Drainage) in consultation with the donor agency. End of project result evaluation will also be carried out by and independent team appointed by line ministries and it will be incorporated to the Project Completion Report.

3.5.11 Possible Complications/Challenges

Potential challenges for achieving targets of rehabilitation/restoration of minor tank net work (cascade) systems are lack of a national water policy for the country, political intervention in decision making, poor enforcement of environmental policies/rules, lack of regular water quality monitoring programmes, absence of principles for sharing water between the upper and lower riparian as well as between drinking and irrigation purposes, allocation of water by large water users to themselves regardless of the needs of others and high cost of heavy machinery and equipment required for heavy rehabilitation processes. Another challenge is that reason(s) for prevailing kidney diseases reported in Anuradhapura are not yet confirmed.

Potential challenges for achieving targets of installation of roof top rain water harvesting systems are high cost for storage tanks, maintenance, pump, pressure controller and fittings and plumber's labour. Another disadvantage is the limited supply and uncertainty of rainfall. The first rain drains the dust, bird droppings, leaves, etc. which is found on the roof surface and it may contaminate harvested rain water result in health risks. Other disadvantages include low storage capacity which will limit rainwater harvesting, whereas, increasing the storage capacity will add to the construction and operating costs making the technology less economically feasible. Leakages from cisterns can cause deterioration of load-bearing slopes.

Potential challenge for achieving targets of installation of boreholes is poor quality of groundwater in certain areas is a limiting factor for implementation of this project. For example, about 40 % of tube wells constructed in the last decade have been abandoned due to contamination with iron, manganese and fluoride ions, salt water intrusion etc. Type of bed rock is also a limiting factor when selecting suitable sites for installation of boreholes.

3.5.12 Responsibilities and Coordination

The proposed project will be implemented jointly by Ministry of Agrarian Services and Wildlife Conservation, Ministry of Irrigation and Water Resources Management and Ministry of Water Supply and Drainage. Implementation of the project requires the support and collaboration from M/Local Government and Provincials, M/Health, M/ Finance and Planning, M/ Fisheries and Aquatic Resources, M/Science & Technology, M/Environment (Climate Change Secretariat), Dept. of Agrarian Development, Provincial Councils, Dept. of Health, NWSDB, WRB, Medical Officers of Health, local and international NGOs,

private sector institutions, Farmer organizations, Cascade Management Teams, Urban Development Authority, CEA, Lanka Rain water Harvesting Forum, Inland fisher communities, Universities, Research Institutes, Central Bank, Treasury, Private sector, Registered organizations as tube well constructors, A Project steering committee appointed jointly by line ministries (Ministry of Agrarian Services and Wildlife Conservation, Ministry of Irrigation and Water Resources Management and Ministry of Water Supply and Drainage) will carry out project coordination and monitoring on bi-annual basis.

3.5.12 List of References

1. Water Issue Brief: IWMI; ISSUE 7 2010
2. National Conference on Water, Food Security and Climate Change in Sri Lanka-Volume 3. Policies, Institutions and Data Needs for Water Management, Volume 3, K.Jinapala, Sanjiv De Silva and M.M.M. Aheeyar, editors; June 2009
3. Adrienne LaBranche, Hans-Otto Wack, David Crawford, Ed Crawford, Nickolas J. Sojka, DVM and Cabell BrandVirginia; Rainwater Harvesting Manual 2007, 2009; The Cabell Brand Center
4. DIN 1989-1. 2002. Rainwater Harvesting Systems – Part 1: Planning, Installation, Operation and Maintenance. German Institute for Standardisation, Berlin, 2002.
5. Annual Report (2011), Central Bank of Sri Lanka
6. Mahinda Chinthanaya - The Department of National Planning; 2010
7. Dayaratne M.H.S.,A Review of Alternative Strategies for Improving Farmer-Managed Irrigation Systems in Sri Lanka IIMI Country Paper-Sri Lanka-No.7 ,1991
8. Impact of Climate Change on Agriculture in Sri Lanka, C. Shanthi de Silva, 2012, http://climatenet.blogspot.com/2012/09/impact-of-climate-change-on-agriculture.html
9. Krishnaveni M, Sankari Silva, Rajeswari A, Rehabilitation of Irrigation Tank Cascade System Using Remote Sensing GIS and GPS, International Journal of Engineering Science and Technology (IJEST)ISSN : 0975-5462, 2011, p.1624
10. Sri Lanka's second national communication on climate change, Ministry of Environment, 2011
11. UNICEF, Evaluation of the Rooftop Rainwater Harvesting Project, Study Abstract 2004
12. Rainwater Harvesting Project at the Development Technology Unit of School of Engineering, University of Warwick, UK , http://www.eng.warwick.ac.uk/DTU
13. Ferdinando D.N.J., Accelerated Groundwater Development for Rural Water Supplies in Sri Lanka, 6th Rural Water Supply Network Forum, Uganda, http://rwsnforum.files.wordpress.com/2011/11/169-ferdinando-sri-lanka-short-paper.pdf., 2011
14. Ferdinando D.N.J., Rural Water Supply in the 21st Century: Myths of the Past, Visions for the Future, http://rwsnforum.files.wordpress.com/2011/11/169-ferdinando-sri-lanka-short-paper.pdf., 2011
15. http://www.ecapra.org/sri-lanka

16. http://www.mwsd.gov.lk/sub_pgs/Performance2011_English.pdf; PERFORMANCE REPORT – 2011, Ministry of Water Supply and Drainage
17. Solutions for issues in construction of borehole wells in Sri Lanka: A hydrogeological and economic approach; Shanuka Palamure *et al.*, 2012.

CHAPTER 4

Project Ideas for Coastal Sector

4.1 Brief summary of the Project Ideas for Coastal Sector

Coastal belt of Sri Lanka, which is an island in the Indian Ocean, is 1620 km and it includes several sensitive ecosystems, i.e. coral reefs, mangroves, sand dunes, sea grass beds, lagoons, estuaries, salt marshes and other wetlands, which are of ecological and economic importance to the country. Their extent is as indicated in Table 1

Table 4.1: Extent of important coastal ecosystems around Sri Lanka

Type of ecosystem	Area (ha)/% from coastline
Estuaries & Lagoons	158,017 ha
Mangroves	12,500 ha
Salt marshes	23,819 ha
Sand dunes	7,606 ha
Beaches	11,788 ha
Marshes	9,754 ha
Other water bodies	18,839 ha
Coral reefs (near shore fringing reefs)	32.4 Km (2% of the coastline) (Swan,1983)

Source: State of the Environment, 2001; Rajasuriya, 2011

The occurrence and response to the effects of climate change and impacts due to Sea Level Rise (SLR) will not be uniform around the country due to the high morphological and ecological variability of Sri Lanka's coastal zone, on different coastal areas can vary drastically. Most important impacts expected to the coastal zone of Sri Lanka due to the 0.5m average global SLR expected by 2050 are coastal inundation and erosion, loss of coastal terrestrial habitats, saltwater intrusion and changes in biodiversity and in coastal morphology. Considering the above, the Sri Lanka's 2nd National Communication to the UNFCC, several adaptations required for Climate Change in the Coastal Sector have been identified and they are; Identification of available resources; Area Management Plans; Monitoring Methodology; Integrated Coastal Zone Management and Wetlands Conservation; Near Shore infrastructure & Tourism.

Considering the economic feasibility of activities that could be adapted to Sri Lanka to reduce the impact of climate change on the coastal belt, three most socio economically important adaptive technologies with an economic feasibility were identified and accordingly, following project ideas were developed.
The table shows proposed projects for each of the three prioritized technologies:

Technology	Project Idea
1. Restoration of Sand dunes	1. Rehabilitation and restoration of sand dunes in North Western, Southern & Eastern Provinces of Sri Lanka as a soft barrier against sea level rise, while improving socioeconomic status of coastal communities.
2. Rehabilitation of Mangroves	2. Rehabilitation of mangroves as soft barriers against sea level rise in the North Western, Eastern and Southern coastal belts of Sri Lanka, while maintaining the ecological balance and sustainability of socioeconomic activities, ,
3. Restoration of Coral Reefs	3. Restoration of coral reefs of southern and south-western coastal belt of Sri Lanka, as a soft barrier against sea level rise and coastal erosion and as a tourist attraction to promote eco-friendly tourism.

4.2 Project Idea for Technology 1: Restoration of Sand dunes

Project Idea:

'Rehabilitation and restoration of sand dunes in North Western, Southern & Eastern Provinces of Sri Lanka as a soft barrier against sea level rise, while improving socioeconomic status of coastal communities'

4.2.1 Introduction/Background

A sand dune is a mount, hill or ridge of sand that lies behind the areas affected by tidal action. Sand separates out from the soil that washes off to the coastal belt from inland rivers, due to density variations of different components such as clay, humus, etc. and deposits on beaches. The series of mounts/hills/ridges formed by this continuous landwards pushing of the sand by wind, are known as dunes and are formed over many years. Sand dunes are distributed along the South-Western, South-Eastern and Eastern coasts of Sri Lanka. As an adaptation against coastal erosion and inundation, due to sea level

rise, these natural sand barriers with their vegetation could be used. Wherever they have been removed as a result of human activities, dune vegetation should be replanted.[14]

Coastal dune flora plays an important role in dune stabilization and restoration due to their root and vegetative systems, which are adapted to hold the dune sand. Their economic and medicinal values also have been reported. *Pandanus* plantations are widely practiced in Pacific islands and it has been accepted by the local communities, due to its economic value. Under the tsunami rehabilitation programme funded by the CIDA (Candada) assisted the coastal communities of Matara District (Southern Province, Sri Lanka), for re-establishing *Pandanus* sp. Medicinal value of dune flora has been reported by a study in Puducherry in India, where 52 species of medicinal herbs, belonging to 34 families have been identified[15]. Since Sri Lanka's closest neighbour is India, with floral species common to both countries, most of the above medicinal plants could be indigenous to Dune ecosystems of Sri Lanka.

Restoration of sand dunes and its vegetation were given least attention, until the destructive tsunami struck the coastal districts of Sri Lanka. In certain areas where the natural sand dunes and vegetation existed, it provided protection to coastal infrastructure and human dwellings. Coastal communities are depending on resources extracted from dune ecosystems for their socioeconomic gains and they are reluctant to give up such activities, due to absence of alternative income sources available in the area. Extraction of dune sand for construction purposes, extraction of dune vegetation for cottage industries and clearing of dune areas for economic activities (tourism, fisheries, etc.), are the most important destructive anthropogenic activities that affect the dune ecosystems. This is a result of the general lack of awareness on the non-extractive importance of sand dunes & its vegetation and/or the selfish attitudes of persons involved in economic activities. Destruction of sand dunes are reported quite often in the North-Western Province of Sri Lanka, due to uncontrolled anthropogenic activities, such as use of heavy vehicles for operation of beach seines, illigal removal and transportation of dune sand for construction purposes, disturbance of dunes for coastal constructions such as tourist resorts, etc. . In addition to the above *Pandanus* plants with a root system that helps to stabilise the dune sand is used for cottage industries and its flower is used for religious activities which will be a serious threat to the genetic diversity within *Pandanus* plantations.

Propagation of plants could be done by using seeds or propagules of indigenous dune vegetation. Choudury et al., (2003) (as quoted by Mittapala, 2010) have highlighted the additional problems when exotic species such the Whistling Pine (*Casuarina equisetifolia*) are planted; viz. prevention of marine turtles from nesting. Some of the coastal plantations of *Casuarina equisetifolia* in Matara and Hambantota

[14] Joseph, 2001

[15] Padmavathy & Anbarashan, 2011

Districts proved to be unsuccessful as green belts during tsunami in 2004. Best protection against tsunami was given by natural dune vegetation such as *Pandanus spp.*

This project will be conducted in the South-Western, Southern and Eastern coastal districts of Sri Lanka and from each of the districts one sand dune site is selected and they are Kalpitiya, Hambantota and Pottuvil. Issues to be addressed are, Inadequate funds for dune restoration; Lack of awareness among stakeholders on non-extractive uses of sand dune ecosystems; Inadequate knowledge on suitable vegetation to be used for restoration programmes; Lack of alternative livelihoods for communities depend on dune resources for socioeconomic activities and Poor coordination/cooperation among stakeholders, when rapid development programmes are introduced to the coastal area.

4.2.2 Objectives

The objectives of the proposed project are as follows;

- Restoration of sand dunes and its vegetation subjected to anthropogenic destructions to develop soft barriers against SLR, storm surges, inundation, etc. and as wind belts where ever it is applicable.
- Conserve natural sand dunes and turtle nesting sites in their vicinity.
- Reduce unemployment among coastal communities depend on dune resources and improve their socioeconomic status through sustainable management of sand dunes and their resources.
- Uplift the country's economy through eco-friendly tourism within coastal belts with sand dunes

4.2.3 Outputs and measurables:

Rehabilitation of sand dunes with dune vegetation in 10 suitable sites with an area of 2 ha in each site. Train at least 100 persons from all three coastal districts as trainers for rehabilitation and sustainable utilisation of sand dunes and its resources, tissue culture, SMEs related to dune resources, ecotourism, etc. Establishment of 3 tissue culture laboratories in research/academic institutions, establishment of at least four SMEs in each of the coastal districts selected. Establishment of sand dune nature trails and herbal gardens with clusters of tourist resorts. In areas affected by strong winds development of wind belts using dune vegetation 25% reduction of sand dune extraction for construction purposes.

Measurable output of the project would be around 25% reduction of unemployment among coastal communities by 4th quarter of year 2005 (Second year). Elevation of the coastal belt at least by 10cm height.

4.2.4 Relationship to the country's sustainable development priorities

As expected by the National Environment Policy (NEPO, 2003) protect and sustainably manage of coastal environment and resources of dune ecosystems, by maintaining transparency and public accountability, securing sustainable socioeconomic development, healthy and peaceful life style of all coastal communities and stakeholders by developing a pleasant coastal environment and securing the human dwellings and their properties and by providing employment opportunities while reducing destructive anthropogenic activities. Conserve the natural biodiversity of sand dunes as reservoirs as laid down by the National Policy on Wild Life Conservation (2000), and maintain resources, soils, water and aesthetic values, to increase the tree cover and productivity of the natural dune vegetation to meet the protection from the impacts of natural hazards and SLR to present and future generations for their products and services and to enhance the contribution to the welfare of the coastal communities and by strengthening the national economy, with special attention paid to equity in economic development. Conserve, protect and manage the coast & its resources for the wellbeing of the coastal communities and to improve the socio-economy of coastal communities and the country's economy according to the Conservation Act No. 57 & Act No. 64, Coastal zone management plan (CZMP1997 & 2004), conservation Act. 1990 an Mahinda Chinthena (2005) pp 61 & 64 and *Mahinda Chinthena* way forward (2010)– Vision for the New Future, the Government of Sri Lanka's Ten Year Development Policy Framework[16]..

4.2.5 Project Deliverables

- Protection to the coastal communities from impacts of SLR and strong winds, while providing security to their socioeconomic activities, protecting their dwellings, providing alternative employment opportunities and necessary training to eco-friendly economic activities.
- Improvement of tissue culture technology for production of dune plant prapagules.
- Conservation and protection of coastal dune biodiversity.
- Improvement of ecotourism and attraction of foreign exchange earnings.
- Improve the aesthetic values of the coastal belt through rehabilitation of indigenous dune vegetation and through introduction of beneficial exotic plants species.

4.2.6 Project Scope and Possible Implementation

Three successful sand dune rehabilitation programmes will be established in the Southern, North-Western and Eastern coastal districts of Sri Lanka and information on most suitable plant species and technology to

[16] Mahinda Chinthana Policy Framework, 2005.

be used will be made available through detailed publications for future expansions of such projects. Economically feasible tissue culture techniques and SMEs based on dune products will be developed through research and such information will be published. Most of the activities will be conducted with community and stakeholder participation and it will ensure socioeconomic sustainability of the community while rehabilitation the dune ecosystems.

4.2.7 Project Activities

1. Selection of suitable sites each with an area of 2 ha of sand dunes for restoration
2. Awareness/training for all stakeholders
3. Establishment of tissue culture laboratories & nurseries in three coastal districts selected
4. Planting sand dune vegetation (2ha in each site selected) and monitoring of performance of restored sand dunes
5. Establishment of Small and medium scale enterprises (SMEs) and community participatory programmes using products from sand dune vegetation
6. Adoption to wider areas (to 10 ha)in each site selected within the sand dunes selected from the coastal belt
7. Evaluation of success

4.2.8 Timelines for the proposed activities

Table 4.2: Proposed Timelines for Implementation of project activities

Activity	Year/ Quarter																											
	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7			
1. Selection of suitable sites																												
2. Awareness/training																												
3. Establishment of tissue culture laboratories & nurseries																												
4. Planting sand dune vegetation and monitoring performance (2ha in 3 sites)																												
5. Establishment of SMEs and development of community participatory																												

programmes																												
6. Adoption to wider area (10ha in each of the 3 sites)																												
7. Evaluation of success																												

4.2.9 Budget/Resource requirements

Table 4.3: Approximate Budget Estimate for the Proposed Project

No.	Activity/Sub Activity	Budget (US $)		
		Domestic	International	Total
1	Selection of suitable sites	50,000		50,000
2	Awareness/training	138,500	537,500	676,000
3	Establishment of tissue culture laboratories & nurseries	260,000	590,000	850,000
4	Planting sand dune vegetation and monitoring performance (2ha in 3 sites)	30,000	120,000	150,000
5	Establishment of SMEs and development of community participatory programmes	101,000	354,000	455,000
6	Adoption to wider area (10ha in each of the 3 sites)	52,000	103,000	155,000
7	Evaluation of success	59,000	-	59,000
Subtotal: Cost of Project Activities		**690,500**	**1,704,500**	**2,395,000**
8.	Project management cost	239,500	-	239,500
Total budget for Technology 1		**930,000**	**1,704,500**	**2,634,500**

The cost of project activities would be approximately US $ 2.395 million and the project management cost would be around 10% of the cost of project activities (US $ 0.24 million). Estimated total cost of the proposed project including the project management cost would be approximately US $ 2.635 million. Required funds will be obtained through domestic (US $: 0.93 million) and international (US $: 1.705 million) sources as indicated in the budget estimate.

4.2.10 Measurement/Evaluation:

An internal monitoring programme (quarterly) and periodic external evaluation (biannually and mid-term) would be implemented for project monitoring and evaluation. Quarterly internal monitoring will be carried out by the planning unit of the Coast Conservation Department. External evaluation will be carried out by

an independent panel of experts appointed by the line ministry (Ministry of Fisheries and Aquatic Resources) in consultation with the donor agency.

Monitoring and evaluation of project activities will be done as follows;

- **Awareness** can be evaluated by the level of involvement of different stakeholders in conservation/ rehabilitation and knowledge dissemination programmes.
- **Annual expansion of sand dunes/dune vegetation** can be measured by the expansion of area covered by dune vegetation. Aerial photographs could be used.
- **Efficiency as a soft barrier against SLR** could be measured by the increased elevation of the coastline and by the stability of dunes and their vegetation under harsh conditionsc.
- **Success of dune plantations** can be evaluated by the numbers of dune plantations/herbal gardens, numbers of propagules of dune plants produced per year by each nursery
- **Success of nurseries established and their performance** could be evaluated by the numbers of nurseries and the quality of propagules produced
- **Effect of training** given on tissue culture could be evaluated by umbers of persons with respective training
- **Quality of propagules** could be evaluated by their survival and growth rate
- **Effect on reduction of unemployment** can be evaluated by numbers employed in sand dune related socioeconomic activities
- **Impact on tourism** could be evaluated by the number of tourists visit nature trails, turtle hatcheries, herbal gardens, etc. every year and through the foreign exchange earnings
- **Improvement of socioeconomic standards** could be evaluated by the increase of average annual income of coastal communities involved in sand dune related activities.
- **Reduction in use of dune sand for construction work** can be evaluated by the invention of new material in place for dune sand for construction purposes.

4.2.11 Possible Complications/Challenges

Inadequate funding for initiation and continuation of the project until it reaches, self sustainable levels; Inadequate international donor funding; Inadequate involvement of local communities, NGOs & INGOs; Resistance from the community to give up their unsustainable socioeconomic activities that are harmful to dune ecosystems; Inadequate patronage at provincial and national government level; Inadequate funding for capacity building at research & higher education institutions for research activities related to plant tissue culture, tissue culture and genetic studies to produce propagules which are temperature and salinity tolerant and with a high growth performance; Unavailability of easily adaptable species of dune flora with a high growth rate and with a high temperature and salinity tolerance; Slow performance/ progress of the project which is politically not attractive; Insufficient collaboration/cooperation among, different stakeholders

Frequent occurrence of extremely harsh environmental conditions such as strong wave action, storm surges, strong winds, etc., prior to establishment and strengthening of dune ecosystems

4.2.12 Responsibilities and Coordination

Stakeholder	Responsibility	Collaborations
CCD	ICZM, Coastal Protection & coordination of coastal projects & development plans	Stakeholders of coastal belt
M/Environment & Natural resources	Policy decisions, financial planning & administration related to coastal environment	All stakeholders, line ministries & treasury
Universities	Training, awareness & research	R & D institutes, CCD, CBOs, NGOs
Tourist Board	Coastal eco-tourism related to dune ecosystems	Tourist hotel owners, CCD, CEA, M/Indigenous medicine
Tourist hoteliers	Coastal eco-tourism related to dune ecosystems, establishment of nature trails among dune vegetation, turtle nesting sites & herbal gardens, reduce environmental impacts to sand dunes	Tourist Board, M/ local government and provincial councils, CBOs, NGOs,
National Physical Planning Department/	Identification of suitable development plans for the coastal belt to reduce impacts on sand dune ecosystems	CCD, M/Tourism, Tourist Board, M/Local government & Provincial Councils
CEA	Conducting IEEs & EIAs	CCD, MEPA,. Research & Higher Educational Institutes
M/Agricultural Development,	Policy decisions related to Agricultural activities, development of dune plantations of economic importance, promote agrarian research	M/Technology & Research, Higher educational & Research Institutes
M/ Indigenous medicine,	Identification of medicinal plants among dune vegetation to establishment of herbal gardens & develop make value added medicinal products from dune plants	M/Tourism, Tourist Board, M/Industrial Development, CBOs, Higher Educational & Research Institutions
M/ Industrial Development,	Awareness and introductions of SMEs	Higher educational & Research Institutions, SMEs, NGOs, CBOs
M/ local government and	Planning of development plans and socioeconomic activities for the well being of	CCD, M/Environment & natural Resources, CBOs, NGOs,

provincial councils.	coastal communities and provide sources of funding for dune rehabilitation activities and to establish CBOs	
M/Technology &Research	Providing funds for R&D activities related to sand dune ecosystems and their resources	M/Finance & Planning, Higher educational & Research Institutions, National & International funding sources
Agrarian research institutes,	Research on establishing suitable environmental conditions (soil, irrigation, fertilizer, etc.)for dune plantations with suitable plant diversities,	Higher educational & other research institutions
SLCARP	Preparation & introduction of relevant agrarian research policies	M/Agricultural Development, Higher Educational & Research Institutes related to Agrarian Services & Research
Botanical garden	Identification of dune plants and awareness & training on maintaining nurseries & dune plantations	Higher educational & Agrarian Research Institutions
Coast Guard	Protection of coastal belt from harmful activities	CCD, MEPA
CBOs	Involvement of community for rehabilitation of sand dunes, establishment & maintenance of dune plantations , awareness on the importance of dunes and dissemination of knowledge on sand dunes, its vegetation, SMEs related to dune resources, etc.	CCD, Higher Educational & Research institutions, NGOs, INGOs, SMEs, M/Industrial Development, M/Tourism,Tourist Board, Tourist Hotel owners
MEPA	Protection of coastal & marine environment from pollution and man-made hazards	CCD, CEA, Coast Guard, Higher Educationmal & Research Institutions
INGOs & NGOs	Organising community participatory workshops, training, finding finances, etc. for dune rehabilitation & socioeconomic activities	CCD, CBOs, M/ local government and provincial councils, Universities/Research Institutions
ICTAD	Development of alternatives for dune sand for construction work & conduct training & awareness programmes about them	NSF, NBRO,
NBRO		NSF, ICTAD
SLLRDC	Beach Nourishment & Dune rehabilitation	CCD, M/National Planning & Development
NSF	Establish Research priorities related to sand	M/Finance & Planning, Higher

	dune restoration, sustainable utilization of resources & provide funding for projects	Educational & Research Institutions, International funding agencies

Duplication of roles will be minimized by **Coast Conservation Department who is the organization responsible for Integrated coastal zone management serving as the main stakeholder and project implementing organization** to conduct the project in collaboration with the participation of all other stakeholders shown above, developing the project proposals with their cooperation and collaboration and by identifying the specific responsibilities of each stakeholder within each project. Preparation of multidisciplinary development projects, with identification of sub projects to be handled by different stakeholder groups/ institutions/organizations and make separate budgetary allocations according to the tasks to be handled, inclusion of key officials from relevant stakeholder institutions/establishments when forming a project coordinating body, participation of all stakeholders, during project progress review meetings also will minimize duplication of roles.

4.2.13 List of References

1. Jayatilake, A. 2008, Climate Change due to Global Warming: A Global Challenge in Sri Lanka Perspective. Economic Review, 2008
2. Joseph, Leslie. NATIONAL REPORT OF SRI LANKA,on the Formulation of a Trans-boundary Diagnostic Analysis and Strategic Action Plan for the Bay of Bengal Large Marine Ecosystem Programme *http://www.boblme.org/documentRepository/Nat_Sri Lanka.pdf*
3. Kotagama, S .W. & C N B Bambaradeniya (2006). An Overview of the Wetlands of Sri Lanka and their Conservation Significance. In "National Wetland Directory of Sri Lanka, Colombo, Sri Lanka". IUCN Sri Lanka and the Central Environmental Authority. http://dw.iwmi.org/wetland/SriLankanWetland_Introduction.aspx)
4. Linham, Mathews M. & Robert J. Nicholls((2010). Technologies for Climate Change Adaptation – Coastal Erosion & Flooding- (Xaanil Zhu ed.). UNEP Riso Centre, University of Southhampton. ISBN978-87550-3855-4
5. Ministruy of Environment (b), 2010, Climate Change Vulnerability in Sri Lanka - Sector Vulnerability Profile: Water.
6. Ministry of Environment(a), 2010, Climate Change Vulnerability in Sri Lanka - Sector Vulnerability Profile: Urban Development, Human Settlements and Economic Infrastructure.
7. Miththapala, S (2008). Seagrasses and Sand Dunes. *Coastal Ecosystems Series* (Vol 3) pp 1-36 + iii. Colombo, Sri Lanka: Ecosystems and Livelihoods Group Asia, IUCN.
8. National Climate Change Adaptation Strategy for Sri Lanka 2011 – Practical Action. www.climatechange.lk/adaptation/.../Strategy_Booklet-Final_for_Pri...(visited *in July 2012)*

9. Packham, J. R. and Willis, A. J (1997). *Ecology of dunes, salt marsh and shingle.* 352 pp. New York, NY: Springer. 352 pp.
10. Padmavathy, A.* and M. Anbarashan, (2011)., Phytomedicinal study of coastal sand dune floras in Puducherry. Journal of Medicinal Plants Research Vol. 5(12), pp. 2566-2571, 18 June, 2011.Available online at http://www.academicjournals.org/JMPR. ISSN 1996-0875 ©2011 Academic Journals
11. Rajasuriya, A (2001). Development, Environment & Management Associates (2001). Sri Lanka :State of the Environment-2001. http://www.grida.no/soe/iea/Purna/PDF-file/National%20SOE/Srilanka/SoE_SRILNK.pdf.
12. Sivarajah, P. and M. Anas, (2010). Community dependency on sand dunes for household income: Evidence from two coastal villages in Pottuvil. Department of Agricultural Economics Faculty of Agriculture Eastern University, Sri Lanka. http://environmentlanka.com/blog/2010/community-dependency-on-sand-dunes-for-household-income-evidence-from-two-coastal-villages-in-pottuvil/
13. Species Profiles for Pacific Island Agroforestry (2006) *Pandanus tectorius* (pandanus) Pandanaceae (screwpine family) www.traditionaltree.org (april 2006)
14. Thomson, Lex A.J., Lois Englberger, Luigi Guarino, R.R. Thaman, and Craig R. Elevitch, (2006). Species Profiles for Pacific Island Agroforestry: *Pandanus tectorius* (pandanus). April 2006, ver. 1.1 www.traditionaltree.org (visited in 2012)

4.3 Project Idea for Technology 2: Rehabilitation of Mangroves

Project Idea:

'Rehabilitation of mangroves as soft barriers against sea level rise in the North Western, Eastern and Southern coastal belts of Sri Lanka, while maintaining the ecological balance and sustainability of socioeconomic activities'

4.3.1 Introduction/Background

The mangrove systems covering an area of 6000-7000 ha are interspersed along the coastline of Sri Lanka. The largest mangrove system is located in Puttalam Lagoon – Dutch Bay – Portugal Bay complex and covers an area of 3385 ha. The other large concentrations are in Batticaloa and Trincomalee districts. The mangrove forests in Bentota are highly threatened as a result of unchecked growth of the tourism sector. Until recent times, mangrove areas have received very little or no attention in terms of their conservation or sustainable management. As a result, most of the mangrove areas have been lost due to indiscriminate clearing and reclamation for industrial, urban, tourist resorts, roads, aquaculture ponds, and fishing ports development. Although the legal jurisdiction of the mangrove ecosystem falls under the Forest Department, Department of Wildlife Conservation, and the Coast Conservation Department, there is

inadequate legal protection for protection of mangroves in the country. Total land area in Sri Lanka covered by mangroves is around 12,570 Acres. This unique ecosystem is home to over 20 true mangrove species of Sri Lanka and the major genera that represent these species are *Avicennia, Rhizophora*, *Bruguiera*, and *Sonneratia*. In addition to the true mangroves there are several species of plants found in association with mangroves and they are known as "Associated Mangroves" and details of them are also important for replanting programmes.

There has been indiscriminate exploitation of mangroves for commercial, industrial, housing needs mainly due to the lack of knowledge of non-extractive and ecological role of the mangroves amongst the decision-makers. Coastal wetlands also provide a number of important ecosystem services, which are of socioeconomic importance, which includes water quality and climate regulation. They are valuable accumulation sites for sediment, contaminants, carbon and nutrients and they also provide vital breeding and nursery ground for a variety of birds, fish, shellfish and animals. They are also a sustainable source of timber, fuel and fibre[17]. Wetlands are capable of undergoing 'autonomous' adaptation to SLR, through increased accumulation of sediments to allow the elevation of the wetland to keep pace with changes in sea level (Nicholls & Klein, 2005). Provided wetlands are not subjected to coastal squeeze, and the rate of SLR is not too rapid to keep pace, wetlands are capable of adapting to SLR without further investments.

Red mangrove (*Rhyzophora mangle*) is a source of timber, fuel, railroad ties and tannin in the tropics and it is having a short crop rotation period, which makes it a popular choice. In Asia, It is also used for construction of boats, houses and furniture for which commercial mangrove production is necessary. The wood of this plant is used for manufacture of charcoal and for industrial applications such as metal production, due to its high calorific value.
There are four major problems to be addressed and they are; inadequate financial assistance for rehabilitation of mangroves; inadequate awareness among all stakeholders on the importance of non-extractive uses of mangroves; inadequate knowledge on suitable floral species, composition/diversity and density to be used for restoration of mangrove vegetation; lack of alternatives to communities who depend on mangroves for socioeconomic activities and poor coordination among stakeholders when rapid development programmes are undertaken in mangrove areas.

This project would be implemented in the South-Western, Eastern and Southern provines of Sri Lanka. For rehabilitation of mangroves, 5 districts are selected and they are Puttlam (Kalpitiya) & Mannar Districts from the North-Western Province, Baticoloa & Mulativu Districs from the Eastern Province and Hambantota from the Southern Province.

[17] White et al., 2010

4.3.2 Objectives

- Restoration of mangroves and its vegetation, to develop soft barriers against SLR, storm surges, inundation, etc. and as wind belts where ever it is applicable.
- Conservation of natural sand dunes and turtle nesting sites in their vicinity to promote eco-tourism
- Reduce unemployment & to uplift socioeconomic status of coastal communities.
- Explore the possibilities of introducing economically important exotic species of mangrove plant species (e.g *Rhyzophora mangle*) to Sri Lanka and also the possibilities of using other Rhyzophora spp available in Sri Lanka for such small-scale industries.
- Uplift the economy of the country, through development of eco-friendly within coastal belts with mangroves.

4.3.3 Outputs and measurable

At the end of the project following would be achieved,

1. Ten (10) suitable sites with an area of 2ha of mangroves will be rehabilitated.
2. About 100 persons will be trained as trainers for future rehabilitation programmes, tissue culture techniques, plant propagation, sustainable utilisation of dune resources, for SMEs, ecotourism, etc.
3. Three (03) tissue culture laboratories will be established.
4. Suitable technology will be developed to utilise mangrove resources (e.g. from *Soneratia* sp & *Rhyzophora* spp.) to promote SMEs based on mangrove resources.
5. Establish nature trails close to clusters of tourist resorts within mangrove areas.
6. Unemployment among coastal communities depending on mangrove ecosystems will be reduced by 10%.

4.3.4 Relationship to the country's sustainable development priorities

As expected by the National Environment Policy (NEPO, 2003) protect and sustainably manage of coastal environment and resources of dune ecosystems, by maintaining transparency and public accountability, securing sustainable socioeconomic development, healthy and peaceful life style of all coastal communities and stakeholders by developing a pleasant coastal environment and securing the human dwellings and their properties and by providing employment opportunities while reducing destructive anthropogenic activities. Conserve the natural biodiversity of mangroves as reservoirs as laid down by the National Policy on Wild Life Conservation (2000), and maintain resources, soils, water and aesthetic values, to increase the tree cover and productivity of the natural dune vegetation to meet the protection from the impacts of natural hazards and SLR to present and future generations for their

products and services and to enhance the contribution to the welfare of the coastal communities and by strengthening the national economy, with special attention paid to equity in economic development. Conserve, protect and manage the coast & its resources for the wellbeing of the coastal communities and to improve the socioeconomic of coastal communities and the country's economy according to the Conservation Act No. 57 & Act No. 64, Coastal zone management plan (CZMP1997 & 2004), conservation Act. 1990 an *Mahinda Chinthena* (2005)p p 61 & 64 and Mahinda Chinthena way forward (2010) – Vision for the New Future is the Government of Sri Lanka's Ten Year Development Policy Framework[18].

4.3.5 Project Deliverables

Protection of coastal, communities and their properties, from impacts of SLR/climate change and provide alternative livelihoods to those involved in destructive socioeconomic activities associated with coral reef ecosystems; Low cost technology made available, to restore reef ecosystems and to establish artificial reefs to be used for ecotourism as a sustainable industry to reduce unemployment and to provide alternative employment opportunities to those who involved in unsustainable activities within coral reefs; Unemployed youth trained tour guides to be involved in ecotourism; Conservation and protection of biodiversity of coral reefs to the benefit of present & future generations; Improvement of aesthetic values of the coastal reef habitats and Information on economically important reef forming and reef associated species that could be cultured and used for economic, medicinal and agrochemical practices are the project deliverables.

4.3.6 Project Scope and Possible Implementation

Ensure and sustainable socioeconomic development of communities living in the vicinity of mangroves through selection of most suitable sites selected for the rehabilitation. Rehabilitation of 5 selected mangrove sites the Southern, North-Western and Eastern coastal districts of Sri Lanka and technology used for them will be made available through detailed publications for future expansions of such projects to other mangrove areas. Information on the most suitable species of mangrove flora to be used for replanting on Southern, North-Western and Eastern coastal belts of Sri Lanka will be identified, with the correct diversity and composition to be used for each specific site depending on the physicochemical and biological nature of the sites and the type of protection and socioeconomic development expected. Suitability of exotic species of mangrove plants with an economic value, to be introduced to mangrove plantations will be identified through scientific investigations and information will be made available to all stakeholders through booklets/leaflets for dissemination of knowledge on them. Economically feasible tissue culture techniques and SMEs based on mangrove products will be developed through research and

[18] Mahinda Chinthana Policy Framework, 2005.

the information will be published and will be made available to the community to be used for future socioeconomic development programmes. Most of the activities will be conducted with community and stakeholder participation and the project is associated with establishment and improvement of economic establishments, education and improvement of employment opportunities, which will benefit the coastal communities and they will ensure the sustainability of the project. Improved cooperation among different stakeholder groups for successful implementation of the proposed project activities.

4.3.7 Project activities

1. Selection of sites and suitable species for replanting mangroves (using aerial photographs and published information)
2. Awareness/training for all stakeholders (local & foreign)
3. Collection & preparation of propagules (tissue culture, nurseries, etc) for replanting and planting them in selected sites
4. Establishment of community participatory SMEs & eco-friendly tourism based on mangroves & their products.
5. Research for development of low cost technologies for mangrove based products
6. Evaluation of success

4.3.8 Timelines for proposed activities

Table 4.4: Proposed Timelines for Implementation of project activities

Activity	Year 1				Year 2				Year 3				Year 4				Year 5			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1. Selection of sites and suitable species for replanting mangroves																				
2. Awareness/training for all stakeholders																				
3. Collection & preparation of propagules (tissue culture, nurseries, etc) for replanting and planting them in selected sites																				
4. Establishment of community participatory SMEs & eco-friendly tourism based on mangroves & their products																				
5. Research for development of low cost technologies for mangrove based																				

products																				
6. Evaluation of success																				

4.3.9 Budget/Resource requirements

Table 4.5: Approximate Budget Estimate for the Proposed Project

Activity/Sub Activity		Budget (US $)		
No.	Activity/Sub Activity	Domestic	International	Total
1	Selection of sites and suitable species for replanting	20,000	40,000	**60,000**
2	Awareness/training for all stakeholder groups (local & foreign)	38,000	125,000	**163,000**
3	Collection & preparation of propagules (tissue culture, nurseries, etc) for replanting & planting them in selected sites	40,000	150,000	**190,000**
4	Establishment of community participatory SMEs & eco-friendly tourism based on mangroves & their products	30,000	105,000	**135,000**
5	Research for development of low cost technologies for mangrove based products	25,000	100,000	**125,000**
6	Evaluation of success	25,000	-	**25,000**
Subtotal: Cost of Project Activities		**178,000**	**520,000**	**698,000**
7. Project Management cost		69,800	-	69,800
Total budget for Technology 2		**247,800**	**520,000**	**767,800**

The cost of project activities would be approximately US $ 0.698 million and the project management cost would be around 10% of the cost of project activities (US $ 0.07 million). Estimated total cost of the proposed project including the project management cost would be approximately US $ 0.768 million. Required funds will be obtained through domestic (US $: 0.248 million) and international (US $: 0.52 million) sources as indicated in the budget estimate.

4.3.10 Measurement/Evaluation:

An internal monitoring programme (quarterly) and periodic external evaluation (biannually and mid-term) would be implemented for project monitoring and evaluation. Quarterly internal monitoring will be carried out by the planning unit of the Coast Conservation Department. External evaluation will be carried out by

an independent panel of experts appointed by the line ministry (Ministry of Fisheries and Aquatic Resources) in consultation with the donor agency.

Monitoring and evaluation of project activities will be done as follows;
Awareness can be evaluated by the level of involvement of different stakeholders in rehabilitation and awareness programmesx related to mangroves. **Success of mangroves restoration** will be indicated by the expansion of the area covered by mangroves, which can be measures using aerial photographs. **Efficiency of replanted mangroves as a soft barrier against SLR** will be evident by the increased stability of mangroves under harsh conditions and through the stability of the banks of lagoons and estuaries. **Success in establishing nurseries and their performance** could be evaluated by the numbers of nurseries established during the project period and numbers of propagules produced per nursery per year and by the quality of propagules produced. **Effect of training** given on tissue culture, SMEs etc. could be evaluated by available numbers of persons with respective training and by the percentage increase in the production of high quality propagules per year at a low cost and through availability of mangrove products produced by SMEs in the local market. **Quality of propagules** could be evaluated by their survival rate and growth rate (height, numbers of leaves, flowers and fruits produced per ha). **Effect on reduction of unemployment** can be evaluated by numbers of persons involve in sand dune related activities (SMEs, eco-tourism, management of community centres related to mangrove activities. **Impact on tourism** could be evaluated by the number of tourists visit nature trails, through foreign exchange earnings. **Improvement of socioeconomic standards** could be evaluated by the percentage increase of average annual income of coastal communities involved in mangrove related activities.

4.3.11 Possible Complications/Challenges

Inadequate national & /or International funding for initiation and continuation of the project until it reaches, self sustainable levels; Inadequate involvement of local communities, NGOs & INGOs; Resistance from the stakeholders and community (tourist resort owners, fisher communities, etc.) to give up their unsustainable socioeconomic activities; Inadequate patronage at provincial and national government level; Inadequate funding for capacity building at research & higher education institutions for research activities (tissue culture, genetic studies, etc.); Unavailability mangrove species with a high growth rate and adaptability to high temperature and salinity; Slow performance/ progress of the project; Iadequatet collaboration/cooperation among, different stakeholders; Frequent occurrence of extremely harsh environmental conditions; Illicit and illegal activities within mangrove.

4.3.12 Responsibilities and Coordination

Stakeholder	Responsibility	Collaborations
CCD	ICZM, Coastal Protection & coordination of coastal projects & development plans	All stakeholders of the coastal belt
M/Environment & Natural Environment	Policy decisions, financial planning and administrative matters related to coastal environment	All stakeholders and their line ministries & treasury
Universities	Training, awareness & research	R & D institutes, CCD, CBOs, NGOs
Tourist Board	Development coastal tourism and eco-tourism related to mangrove ecosystems	Tourist hotel/resort owners, CCD, CEA,
Tourist hoteliers	Development coastal tourism and eco-tourism	Tourist Board, M/ local government and Provincial councils, CBOs, NGOs,
National Physical Planning Department/	Identification of suitable development plans for the coastal belt to reduce impacts on mangrove ecosystems	CCD, M/Tourism, Tourist Board, M/Local government & Provincial Councils
CEA	Conducting IEEs & EIAs	CCD, MEPA,. Universities & Research Institutes
M/Agricultural Development,	Policy decisions related to Agricultural activities, development of dune plantations of economic importance, promote agrarian research	M/Technology & Research, Universities & Research Institutes
M/ Industrial Development,	Awareness and introductions of SMEs related to mangrove products	Universities & Research Institutions, Dept. Of Agriculture, SMEs, NGOs, CBOs
M/ local government and provincial councils.	Planning of development programmes and socioeconomic activities for the well being of coastal communities and provide sources of funding for mangrove rehabilitation activities and to establish CBOs	CCD, M/Environment & natural Resources, CBOs, NGOs,
M/Technology &Research	Providing funds for R&D activities related to mangrove ecosystems and their resources	M/Finance & Planning, Universities & Research Institutions, funding agencies

Agrarian research institutes,	Research on establishing suitable environmental conditions (soil, irrigation, fertilizer, etc.)for mangrove plantations to rehabilitate with suitable plant diversities,	Higher educational & other research institutions
SLCARP	Preparation & introduction of relevant agrarian research policies	M/Agricultural Development, Universities& Research Institutes
Coast Guard	Protection of coastal belt from harmful activities	CCD, MEPA
Community –based organizations (CBOs)	Involvement of community for rehabilitation of mangroves, establishment & maintenance of mangrove plantations, promote awareness on the importance of mangroves and dissemination of knowledge on conservation and management of mangrove forests and plantations and vegetation, SMEs related to dune resources, etc.	CCD, Higher Educational & Research institutions, NGOs, INGOs, SMEs, M/Industrial Development, M/Tourism,Tourist Board, Tourist Hotel owners
MEPA	Protection of coastal & marine environment from pollution and man-made hazards	CCD, CEA, Coast Guard, Universities & Research Institutions
INGOs & NGOs	Organising community participatory activities such as workshops, training, finding finances, etc. for activities related to mangrove rehabilitation and for socioeconomic development of coastal communities	CCD, CBOs, M/ local government and provincial councils, Higher educational & Research Institutions
SLLRDC	Rehabilitation of mangrove ecosystems and land reclamation through mangrove plantations	CCD, M/National Planning & Development
NSF	Encourage preparation of research proposals related to Sand dune restoration, sustainable utilization of resources and provide funding for projects related to them	M/Finance & Planning, Universities & Research instites, International funding agencies

Duplication of roles will be minimized by selecting **Coast Conservation Department, which is the organization responsible for Integrated coastal zone management , as the main stakeholder and as project implementing organization**, to conduct the project in collaboration with all other stakeholders; By obtaining the cooperation and collaboration of all stakeholder groups when developing the project proposals and for identification of specific responsibilities of each stakeholder; Through preparation of multidisciplinary development projects, with sub projects to be handled by different stakeholder groups/ institutions/organizations and make separate budgetary allocations according to the tasks to be handled by

each stakeholder; Through inclusion of key officials from relevant stakeholder institutions/establishments when forming a project coordinating body and through participation of all stakeholders, during project progress review meetings.

4.3.13 List of References

1. Dawes, C. J. (1981). Mangrove communities. pp. 516–538 In: *Marine Botany*. New York, N.Y.:Wiley-Interscience. 628 pp.
2. http://data.iucn.org/dbtw-wpd/edocs/2008-018.pdf
3. http://water.epa.gov/lawsregs/guidance/wetlands/definitions.cfm (browsed on 11-10-2011)
4. http://water.epa.gov/lawsregs/guidance/wetlands/definitions.cfm (browsed on 09-10-2011)
5. http://www.slideshare.net/Sammy17/10700mangroveecosystemsdoc
6. http://www.water.ncsu.edu/watershedss/info/wetlands/class.html
7. http://www.water.ncsu.edu/watershedss/info/wetlands/class.html (browsed on 12-10-2011)
8. http://www.water.ncsu.edu/watershedss/info/wetlands/definit.html (browsed on 11-12-2011)
9. http://www.water.ncsu.edu/watershedss/info/wetlands/definit.html (browsed on 09-10-2011)
10. Kotagama, S .W. & C N B Bambaradeniya (2006). **An Overview of the Wetlands of Sri Lanka and their Conservation Significance.** In "National Wetland Directory of Sri Lanka, Colombo, Sri Lanka". IUCN Sri Lanka and the Central Environmental Authority. http://dw.iwmi.org/wetland/SriLankanWetland_Introduction.aspx)
11. Linham, Mathews M. & Robert J. Nicholls((2010). Technologies for Climate Change Adaptation – Coasta Erosion & Flooding- (Xaanil Zhu ed.). UNEP Riso Centre, University of Southhampton. ISBN978-87550-3855-4
12. Mangroves in Sri Lanka. In Building Sri Lanka for Sri Lankans by Small Fishers Federation. http://www.smallfishers.lk/Other%20Pages/Mangroves%20in%20Sri%20Lanka.html (Visited in October 2012)
13. Uses for Red Mangroves. http://www.beachbeans.com/mangrove/mangrove_uses.html

4.4 Project Idea for Technology 3: Restoration of Coral Reefs

Project Idea:

'Restoration of coral reefs of southern and south-western coastal belt of Sri Lanka, as a soft barrier against sea level rise and coastal erosion and as a tourist attraction to promote eco-friendly tourism'

4.4.1 Introduction/Background

Coastal belt of Sri Lanka is blessed with near shore patchy fringing reefs and offshore bar reefs and they are unevenly distributed along the Southern, North-western, Northern, Eastern and South-Eastern coastal belts of Sri Lanka. According to Swan (1983) these near shore fringing reefs consists of 2% of the coastal belt. Both the fringing reefs and offshore reefs have been reported to be of varying conditions and they have been categorized into three main habitat types, i.e. the true coral habitats consisting of live coral as well as calcareous substances, sandstone and rocky habitats[19]. The growth of coral reefs around Sri Lanka has been influenced and being influenced by both natural phenomena (i.e. monsoonal and warm water currents, tsunami, strong waves, tidal variations, etc.) and anthropogenic activities (i.e. coral mining; destructive fishing activities, such blast fishing, seining, use of moxy nets, etc.; recreation, release of effluents, sewage and other pollutants to near shore areas, sedimentation due to sand mining, deforestation & land reclamation; etc.), which cause impacts on the light penetration, salinity and productivity, especially in shallow coastal waters due to increased turbidity, sedimentation, freshwater intrusion and eutrophication. Mainly due to such reasons coral reef development in the southwestern sector of the coastline is very poor, and therefore extensive coral reef habitats are limited to areas with lower levels of sedimentation with semi-dry climates found in the north-western and eastern coastal areas and a chain of fringing coral reefs occur around the Jaffna Peninsula[20].

Coral reefs deliver ecosystem services to tourism, fisheries and shoreline protection. The annual global economic value of coral reefs has been estimated at $US 375 billion. For centuries, reef resources have been utilized for food and building materials. Increased human activities in recent times have begun to degrade the quality of the reefs, particularly the near shore habitats. The major uses of the reefs are extraction of living and dead coral for the lime industry, capture fisheries and the harvesting of exotic reef resources such as ornamental fish for export and for tourism related activities[21]. Most of the fishing is concentrated in coastal waters classified as within the first 40 km from the shore. Export industry for reef

[19] Rajasuriya & De Silva, 1988; De Silva & Rajasuriya, 1989; Rajasuriya, De Silva & Ohman, 1995

[20] Rajasuriya, 2011

[21] Rajasuriya, 2011

fish, invertebrates and live coral for the ornamental fish is rated as the third highest in volume and value after prawns and lobsters[22]. In addition to the above coastal areas, with fringing reefs have become important locations for tourism development and recreational activities such as swimming, snorkeling, scuba diving and viewing corals through glass- bottom boats etc.

Major causes of reef degradation are sedimentation, destructive fishing methods such as the use of explosives and bottom-set nets, mining of coral from the sea for lime production and uncontrolled harvesting of reef resources. Pollution and sewage released to reef sites have also contributed to the overall degradation of the marine environment. Coral mining in the sea to produce lime for the construction industry has destroyed most of the fringing reefs along Sri Lanka's southwestern coast.
Furthermore, the majority of hotels along the coast line have been constructed without proper planning and as result numerous problems such as liquid and solid waste disposal have become major issues. In some locations such as in Hikkaduwa these issues have become acute and it has now begun to have an adverse impact on the marine environment[23]. (Nakatani et al. 1994; Rajasuriya et al 1995). Dumping of garbage into city waterways and onto beaches has a negative impact on the marine environment in general and on the reefs in particular. Oil pollution in harbours is a chronic problem particularly when fishing boats are anchored in the protected bays formed by fringing reefs or estuaries.

There are several major problems to be addressed and they are, Inadequate awareness among all stakeholders on the importance of non-extractive uses of coral reefs, time taken for recovery of reefs subjected to destruction due to anthropogenic activities and the sensitivity of reef ecosystems to slight changes in coastal environmental conditions; Inadequate financial assistance for restoration programmes and for providing diving training and equipment to persons to be employed for coral restoration activities; Inadequate knowledge on technology adopted for restoration of coral reefs and on the most suitable coral forming and associated species to be used for restoration of coral reefs; Lack of alternative livelihoods to communities depending on dune resources for socioeconomic activities; Poor coordination/cooperation among stakeholders, when rapid development programmes are introduced to the coastal belts; Unplanned land-based development programmes and socioeconomic activities that cause sedimentation and pollution within the coastal areas and Limited time available for coral transplanting programmes annually due to rough sea conditions prevailing during monsoonal periods.

The proposed project will be implemented in the Southern, South-Western and Eastern and provinces of Sri Lanka, for restoration coral reefs subjected to natural disasters and anthropogenic activities and also in coastal areas where ecotourism could be promoted. Hikkaduwa, Unawatuna, Weligama & Polhena from the Southern coastal belt, shallow reef areas in Kandekuliya, Bar reef sanctuary, Arippu, Silawatturai and

[22] Baldwin, 1991

[23] Nakatani et al. 1994; Rajasuriya et al 1995

Thalawila from North-western coastal belt, Delft Islands from the Northern coastal belt and reefs damaged due to recreational and destructive fishing activities in Trincomalee (Pigeon Islands) and in Baticoloa (Pasikuda & Kalkuda) from the Eastern coast of Sri Lanka will be included in the restoration programme.

4.4.2 Objectives

1. Restoration of coral reefs as soft coastal barriers against SLR,
2. Reduce the impact of anthropogenic activities on the reef ecosystems,
3. Provision of eco-friendly alternative employment opportunities to coastal communities to reduce destructive socioeconomic activities and unemployment problem among coastal communities through SMEs and promotion of ecotourism through community-based organisations.

4.4.3 Outputs and measurable

The following are the measurable out puts of the proposed project;

1. One hectare of corals transplanted in each reef site after the 5th year of the project.
2. One hundred persons trained for scuba diving, coral restoration and coral growth monitoring activities and at least 25 youth trained as tour guides from each reef site selected for restoration.
3. Two responsible community participatory organisations established for each coastal district related to reef sites to provide information, disseminate knowledge, promote ecotourism and research and to manage reef related activities.
4. At least one artificial reef in each of the sites selected to be used for ecotourism.
5. Reduce unemployment of coastal communities depend on reef resources by 25% at the end of 5 years.
6. Adoption of environmentally friendly policies for coastal development programmes after 1 year.
7. Improved awareness among government officials on the importance of collaborative approach on development programmes within the coastal region, for their sustainability.
8. Preparation of unbiased IEEs and EIAs to grant approval to all coastal developmental activities and economic programmes after 0.5 years.
9. Twenty five to ninety percent reductions of unsustainable socioeconomic activities from 2 to 7 years.
10. Twenty five to seventy percent recovery of natural reefs from by 1.5 to 7.0 years.
11. Ten (10) trained persons available in each reef sites to serve as trainers to handle all training activities related to reef restoration programmes after 1.0 year.
12. Availability of a long-term management plan for coral reef ecosystems, acceptable to all stakeholders after 2 year.

13. Sustainable management of coral reefs through stakeholder participation from second year onwards.
14. Existence of a data base with baseline information, on coral biodiversity and physicochemical conditions required for each reef forming organism to maintain a live reef.
15. Identifying early signs of bleaching and hazards after 0.5 years.
16. Healthy coral reefs, growing satisfactorily without or less disturbances from exotic materials, from year 1 to year 7 and onwards.
17. Severe punishments imposed to persons/organisations involved in coral reef destructive activities,

4.4.4 Relationship to the country's sustainable development priorities

According to the National Environment Policy (2003) of Sri Lanka, coral reefs ecosystems are an important component of coastal environment and it should be conserved and managed together with its biodiversity, soils, water and aesthetic values, to increase the productivity to meet the protection from the impacts of natural hazards and SLR to present and future generations for their products and services and to enhance the contribution to the welfare of the coastal communities and by strengthening the national economy, with special attention paid to equity in economic development, while securing rights to coral reef resources and services without harming their sustainability and by sharing the benefits & costs. Biodiversity in the natural coral reefs should be conserved to maintain biological resources (flora & fauna) as reservoirs for the benefit of present and future generations, as laid down by the National Policy on Wild Life Conservation (2000), for the benefit of the coastal communities as laid down by Coast Conservation Act No. 57 & Act No. 64, Coastal zone management plan (CZMP1997 & 2004), conservation Act. 1990 an *Mahinda Chinthena* (2005)p p 61 & 64 and *Mahinda Chinthena* way forward (2010) Vision for the New Future is the Government of Sri Lanka's Ten Year Development Policy Framework[24].

4.4.5 Project Deliverables

Protection of coastal, communities and their properties, from impacts of SLR/climate change and provide alternative livelihoods to those involved in destructive socioeconomic activities associated with coral reef ecosystems; Low cost technology made available, to restore reef ecosystems and to establish artificial reefs to be used for ecotourism as a sustainable industry to reduce unemployment and to provide alternative employment opportunities to those who involved in unsustainable activities within coral reefs; Unemployed youth trained tour guides to be involved in ecotourism; Conservation and protection of biodiversity of coral reefs to the benefit of present & future generations; Improvement of aesthetic values of the coastal reef habitats and Information on economically important reef forming and reef associated

[24] Mahinda Chinthana Policy Framework, 2005.

species that could be cultured and used for economic, medicinal and agrochemical practices are the project deliverables.

4.4.6 Project Scope and Possible Implementation

Selection of 12 most suitable reef sites from Southern, North-Western, Northern and Eastern coastal belt of Sri Lanka, to be restored as soft barriers against SLR, to ensure protection and sustainable socioeconomic development of communities living in their vicinity and to support the development of country's socioeconomic standards; Technology used for restoration could be made available through detailed publications for future expansions of such projects to other degraded reef sites, to ensure successful restoration of all coral reefs and for their sustainable management as soft barriers against SLR and other impacts from climate change; Information on the most suitable species of corals to be used for restoration programmes for Southern, North-Western, Northern and Eastern coastal belts of Sri Lanka could be identified, with the correct diversity and composition to be used for each specific site depending on the physicochemical and biological nature of the sites; Such information could be made available to all stakeholders through booklets/leaflets prepared for dissemination of knowledge;

Most of the activities will be conducted with community and stakeholder participation and the project will be associated with establishment of information centres, education/awareness and improvement of employment opportunities, which will benefit the coastal communities and therefore the stakeholders will ensure the sustainability of the project; Collaboration and cooperation among different stakeholder groups will be improved for successful implementation of the programme

4.4.7 Project activities

Following are the main activities of the proposed project;

1. Awareness to all stakeholders & training programmes on reef restoration and conservation related eco-friendly socio-economic activities (eco-friendly tourism, diving & snorkelling, coral transplanting, captivity breeding of ornamental fish, etc.) to 10 persons from each selected sites and from related institutions to serve as trainers.
2. Selection of suitable sites & transplanting of corals in those sites
3. Formation of community participatory organisations with diving & snorkelling facilities with the involvement of trainers and committed persons from the community for restoration work and to provide security to sensitive coral reefs and transplanted corals
4. River basin management programmes and control of land use patterns to reduce coastal sedimentation
5. Development of a seasonal monitoring & resilience programme and a sustainable management plan by using GIS & remote sensing techniques & through consultation of stakeholders and experts.
6. Evaluation of success

4.4.8 Timelines for proposed activities

Table 4.6: Proposed timelines for Implementation of Project Activities

Activity	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1. Awareness to all stakeholders & training for 10 persons from each selected sites																												
2. Selection of suitable sites & transplanting corals																												
3. Formation of community participatory organisations																												
4. River basin management programmes and control of land use patterns																												
5. Development of a seasonal monitoring & resilience programme and a sustainable management plan																												
6. Evaluation of success																												

4.4.9 Budget/Resource requirements

Table 4.7: Approximate Budget Estimate for the Proposed Project

Activity/Sub Activity		Budget (US $)		
No.	Activity/Sub Activity	Domestic	International	Total
1	Awareness to all stakeholders & training programmes on reef restoration and conservation related eco-friendly socio-economic activities to 10 persons from each selected sites and from related institutions to serve as trainers.	38,000	118,000	**156,000**
2	Selection of suitable sites & transplanting of corals in	50,000	200,000	**250,000**

	those sites			
3	Formation of community participatory organisations with diving & snorkelling facilities	150,000	1,500,000	**1,650,000**
4	River basin management programmes and control of land use patterns to reduce coastal sedimentation	80,000	230,000	**290,000**
5	Development of a seasonal monitoring & resilience programme and a sustainable management plan	8,000	60,000	**68,000**
6	Evaluation of success	5,000	16,0000	**21,000**
Subtotal: Cost of Project Activities		**331,500**	**2,103,500**	**2,435,000**
7. Cost of Management (10% the cost of project activities)		243,500	-	243,500
Total budget for Technology 3		**575,000**	**2,103,500**	**2,678,500**

The cost of project activities would be approximately US $ 2.435 million and the project management cost would be around 10% of the cost of project activities (US $ 0.244 million). Estimated total cost of the proposed project including the project management cost would be approximately US $ 2.679 million. Required funds will be obtained through domestic (US $: 0.575 million) and international (US $: 2.104 million) sources as indicated in the budget estimate

4.4.10 Measurement/Evaluation

An internal monitoring programme (quarterly) and periodic external evaluation (biannually and mid-term) would be implemented for project monitoring and evaluation. Quarterly internal monitoring will be carried out by the planning unit of the Coast Conservation Department. External evaluation will be carried out by an independent panel of experts appointed by the line ministry (Ministry of Fisheries and Aquatic Resources) in consultation with the donor agency.

Monitoring and evaluation of project activities will be done as follows;

Awareness can be evaluated by the level of involvement of different stakeholders in restoration programmes. **Restoration rate of coral reefs could be measured** by manually measuring the expansion of reef areas transplanted with corals and by measuring the growth of coral colonies, changes in diversity and density of different coral forming and associated organisms. **Coral growth** can be measured by the expansion of area covered by live corals.

Efficiency as a soft barrier against SLR could be measured by the increased stability of the coastal land and elevation of the coastal beaches. **Effect on reduction of unemployment** can be evaluated by numbers of persons employed in sustainable reef related activities. **Impact on tourism** could be evaluated by the number of tourists visit coral reefs and artificial reefs for ecotourism. **Improvement of socioeconomic standards** could be evaluated by the percentage increase of average annual income of coastal communities involved in reef related sustainable activities.

4.4.11 Possible Complications/Challenges

Inadequate funding for initiation and continuation of the project until it reaches, self sustainable levels, inadequate involvement of local communities, NGOs & INGOs in restoration programme, resistance from the stakeholders and community (tourist resort owners, fisher communities, etc.) to give up their unsustainable socioeconomic activities, that are harmful to reef ecosystems, inadequate patronage at provincial and national government level and inadequate funding for capacity building at research & higher education institutions for research activities related to coral reef restoration could be challenges for the project..

4.4.12 Responsibilities and Coordination

Stakeholder	Responsibility	Collaborations
Coast Conservation Department (CCD)	Integrated coastal Zone Management, Coastal Protection & coordination of coastal projects & development plans	All stakeholders of the coastal belt
M/Environment & Natural Environment	Policy decisions, financial planning and administrative matters related to coastal environment	All stakeholders, line ministries Treasury
Universities	Training, awareness & research	R & D institutes, CCD, CBOs, NGOs
Tourist Board	Development of coastal tourism and eco-tourism related to coral refs and artificial reefs	Tourist hotel/resort owners, CCD, CEA,
Tourist hotel owners	Development coastal tourism and eco-tourism, reduce environmental impacts to restored reefs during recreational activities of tourists	Tourist Board, M/ local government and provincial councils, CBOs, NGOs,
National Physical Planning Department/	Identification of suitable development plans for the coastal belt to reduce impacts on coral reefs	CCD, M/Tourism, Tourist Board, M/Local government & Provincial Councils
Central Environmental Authority (CEA)	Conducting IEEs & EIAs for development projects in the coastal belt	CCD, MEPA,. Research & Higher Educational Institutes
M/ local government and provincial	Planning of development programmes and socioeconomic activities for the well being of	CCD, M/Environment & natural Resources, CBOs, NGOs,

councils.	coastal communities, provide funding for restoration related activities	
M/Technology &Research	Providing funds for R&D activities related to reef ecosystems and their resources	M/Finance & Planning, Universities & Research Institutions, National & International funding sources
Coast Guard	Protection of coastal belt from harmful activities	CCD, MEPA
Community –based organizations (CBOs)	Involvement of community for rehabilitation of coral reefs, establishment of artificial reefs, promote awareness on the importance of coral reefs and for dissemination of knowledge on conservation, management of corals, to all stakeholders, etc.	CCD, Universities & Research institutions, NGOs, INGOs, SMEs, M/Industrial Development, M/Tourism,Tourist Board, Tourist Hotel owners
MEPA	Protection of coastal & marine environment from pollution and man-made hazards	CCD, CEA, Coast Guard, Universities & R & D Institutions
INGOs & NGOs	Organising community participatory activities such as workshops, training, finding finances, etc. for activities related to reef restoration & for socioeconomic development of coastal communities	CCD, CBOs, M/ local government and provincial councils, Higher educational & Research Institutions
National Science Foundation (NSF)	Encourage preparation of research proposals related to Sand dune restoration, sustainable utilization of resources and provide funding for projects related to them	M/Finance & Planning, Higher Educational & Research Institutions, International funding agencies

Duplication of roles will be minimized by allowing **Coast Conservation Department, which is the organization responsible for Integrated coastal zone management to be the main stakeholder and project implementing organization** to conduct the project in collaboration with the participation of all other stakeholders with respect to different activities; by obtaining the cooperation and collaboration of all stakeholders when developing the project proposals, identifying the specific responsibilities of each stakeholder within each project; through preparation of multidisciplinary development projects, with sub projects to be handled by different stakeholder groups/ institutions/organizations with separate budgetary allocations to each institution; by including of key officials from relevant stakeholder institutions/establishments when forming a project coordinating bodies; through participation of all stakeholders, during project progress review meetings and by involving community-based organisations in all restoration programmes.

4.4.13 List of References

1. Barnes, R. and; Hughes, R. (1999). *An Introduction to Marine Ecology* (3rd ed.). Malden, MA: Blackwell Science, Inc.. pp. 117–141. ISBN 0-86542-834-4.
2. Daly, M., Fautin, D.G., and Cappola, V.A. (March 2003). "Systematics of the Hexacorallia (Cnidaria: Anthozoa)". *Zoological Journal of the Linnean Society* **139**: 419–437.
3. Garrison, T. (1995). Tropical Oceans in Oceanograpy: An introduction to Marine Science. Wordsworth Publishing Company, New York. 456- 465 pp. ISBN -534-25728-3
4. Hatta, M., Fukami, H., Wang, W., Omori, M., Shimoike, K., Hayashibara, T., Ina, Y., Sugiyama, T. (1999). "Reproductive and genetic evidence for a reticulate evolutionary theory of mass spawning corals" (PDF). *Molecular Biology and Evolution* **16** (11): 1607–1613.
5. http://en.wikipedia.org/wiki/Coral_reef
6. http://water.epa.gov/lawsregs/guidance/wetlands/definitions.cfm **(browsed on 09-10-2011)**
7. http://www.water.ncsu.edu/watershedss/info/wetlands/class.html **(browsed on 12-10-2011)**
8. http://www.water.ncsu.edu/watershedss/info/wetlands/definit.html **(browsed on 09-10-2011)**
9. Kumara, P.B.T.P. (2008). Patterns of coral production and distribution in Southern Sri Lanka :P Reef resilience in an environment affected by major disturbances. Ph.D. Thesis School of Pure & Applied Natural Sciences, University of Kalmar, Sweden
10. Linham, Mathews M. & Robert J. Nicholls((2010). Technologies for Climate Change Adaptation – Coasta Erosion & Flooding- (Xaanil Zhu ed.). UNEP Riso Centre, University of Southhampton. ISBN978-87550-3855-4
11. Rajasuriya, A. (2011). Coral Reefs of Sri Lanka: Current Status And Resource Management http://www.fao.org/docrep/x5627e/x5627e09.htm (visited in October 2012
12. Rajasuriya, A., & White, A.T., (1995) 'Coral reefs of Sri Lanka: Review of their extent, condition and Management status'. *Coastal Management* 23: 70 – 90.
13. Toller, W. W., R. Rowan and N. Knowlton (2001). "Repopulation of Zooxanthellae in the Caribbean Corals *Montastraea annularis* and *M. faveolata* following Experimental and Disease-Associated Bleaching". *The Biological Bulletin* (Marine Biological Laboratory) **201** (3): 360–373.
14. Veron, J.E.N. (2000). *Corals of the World. Vol 3* (3rd ed.). Australia: Australian Institute of Marine Sciences and CRR Qld Pty Ltd.. ISBN 0-64232-236-8.

CHAPTER 5

Project Ideas for Biodiversity Sector

5.1 Brief summary of the Project Ideas for Biodiversity Sector

As per the guidelines provided project ideas have been prepared for the Biodiversity sector covering all five prioritized technologies. The project ideas report for the biodiversity sector includes one project idea for each technology, and an additional project idea covering multiple technologies. These project ideas cover biodiversity aspects of inland, terrestrial, coastal and marine realms. The most important actions identified under each technology were considered for the project ideas.

The table shows proposed projects for each of the three prioritized technologies

Table 5.1: Proposed Projects for prioritized technologies in the Biodiversity Sector

Technology	Project Idea
1. Restoration of degraded areas inside and outside the protected area network to enhance resilience.	'Study on identifying and prioritizing critical areas for restoration'
2. Increasing connectivity through corridors, landscape/matrix improvement and management	'Identification of critical areas to be connected and prioritization of required corridors'.
3. Improve management, and possibly increase extent of protected areas, buffer zones and create new areas in vulnerable zones	'Awareness programme, capacity building and development of materials to promote coexistence with biodiversity'
4. Focus on conservation of resources and carryout special management for restricted range, highly threatened species and ecosystems	'Awareness programme on point endemics and critically endangered species, and the importance of their conservation'
5. Ex-situ conservation for highly threatened species and possible reintroduction.	'Studies to identify and prioritize species for ex-situ conservation, and climate change modeling to identify species vulnerable to climate change'
6. Multiple technologies	'Climate change adaptation for biodiversity: a ridge to reef approach in building climate resilience along the Mahaweli River'

5.2 Project Idea for Technology 1: Restoration of degraded areas inside and outside the protected area network to enhance resilience.

Project Idea:

'Study on identifying and prioritizing critical areas for restoration'

5.2.1 Introduction/Background

This project – 'Study on identifying and prioritizing critical areas for rehabilitation and restoration', is an action identified under 'Technology 1: Restoration of degraded areas inside and outside the protected area network to enhance resilience'.

The ability of degraded ecosystems to cope with the effects of climate change is low. Furthermore, the existing threats that these systems face are likely to be exacerbated in the future due to the stresses of climate change. Therefore, the restoration of degraded ecosystems is a key strategy to enhance the resilience of these ecosystems to climate change, and mitigate the impacts of changing climatic conditions. The restoration of habitats will result in an increase in biodiversity, which will further strengthen the ability of the ecosystem to cope with changing climatic conditions.

However, given that such rehabilitation and restoration work is often costly in terms of financial and spatial resources, as well as manpower, it is vital that these activities are carefully planned and coordinated. As such, in order to ensure that restoration work is carried out in a systematic manner, and thereby maximize the efficiency and effectiveness of such measures, it is essential that critical areas for restoration work are identified and prioritized.

At present, there is no prioritized list of critical areas to be restored in Sri Lanka. Furthermore, there is no national mechanism in place to identify and prioritize such areas. As such, it is vital that this work is carried out in order to avoid a waste of resources and the haphazard implementation of restoration activities.

Climate change modeling tools can be used to identify critical areas that are likely to be impacted significantly due to climate change. These areas can then be prioritized, so as to allow for the organization of conservation activities first in areas for which restoration work is essential and urgent.

The identification and prioritization of critical areas for restoration will be immensely useful in planning such work. However, it is crucial that a mechanism to share this information publicly is in place. Given that such a mechanism does not exist in Sri Lanka at present, the development of an appropriate platform for this purpose will be a key component of the project.

5.2.2 Objectives

1. To identify and prioritize critical areas for rehabilitation and restoration.
2. Demonstration of rehabilitation and restoration through pilot interventions

5.2.3 Outputs of the Proposed Project

- A comprehensive study indentifying and prioritizing critical areas for rehabilitation and restoration covering terrestrial, inland aquatic and coastal and marine areas.
- A prioritized list of critical areas for rehabilitation and restoration.
- Public availability of the prioritized list of critical areas for rehabilitation and restoration and updated information on rehabilitation and restoration work.
- Demonstration of pilot activities at least in three representative habitats

5.2.4 Relationship to the country's sustainable development priorities

The importance of considering and researching the impact of climate change on biodiversity in Sri Lanka is recognized in both the National Biodiversity Strategy and Action Plan - 'Biodiversity Conservation in Sri Lanka: A Framework for Action' (1999) and its Addendum (2007). Work on climate change is also identified as a high priority recommendation in this Addendum. As such, the project is in line with national interests and priorities.

Sri Lanka is signatory to the Convention of Biological Diversity (CBD). The conservation of biodiversity and adaptation to climate change are included in the Convention on Biological Diversity (CBD) and the Aichi Biodiversity Targets for 2011-2020. As such, the project also contributes to national efforts to meet these targets and fulfill obligations arising from Sri Lanka's involvement in the CBD.

5.2.5 Project Deliverables

- A comprehensive report on the study to identify and prioritized critical areas for rehabilitation and restoration, including maps and data developed through the study by Year 3.
- A prioritized list of critical areas for rehabilitation and restoration by Year 3.
- A website providing the prioritized list of critical areas for rehabilitation and restoration, and updated information on restoration work.
- Three pilot projects on ground

5.2.6 Project Scope and Possible Implementation

The project will produce a prioritized list of critical areas for rehabilitation and restoration, which can be used to plan future rehabilitation and restoration work. Given that this information will also be accessible publicly, it will also allow other organizations, such as environmental organizations and community-based organizations, to carry small scale restoration work, in coordination with national efforts. Updates and modifications to the list can be added, along with information about recent restoration activities, through the same platform. This will maximize efforts to restore these critical areas and ecosystems.

5.2.7 Project Activities

Climate change modeling will be used to identify critical areas for rehabilitation and restoration. Through simulations of different climate change scenarios, as well as through a climate change vulnerability assessment, it will be possible to identify critical areas that are vulnerable to, or will be impacted by, climate change, and therefore require rehabilitation and restoration actions.

Based on the analysis of the results of this research, areas will be prioritized objectively using a points-based system, which will consider key criteria including presence within or outside a protected area, ecosystem services provided, the presence of Critically Endangered or point endemic species, the extent to which it is damaged or degraded, and potential for restoration.

Areas that obtain a high score based on the selected criteria will be identified and used to compile the priority list of areas to be restored. Based on this list, a website will be developed so as to establish a platform and mechanism for sharing this information publicly. This website will provide access to an updated prioritized list of critical areas for restoration, as well as up-to-date information on restorations activities.

At least three pilot projects will be implemented for demonstration and learning and sharing purposes.

A panel of select climate change and biodiversity experts will review the outputs of the project, along with the coordinating committee.

List of project activities

- Literature survey and development of appropriate climate change modeling
- Analysis of results of climate change modeling
- Ground truthing and identification of areas for rehabilitation and restoration
- Prioritization of areas for rehabilitation and restoration
- Development of list of representative priority areas for rehabilitation and restoration in consultation with sector experts
- Pilot implementation of rehabilitation and restoration of three sites
- Development of website giving information on priority list of areas for restoration

5.2.8 Timelines for Proposed Activities

Table 5.2: Proposed Timelines for Implementation of the Activities of Project 1

Activity	Year 1				Year 1				Year 1			
	Quarter											
	1	2	3	4	1	2	3	4	1	2	3	4
1. Literature survey and development of modeling												
2. Analysis of results of climate change modeling												
3. Ground truthing and identification of areas for rehabilitation and restoration												
4. Prioritization of areas for rehabilitation and restoration												
5. Development of list of representative priority areas for rehabilitation and restoration												
6. Pilot implementation of rehabilitation and restoration of three sites												
7. Development of website giving information on priority list of areas for restoration												

The project will be carried out over a period of three years.

5.2.9 Budget/Resource requirements

Table 5.3: Approximate Cost for Implementation of the Proposed Activities of Project 1

Activity	Proposed Budget (US $)
1. Literature survey and development of appropriate climate change modeling	500,000
2. Analysis of results of climate change modeling	100,000
3. Ground truthing and identification of areas for rehabilitation and restoration	200 000
4. Prioritization of areas for rehabilitation and restoration	150,000
5. Development of list of representative priority areas for rehabilitation and restoration in consultation with sector experts	100,000
6. Pilot implementation of rehabilitation and restoration of three sites	900,000
7. Development of website giving information on priority list of areas for restoration	50,000
Total	**2,000,000**

Total activity cost US $ 1,700,000
Project Management including M&E Cost (15%) US $ 300,000
Total Cost US $ 2,000,000
Source of funding: Donor 90% by Donor
Co-financing:10% to be sourced

5.2.10 Measurement/Evaluation

Biodiversity Secretariat of the Ministry of Environment in partnership with the Climate Change Secretariat will develop a monitoring and evaluation framework and appoint a suitable entity to do the periodic monitoring and evaluation to be used in learning and sharing.

5.2.11 Possible Complications/Challenges

- There may be inaccuracies in the predictions made through climate change modeling which will be used to identify critical areas for restoration.
- Some areas that are in urgent need of restoration work may be missed or overlooked due to unforeseen problems in the prioritization process.

5.2.12 Responsibilities and Coordination

The project will be coordinated by a committee consisting of representatives of the Department of Wildlife Conservation, the Forest Department, the Climate Change Secretariat of the Ministry of Environment, leading universities in Sri Lanka and relevant environmental organizations. The studies will be carried out by suitable universities, National Aquatic Resources Research and Development Agency (NARA), Ministry of Fisheries and Aquatic Resources Development and environmental organizations, as agreed upon by the committee.
A panel of selected climate change and biodiversity experts will review the outputs of the project, along with the coordinating committee.
Key implementing agencies will be Department of Wildlife Conservation, Forest Department and NARA with technical inputs from Universities and conservation agencies. Biodiversity Secretariat of the Ministry of Environment will be the Project Executing Agency.

5.2.13 List of References

1. Biodiversity Conservation in Sri Lanka: A Framework for Action (1999) http://www.cbd.int/doc/world/lk/lk-nbsap-01-en.pdf (Last accessed: 16/10/2012)
2. Biodiversity Conservation in Sri Lanka: A Framework for Action: Addendum (2007) http://www.cbd.int/doc/world/lk/lk-nbsap-oth-en.pdf (Last accessed: 16/10/2012)
3. Portfolio of Strategic Conservation Sites/Protected are Gap Analysis in Sri Lanka, Ministry of Environment and Natural Resources, 2006
4. The Strategic Plan for Biodiversity 2011- 2020 and the Aichi Targets http://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-en.pdf (Last accessed: 16/10/2012)

5.3 Project Idea for Technology 2: Increasing connectivity through corridors, landscape/matrix improvement and management

Project Idea:

'Identification of critical areas to be connected and prioritization of required corridors'

5.3.1 Introduction/Background

This project – 'Identification of critical areas to be connected and prioritization of required corridors'– is an action identified under 'Technology 2: Increasing connectivity through corridors, landscape/matrix improvement and management'.

Apart from the direct destruction of habitats, development activities affect biodiversity by fragmenting existing natural habitats. This fragmentation results in the creation of 'islands' or pockets of natural habitat which are spatially and functionally isolated from each other. The developed areas separating these fragments are then a barrier to the free movement of biodiversity between these natural areas. Habitat fragmentation can also occur as a result of habitat loss or degradation due to the effects of climate change. The impacts of habitat fragmentation are often significant. The dispersal of seeds and pollen from flora is likely to be hindered. Furthermore, the small habitats created by fragmentation will have a low carrying capacity and will not have the space and resources necessary to support a high number of individuals. As for flora, fragmentation can result in reduced reproduction or inbreeding within isolated fauna populations. The geographic isolation of species can also lead to reduced genetic biodiversity (Frankham et al, 2010). Portfolio of strategic conservation sites: proposed corridors to connect PAs (MENR, 2006) identified a priority list of corridors. Changing climatic conditions can be brought in to prioritise the existing list and to introduce any new areas of importance.

These impacts of fragmentation can be mitigated by enhancing connectivity between fragments of natural habitat, and thereby reducing their isolation. This can be done by establishing wildlife corridors. Such corridors will facilitate the migration and free movement of biodiversity. This is particularly important for species that occupy isolated areas where climate change is likely to result in the loss, damage or degradation of their native habitats.

While the establishment of corridors is essential, the protection of existing corridors is also vital in ensuring that they are secure, and of a suitable standard to facilitate the free migration of biodiversity.
At present, there is no formal list of identified critical areas to be connected. Furthermore, there is no mechanism by which corridors are prioritized. While small-scale restoration activities carried provide some connectivity, such initiatives often have a limited impact as they are not coordinated on a larger scale, and without a scientific basis. In addition, resources are sometimes spent on creating and maintaining less important corridors due to a lack of prioritization. However, in order to maximize the efficiency of conservation efforts and prevent the waste of resources, it is necessary to first identify critical areas that need to be connected, and then to prioritize the required corridors. Once a prioritized list of such corridors is developed, resources can be channeled into the most important and urgent of these corridors first. Similarly, through the project, it will be possible to identify corridors that can, and should, be included in the protected areas network.

5.3.2 Objectives

1. To identify and prioritize critical areas to be connected in light of climate change impacts.
2. To facilitate the inclusion of four critical areas in the protected area network.

5.3.3 Outputs of the Proposed Project

- Climate change modeling data.
- Critical areas to be connected identified.
- Required corridors prioritized.
- Four critical areas included into the protected area network.

5.3.4 Relationship to the country's sustainable development priorities

The importance of the conservation of biodiversity, and research into the impacts of climate change, are recognized in both the National Biodiversity Strategy and Action Plan - 'Biodiversity Conservation in Sri Lanka: A Framework for Action' (1999) and its Addendum (2007). Furthermore, the importance of the creation of awareness about these topics is also highlighted in this document.

The Action Plan for Haritha Lanka Programme has identified its Mission 2 to be 'Saving the Fauna, Flora and Ecosystems' and Mission 3 to be 'Meeting the Challenges of Climate Change'. The Mahinda Chintana - Vision for the Future, which is the Development Policy Framework of the Government of Sri Lanka has identified that the conservation of fauna and flora is important in Chapter 7.

As such, the project is in line with national interests and priorities.

Sri Lanka is signatory to the Convention of Biological Diversity (CBD). The conservation of biodiversity and adaptation to climate change are included in the Convention on Biological Diversity (CBD) and the Aichi Biodiversity Targets for 2011-2020. As such, the project also contributes to national efforts to meet these targets and fulfill obligations arising from Sri Lanka's involvement in the CBD.

5.3.5 Project Deliverables

- A detailed report on the activities carried out during the project and its outputs, including the climate change modeling maps and data.
- A list of critical areas to be connected.
- A prioritized list of corridors.
- The inclusion of four critical areas in the protected area network.

5.3.6 Project Scope and Possible Implementation

The identification of critical areas that need to be connected and the prioritization of the required corridors can be used in the allocation of resources to establish or restore these corridors. Furthermore, the identification priority corridors can facilitate the protection of these areas.

5.3.7 Project activities

Climate change modeling will be used to identify critical areas that need to be connected, in order to enhance the resilience of their biodiversity to changing climatic conditions.

Based on the analysis of the results of this research, areas will be prioritized objectively using a points-based system, which will consider key relevant criteria as decided upon by the committee coordinating the project.

Corridors connecting critical areas that obtain a high score based on the selected criteria will be included in the priority list of corridors required.

The corridors that emerge at the top of this prioritized list will be considered for inclusion in the protected areas network by the relevant authorities, the Forest Department and the Department of Wildlife Conservation.

A panel of select climate change and biodiversity experts will review the outputs of the project, along with the coordinating committee.

List of project activities

1. Literature survey and development of appropriate climate change modeling
2. Analysis of modeling results and identification of critical areas to be connected
3. Ground truthing and prioritization of corridors required for connection of the identified critical areas
4. Development of a list of priority areas for corridors
5. Pilot implementation of interventions at least three corridors

5.3.8 Timelines for the Proposed Activities

Table 5.4: Proposed Timelines for Implementation of the Activities of Project 2

Activity	Year 1				Year 1				Year 1			
	Quarter											
	1	2	3	4	1	2	3	4	1	2	3	4
1. Literature survey and development of appropriate climate change modeling												
2. Analysis of modeling results and identification of critical areas to be connected												
3. Ground truthing and prioritization of corridors required for connection of critical areas												
4. Development of a list of priority areas for corridors												
5. Pilot implementation of interventions at least three corridors												

5.3.9 Budget/Resource requirements

Table 5.5: Approximate Cost for Implementation of the Proposed Activities of Project 2

Activity	Proposed Budget (US$)
1. Literature survey and development of appropriate climate change modeling	500,000
2. Analysis of modeling results and identification of critical areas to be connected	200,000
3. Ground truthing and prioritization of corridors required for connection of the	200,000

identified critical areas	
4. Development of a list of priority areas for corridors	100,000
5. Pilot implementation of interventions at least three corridors	850,000
Total	**1, 850,000**

Total activity cost 1,575,500

Project Management and M&E Cost (15%) 277,500

Total Cost US $ 1,850,000

Source of funding: 90% by Donor

Co-financing: 10% to be sourced

Necessary funding will be obtained from domestic and international sources.

5.3.10 Measurement/Evaluation

Biodiversity Secretariat of the Ministry of Environment in partnership with the Climate Change Secretariat will develop a monitoring and evaluation framework and appoint a suitable entity to do the periodic monitoring and evaluation to be used in learning and sharing.

5.3.11 Possible Complications/Challenges

- There may be inaccuracies in the predictions made through climate change modeling which will be used to identify critical areas for restoration.
- Some areas that are in urgent need of restoration work may be missed or overlooked due to unforeseen problems in the prioritization process.
- There may be difficulties or delays in including the selected critical areas in the protected areas network.

5.3.12 Responsibilities and Coordination

The project will be coordinated by a committee consisting of representatives of the Forest Department, the Department of Wildlife Conservation, Climate Change Secretariat and Biodiversity Secretariat of the Ministry of Environment. Implementation of the project activities will be by these organizations, in conjunction with universities, NARA and Ministry of Fisheries and Aquatic Resources and relevant environmental groups including collaboration with international agencies on climate change modeling.

A panel of select climate change and biodiversity experts will review the outputs of the project, along with the coordinating committee.

Key implementing agencies will be Department of Wildlife Conservation, Forest Department and NARA with technical inputs from Universities and conservation agencies. Biodiversity Secretariat of the Ministry of Environment will be the Project Execution Agency.

5.3.13 List of References

1. Biodiversity Conservation in Sri Lanka: A Framework for Action (1999) http://www.cbd.int/doc/world/lk/lk-nbsap-01-en.pdf (Last accessed: 16/10/2012)
2. Biodiversity Conservation in Sri Lanka: A Framework for Action: Addendum (2007) http://www.cbd.int/doc/world/lk/lk-nbsap-oth-en.pdf (Last accessed: 16/10/2012)
3. Frankham, R., Ballou, J. and Briscoe, D (2010) Introduction to Conservation Genetics: Second Edition. Cambridge University Press, New York.
4. Portfolio of Strategic Conservation Sites/Protected are Gap Analysis in Sri Lanka, Ministry of Environment and Natural Resources, 2006
5. The Strategic Plan for Biodiversity 2011- 2020 and the Aichi Targets http://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-en.pdf (Last accessed: 16/10/2012)

5.4 Project Idea for Technology 3: Improve management, and possibly increase extent of protected areas, buffer zones and create new areas in vulnerable zones

Project Idea:

'Awareness programme, capacity building and development of materials to promote coexistence with biodiversity'

5.4.1 Introduction/Background

This project – 'Create awareness, build capacity and provide material to promote coexisting with biodiversity' – is an action identified under 'Technology 3: Improve management, and possibly increase extent of protected areas, buffer zones and create new areas in vulnerable zones'.

With increasing human populations and the associated increase in the need for land, communities often come in to conflict with the local biodiversity. In many areas, conflicts with macro faunal species, such as elephants, result not only in the destruction of property but also loss of life. Similarly, species such as wild boar, hares, porcupines and monkeys can cause significant damages to crops, resulting in a loss of income for local communities.

Given this conflict, a negative perception of these species is perpetuated, and the coexistence of communities with their local biodiversity becomes an uneasy one. Local communities do not participate actively in the conservation of species about which they have a negative perception. This is often a barrier to the implementation of conservation activities. As many important ecosystems and their associated biodiversity lie outside protected areas, and as many of the threats facing endangered species are anthropogenic in nature, involvement of local communities in conservation activities is pivotal to the maintenance of biodiversity. Furthermore, given that existing threats to biodiversity are likely to be exacerbated due to climate change, it is vital that these ecosystems and their biodiversity are strengthened and conserved, so as to mitigate the effects of the additional stress of climate change.

Therefore, in order to maximize the effectiveness of conservation efforts, it is essential that the coexistence of local communities alongside biodiversity is promoted. This can be done through the implementation of awareness programmes on strategies to maintain a high biodiversity in and around populated areas.
Coexistence with biodiversity can be promoted successfully through a range of strategies that enhance biodiversity while providing benefits to local communities. A prime example of such a strategy is the promotion of agroforestry initiatives such as Kandyan home gardens. These gardens are characterized by mixed crops that are useful to communities and include commercially important species such as banana, jak and pepper (Jacob and Alles, 1987). These gardens are similar to natural forests in their structure, mimicking their stratification, and as such, provide an ideal habitat for other floral and faunal species within populated areas. As such, Kandyan home gardens enhance connectivity between natural habitats and act as wildlife corridors in inhabited areas.

While the development of awareness programmes to promote such initiatives is vital, a number of complementary activities are also necessary. Building capacity to facilitate the promotion of coexistence with biodiversity, and the provision of the necessary materials (eg. leaflets on how to create a Kandyan home garden and the necessary plant seeds) will enable local communities to put into practice the information they gain from participation in the awareness programme. Furthermore, it is important that case studies are used to field test the strategies being promoted, in order to obtain scientifically sound data to support the implementation of these strategies. Any issues identified through these case studies can be used to improve the strategies, and maximize their effectiveness.
At present, there is no such organized and coordinated effort to promote the coexistence of local communities with biodiversity. The present project represents an important initial first step in establishing such a mechanism.

5.4.2 Objectives

- To create awareness promoting coexistence with biodiversity.
- To build capacity to promote coexistence with biodiversity.

- To provide materials necessary to promote coexistence with biodiversity.

5.4.3 Outputs of the Proposed Project

- A detailed action plan on promoting coexistence with biodiversity.
- The successful completion of over 80% of the awareness programmes identified in the action plan.
- The successful completion of five case studies on strategies to enhance biodiversity while promoting coexistence of communities with biodiversity.
- Successful training and capacity building of key stakeholders in strategies to promote coexistence with biodiversity.
- A mechanism for the provision of materials necessary to implement strategies to promote coexistence with biodiversity.

5.4.4 Relationship to the country's sustainable development priorities

The importance of the conservation of biodiversity is recognized in both the National Biodiversity Strategy and Action Plan - 'Biodiversity Conservation in Sri Lanka: A Framework for Action' (1999) and its Addendum (2007). Furthermore, the importance of the creation of awareness about biodiversity is also highlighted in this document.

The Action Plan for Haritha Lanka Programme has identified its Mission 2 to be 'Saving the Fauna, Flora and Ecosystems' and Mission 3 to be 'Meeting the Challenges of Climate Change'. The Mahinda Chintana - Vision for the Future, which is the Development Policy Framework of the Government of Sri Lanka has identified that the conservation of fauna and flora is important in Chapter 7.

As such, the project is in line with national interests and priorities.

Sri Lanka is signatory to the Convention of Biological Diversity (CBD). The conservation of biodiversity and adaptation to climate change are included in the Convention on Biological Diversity (CBD) and the Aichi Biodiversity Targets for 2011-2020. As such, the project also contributes to national efforts to meet these targets and fulfill obligations arising from Sri Lanka's involvement in the CBD.

5.4.5 Project Deliverables

- A detailed action plan on promoting coexistence with biodiversity within 6 months.
- The successful completion of over 80% of the awareness programmes identified in the action plan by Month 12.
- Trained individuals with expertise on strategies to promote coexistence with biodiversity by Month 12.

- Reports of five case studies on strategies for promoting coexistence of communities with biodiversity by Month 12.
- A detailed project report including the action plan, case studies and details of the awareness and training programmes by Month 12.

5.4.6 Project Scope and Possible Implementation

Awareness raised about coexisting with biodiversity will contribute to the conservation of biodiversity, as it will encourage allow local communities to participate actively in the conservation of ecosystems and the connectivity between them, as well as local biodiversity. This will in turn contribute to the mitigation of the impacts of climate change. The training and capacity building carried out during the project will help to build expertise on the subject, and allow trained individuals to promote coexistence with biodiversity beyond the duration of the project. Similarly, through the distribution of leaflets on strategies to promote coexistence with biodiversity, this information will be made available to a wider audience.

5.4.7 Project activities

The project will involve the development of an action plan to promote coexistence with biodiversity. Specific strategies to enhance biodiversity, while providing benefits to local communities, such as Kandyan home gardens, will be identified in this action plan.

Training and capacity building activities based on the strategies identified in this action plan will then be carried out. Through this initiative, key stakeholders will develop expertise in strategies to promote coexistence with biodiversity, and the effective implementation of these strategies.

Awareness programmes promoting coexistence with biodiversity, and highlighting the strategies identified in the action plan, will be conducted for local communities in a number of different locations in Sri Lanka.

The project will also involve the compilation of leaflets with information on ways in which communities can promote biodiversity in and around their homes and work places. The materials necessary to implement these strategies (eg. plant seeds) will also be distributed with the leaflets.

Case studies will be used to field test the recommended strategies identified in the action plans, and gain scientifically robust data on their effectiveness.

List of project activities

- Development of an action plan to promote coexistence with biodiversity
- Training and capacity building on strategies to promote coexistence with biodiversity
- Awareness programmes to promote coexistence with biodiversity
- Compilation of leaflets on strategies to promote coexistence with biodiversity
- Distribution of leaflets on strategies to promote coexistence with biodiversity and provision of necessary materials
- Case studies

5.4.8 Timelines for Proposed Activities

Table 5.6: Proposed Timelines for Implementation of the Activities of Project 3

Activity	Q1	Q2	Q3	Q4
1. Development of an action plan to promote coexistence with biodiversity				
2. Training and capacity building on strategies to promote coexistence with biodiversity				
3. Awareness programmes to promote coexistence with biodiversity				
4. Compilation of leaflets on strategies to promote coexistence with biodiversity				
5. Distribution of leaflets on strategies to promote coexistence with biodiversity and provision of necessary materials				
6. Case studies				

5.4.9 Budget/Resource requirements

Table 5.7: Approximate Cost for Implementation of the Proposed Activities of Project 3

Activity	Proposed Budget (US$)
1. Development of an action plan to promote coexistence with biodiversity	70, 000
2. Training and capacity building on strategies to promote coexistence with biodiversity	50, 000
3. Awareness programmes to promote coexistence with biodiversity	85,000
4. Compilation of leaflets on strategies to promote coexistence with biodiversity	10, 000
5. Distribution of leaflets on strategies to promote coexistence with biodiversity and provision of necessary materials	55, 000
6. Case studies	5, 000
Total	**275, 000**

Total activity cost 233,750

Project Management and M&E Cost (15%) 41,250

Total Cost US $ 275,000

Source of funding: Government of Sri Lanka 75%

Co-financing: 25% to be explored

Necessary funding will be obtained from domestic and international sources

5.4.10 Measurement/Evaluation

Biodiversity Secretariat of the Ministry of Environment in partnership with the Climate Change Secretariat will develop a monitoring and evaluation framework and appoint a suitable entity to do the periodic monitoring and evaluation to be used in learning and sharing.

5.4.11 Possible Complications/Challenges

- The oversight of actions that can promote coexistence with biodiversity during the preparation of the action plan.
- Poor participation in the awareness programmes.

5.4.12 Responsibilities and Coordination

The project will be coordinated by a committee consisting of representatives of the Department of Wildlife Conservation, the Forest Department, Department of Agriculture, Ministry of Environment and relevant environmental organizations in Sri Lanka. The studies will be carried out by suitable universities and environmental organizations, as agreed upon by the committee.

A panel of biodiversity and environmental management experts will review the outputs of the project, along with the coordinating committee.

Key implementing agencies will be Ministries of Environment, Fisheries and Aquatic Resources Development and Wildlife and Agrarian Services (ministries responsible for the subjects of conservation of terrestrial, inland, coastal and marine fauna and flora and ecosystems) with technical inputs from Universities and conservation agencies.

Biodiversity Secretariat of the Ministry of Environment will be the Project Execution Agency.

5.4.13 List of References

1. Biodiversity Conservation in Sri Lanka: A Framework for Action (1999) http://www.cbd.int/doc/world/lk/lk-nbsap-01-en.pdf (Last accessed: 16/10/2012)
2. Biodiversity Conservation in Sri Lanka: A Framework for Action: Addendum (2007) http://www.cbd.int/doc/world/lk/lk-nbsap-oth-en.pdf (Last accessed: 16/10/2012)
3. Jacob, V.J. and Alles, W.S. (1987) Kandyan Gardens of Sri Lanka. *Agroforestry Systems* Volume 5, Number 2, 123-137, DOI: 10.1007/BF00047517.
4. The Strategic Plan for Biodiversity 2011- 2020 and the Aichi Targets http://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-en.pdf (Last accessed: 16/10/2012)

5.5 Project Idea for Technology 4: Focus on conservation of resources and carryout special management for restricted range, highly threatened species and ecosystems

Project Idea:

'Awareness programme on point endemics and critically endangered species, and the importance of their conservation'

5.5.1 Introduction/Background

'Awareness programme on point endemics and Critically Endangered species' is one of the actions highlighted under 'Technology 4: Focus conservation resources and carryout special management for restricted range, highly threatened species and ecosystems'. By raising awareness specifically about point endemic and Critically Endangered species, conservation efforts can be focused on these vulnerable target species.

Point endemic species are species which consist of a single population that is found at one location alone. Given the fact that these species are restricted to one specific locality, it is often the case that there is little awareness about point endemic species amongst the general public, as well as amongst policy makers and other key stakeholders. Given the fact that, by definition, point endemic species have a restricted distribution, they are often threatened with extinction. Furthermore, given that their distribution is extremely restricted, the destruction or degradation of the locality in which they are found will result in the loss of its sole habitat and as such, is likely to result in the complete loss of the species.

Critically Endangered species are species that are at a critically high risk of extinction (IUCN, 2001). Conservation interventions are crucial for the survival of these species. These species are extremely vulnerable to the effects of climate change as their populations are often fragile and vulnerable to changes in conditions.

Both point endemic species and Critically Endangered species can play a pivotal role in their native ecosystems. If they become extinct, these ecosystems maybe disrupted. Furthermore, they may provide valuable ecosystem services that will be lost, if this species were to go extinct.

As such, it is necessary to prevent the extinction of these species. Given that many of the threats to biodiversity, including point endemic and Critically Endangered species, often stem from anthropogenic causes, engaging the general public, policy makers and other key stakeholders is crucial. Raising awareness about these species is therefore essential, as these threats are often the result of a lack of knowledge and awareness about these species, their importance and the threats the face. An effective means of achieving this is through conducting awareness workshops.

5.5.2 Objectives

To create awareness of the importance of point endemic species and their conservation through preparation of awareness materials and disseminating them. Targeted audience includes members of the public, policy makers and other key stakeholders.

5.5.3 Outputs of the Proposed Project

- Preparation and dissemination of awareness materials on web.
- Conduct at least five national level awareness workshops per year, each with a capacity of 50 individuals.

5.5.4 Relationship to the country's sustainable development Priorities

The project is in line with the recommendations of the National Biodiversity Strategy and Action Plan and its Addendum. The need for education and awareness on the importance of biodiversity and its conservation is highlighted in the 'Biodiversity Conservation in Sri Lanka: A Framework for Action' (1999), as well as in the Addendum to this document (2007). The importance of considering and researching the impact of climate change on biodiversity is also given priority in this Addendum.

Sri Lanka is signatory to the Convention on Biodiversity (CBD). As such, it has a responsibility to conserve its rich biodiversity, and to achieve the targets set out by the convention. Therefore, the Aichi Biodiversity Targets for 2011-2020 need to be addressed by Sri Lanka. The project contributes to national efforts to meet these targets, by raising awareness about biodiversity and its importance, and by contributing to the mitigation of the impacts of climate change through the education of stakeholders about of species that are highly vulnerable to these impacts.

5.5.5 Project Deliverables

Publishing awareness materials on web. Five awareness workshops per year, with 50 stakeholders present at each workshop and 250 participants overall.

5.5.6 Project Scope and Possible Implementation

The project is easily replicable, as long as the necessary resources are available. The content of the workshops can be updated and modified to accommodate new information and developments. Furthermore, there is potential to increase the number of workshops held each year, as well as the number of participants for each workshop.

5.5.7 Project activities

The project will involve the development of an awareness programme on the importance of point endemic and Critically Endangered species, as well as the organization and implementation of five awareness workshops. Each workshop will have 50 participants, with 250 individuals participating annually. The awareness workshops will be one day long and will include the following:

(1) An introduction to point endemic species and their importance
(2) An introduction to Critically Endangered species and their importance
(3) The threats faced by these species
(4) What can be done to minimize or mitigate these threats

The workshops will be held in different locations (to be decided by the organizing committee) and in the vernacular of each area.

A review meeting will be held following the first awareness in order to discuss issues encountered during the initial awareness workshop and to improve the programme further.

List of project activities

1. Development of an awareness programme and awareness materials
2. Review meeting
3. Two awareness workshops to government officials
4. Two mass media events on the importance of point endemic and critically endangered species
5. Two awareness workshops to local communities
6. Two awareness workshops to NGOs
7. Two awareness workshops to Students

5.5.8 Timelines for the Proposed Activities

Table 5.8: Proposed Timelines for Implementation of the Activities of Project 4

Activity	Q1	Q2	Q3	Q4
1. Development of an awareness programme and awareness materials				
2. Review meeting				
3. Two awareness workshops to government officials				
4. Two mass media events				
5. Two awareness workshops to local communities				
6. Two awareness workshops to NGOs				
7. Two awareness workshops to Students				

Ten workshops will be conducted during the year

5.5.9 Budget/Resource requirements

Table 5.9: Approximate Cost for Implementation of the Proposed Activities of Project 4

Activity	Proposed Budget (US$)
1. Development of the awareness materials and programme	75,000
2. Publishing of awareness materials	25,000
3. Conducting 08 Awareness workshops	150,000
4. Two mass media events	20,000
Total	**270,000**

Total activity cost 229,500

Project Management and M&E Cost (15%) 40,500

Total Cost US $ 270,000

Source of funding: 75% Local

Co-financing: 25% to be explored

Funds necessary for the project will be obtained from domestic, as well as international, sources.

5.5.10 Measurement/Evaluation

The success of the awareness programme and the first awareness workshop will be evaluated during review meeting. Any changes necessary to develop and improve the programme can then be made, so as to ensure that the remaining four awareness workshops will be successful.

5.5.11 Possible Complications/Challenges

- It is possible that attendance for the workshops is poor.
- It is possible that the participants will avoid being actively involved in activities carried out during the workshop.
- It is possible that one or more workshops will have to be cancelled or postponed due to unforeseeable circumstances such as inclement weather.

5.5.12 Responsibilities and Coordination

The awareness programme will be developed and coordinated by a committee consisting of representatives from the Forest Department, the Department of Wildlife Conservation, the Ministry of Environment, universities and key environmental organizations. The awareness workshops will be run by jointly by selected environmental organizations and universities.

Key implementing agencies will be Ministries of Environment, Fisheries and Aquatic Resources Development and Wildlife and Agrarian Services (ministries responsible for the subjects of conservation of terrestrial, inland, coastal and marine fauna and flora and ecosystems) with technical inputs from Universities and conservation agencies.

Biodiversity Secretariat of the Ministry of Environment will be the Project Execution Agency.

5.5.13 List of References

1. Biodiversity Conservation in Sri Lanka: A Framework for Action (1999) http://www.cbd.int/doc/world/lk/lk-nbsap-01-en.pdf (Last accessed: 16/10/2012)
2. Biodiversity Conservation in Sri Lanka: A Framework for Action: Addendum (2007) http://www.cbd.int/doc/world/lk/lk-nbsap-oth-en.pdf (Last accessed: 16/10/2012)
3. IUCN (2001) IUCN Red List Categories and Criteria version 3.1 http://www.iucnredlist.org/static/categories_criteria_3_1#critica (Last accessed: 16/10/2012)
4. The Strategic Plan for Biodiversity 2011- 2020 and the Aichi Targets http://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-en.pdf (Last accessed: 16/10/2012)

5.6 Project Idea for Technology 5: Ex-situ conservation for highly threatened species and possible reintroduction.

Project Idea:

'Studies to identify and prioritize species for ex-situ conservation, and climate change modeling to identify species vulnerable to climate change'

5.6.1 Introduction/Background

This project – 'Studies to identify and prioritize species for ex-situ conservation, and climate change modeling to identify species vulnerable to climate change' – is a proposed action under 'Technology 5: Ex-situ conservation for highly threatened species and possible reintroduction'.

Threats to biodiversity often affect the habitats of species. In instances where such threats are unrelenting, the effectiveness of *in-situ* conservation efforts - interventions based within the natural range of a species - is limited. As a result, it is necessary to supplement *in-situ* conservation actions with *ex-situ* interventions. *Ex-situ* interventions are based outside the natural habitat of a species, and often involve housing floral and fauna species in a secure and controlled environment, such as botanical or zoological gardens, where fluctuations in environmental conditions and threats are removed or minimized. *Ex-situ* conservation activities can also involve the preservation of genetic material and germ-plasm in genetic banks.

Ex-situ conservation efforts are often costly in terms of resources (financial as well as spatial) and man-power, and as such, it is not possible to use this form of intervention in every case. Therefore, it is necessary to focus ex-situ conservation efforts on selected priority species that require *ex-situ* interventions urgently. Given that there is no such list of species in Sri Lanka at present, the compilation of a priority list will be immensely useful in the efficient and objective allocation of resources and conservation efforts.

In the future, it is likely that certain habitats, such as montane and coastal ecosystems, will be altered, damaged or lost disproportionately due to climate change. Species that are supported by these habitats, particularly point endemic species which are restricted to a single locality, will be affected adversely as a result. Given that *in-situ* conservation efforts are likely to be insufficient, or ineffective, for these species in such instances, *ex-situ* conservation efforts will be crucial to their survival. However, *ex-situ* conservation efforts are most successful when planned and carried out in a timely fashion. As such, the identification of species that are vulnerable to climate change, and as such, likely to become priority species for *ex-situ* conservation in the future, is crucial. Once these species are identified, their populations can be monitored *in-situ* so as to gain insight into the ways in which they are affected by climate change, while the chances of their survival can be enhanced by establishing *ex-situ* populations.

The information generated through this project can be used to maximize the use of resources allocated for conservation activities, and to ensure the survival of species that require *ex-situ* conservation urgently, or will require such interventions in the future with changing climatic conditions.

5.6.2 Objectives

- To identify and prioritize species for ex-situ conservation.
- To identify species vulnerable to climate change through climate change modeling.

5.6.3 0utputs of the Proposed Project

- A comprehensive study of species requiring *ex-situ* conservation and species that
- A list of priority species for *ex-situ* conservation in light of climate change vulnerability.
- Capacity building and development of expertise on climate change modeling.
- Modeling data and maps predicting the habitats that are vulnerable to climate change in future.

5.6.4 Relationship to the country's sustainable development priorities

The project involves the identification of priority species for *ex-situ* conservation. The importance of *ex-situ* conservation is recognized in both National Biodiversity Strategy and Action Plan - 'Biodiversity Conservation in Sri Lanka: A Framework for Action' (1999) and its Addendum (2007). The importance of considering and researching the impact of climate change on biodiversity is also given priority in this Addendum. The project will also involve research development and technology transfer, as well as capacity building, which are addressed in this document. As such, the project is in line with national interests and priorities.

Sri Lanka is signatory to the Convention of Biological Diversity (CBD). The conservation of biodiversity and adaptation to climate change are included in the Convention on Biological Diversity (CBD) and the Aichi Biodiversity Targets for 2011-2020. As such, the project also contributes to national efforts to meet these targets and fulfill obligations arising from Sri Lanka's involvement in the CBD.

5.6.5 Project Deliverables

- A detailed report on the study on priority species for ex-situ conservation by Year 3.
- A list of priority species for *ex-situ* conservation (with 50 flora and 50 fauna species) by the end of Year 1.
- A detailed report on the study on species that are vulnerable to climate change, including maps and data from climate change modeling by Year 3.
- A list of species that are vulnerable to climate change by Year 3.

5.6.6 Project Scope and Possible Implementation

The priority list of species for ex-situ conservation can be used by the National Zoological Gardens and National Botanical Gardens. Here, resources and efforts can be focused on the proper care and breeding of these species, so as to aid their conservation. This list will enable efficient and objective decision making where resources are limited and only a few species can be given priority over others.

The list of species vulnerable to climate change can be used to inform future ex-situ conservation efforts. Special attention can be focused on these species so that their populations and habitats are monitored adequately, and to facilitate the investment of conservation resources and efforts on these species.

Both lists of species can be updated over time, as new studies are carried out.

5.6.7 Project activities

(i) Studies to identify and prioritize species for ex-situ conservation

Species belonging to the Critically Endangered and Endangered categories of the most recently published IUCN Red List will be used to form a shortlist of species for consideration. A priority list of species will be formed by selecting species for which ex-situ conservation is critical. This selection process will be carried out objectively, using a set of key criteria and a points-based system.

This set of criteria should include consideration of the following factors:

(1) Conservation status of the species (the extent to which it is threatened): species that are Critically Endangered will be assigned a high score.

(2) Distribution of the species: species with a restricted range (particularly point endemic species) will be assigned a high score.

(3) The nature of the threats (can they mitigated): threats that can be mitigated or minimized realistically will be assigned a higher score.

(4) Potential for success in ex-situ conditions: species that can be kept in in-situ facilities and will survive well under these conditions will be assigned a higher score.

(5) Potential for reintroduction in the future: species that can be re-introduced into their natural habitat successfully in the future will be assigned a higher score.

(6) Presence outside protected areas: species that are found outside protected areas will be assigned a high score.

(7) Impact of the loss of the species on its ecosystem and the ecosystem services it provides: species for which the impact of its loss will be high, will be assigned a higher score.

(8) Potential impact of climate change on the habitat of the species: species that occupy a habitat that is likely to be impacted significantly due to climate change (eg. montane species) will be assigned a higher score.

Fifty flora species and fifty fauna species will be included in the priority list and will be ranked according to their score.

(ii) Climate change modeling to also identify species vulnerable to climate change

The necessary training required to carry out the climate change modeling study will be provided. Capacity building to improve the technical knowledge base and expertise on this subject will also be carried out.

Climate change modeling will be used to predict the way in which species will be affected by changing climatic conditions. This can be done through computer based simulations of conditions that are likely to arise as a result of climate change. Through this, habitats and ecosystems that are especially vulnerable to climate change can be identified (eg. montane and coastal habitats). Species that are Critically Endangered or Endangered, and have a restricted range within the habitats identified as vulnerable to climate change (particularly point endemic species), can then selected to form a list of species vulnerable to climate change.

All outputs produced from the studies carried out during the project will be reviewed by the coordinating committee as well as biodiversity and climate change experts.

List of project activities

1. Compilation of the priority list of species for *ex-situ* conservation
2. Training of personnel in climate change modeling and capacity building
3. Climate change modeling and identification of vulnerable habitats
4. Identification of species vulnerable to climate change
5. Review of outputs by biodiversity and climate change experts
6. Dissemination of information gathered during the studies with relevant stakeholders and policy makers

5.6.8 Timelines for the Proposed Activities

Table 5.10: Proposed Timelines for Implementation of the Activities of Project 5

Activity	Year 1				Year 1				Year 1			
	Quarter											
	1	2	3	4	1	2	3	4	1	2	3	4
1. Compilation of the priority list of species for *ex-situ* conservation												
2. Training of personnel in climate change modeling and capacity building												
3. Climate change modeling and identification of vulnerable habitats												
4. Identification of species vulnerable to climate change												

5. Review of outputs by biodiversity and climate change experts												
6. Dissemination of information gathered during the studies with stakeholders and policy makers												

5.6.9 Budget/Resource requirements

Table 5.11: Approximate Cost for Implementation of the Proposed Activities of Project 5

Activity	Proposed Budget (US$)
1. Compilation of the priority list of species for *ex-situ* conservation	200,000
2. Training of personnel in climate change modeling and capacity building	100,000
3. Climate change modeling and identification of vulnerable habitats	400,000
4. Identification of species vulnerable to climate change	200,000
5. Review of outputs by biodiversity and climate change experts	100,000
6. Dissemination of information gathered during the studies with relevant stakeholders and policy makers	100,000
7. Piloting *ex-situ* conservation of at least 10 species	900,000
Total	**2, 000,000**

Total activity cost 1,700,000

Project Management and M&E Cost (15%) 300,000

Total Cost US $ 2,000,000

Source of funding: 80% donor and 10% Local

Co-financing: 10% to be explored

5.6.10 Measurement/Evaluation

Biodiversity Secretariat of the Ministry of Environment in partnership with the Climate Change Secretariat will develop a monitoring and evaluation framework and appoint a suitable entity to do the periodic monitoring and evaluation to be used in learning and sharing.

5.6.11 Possible Complications/Challenges

- Priority species that are in urgent need of *ex-situ* conservation may be missed during the prioritization process.
- There may be accuracies in the predictions made through climate change modeling.

5.6.12 Responsibilities and Coordination

The project will be coordinated by a committee consisting of representatives of the Department of Wildlife Conservation, the Forest Department, the Climate Change Secretariat of the Ministry of Environment, leading universities in Sri Lanka and relevant environmental organizations. The lead in implementing the project will be taken by the Department of National Zoological Garden, Department of National Botanical Gardens and Plant Genetic Resources Centre of the Department of Agriculture. The studies will be carried out by suitable universities and environmental organizations, as agreed upon by the committee.

Key implementing agencies include Department of National Zoological Garden, Department of National Botanical Gardens and Plant Genetic Resources Centre of the Department of Agriculture. Biodiversity Secretariat of the Ministry of Environment will be the Project Execution Agency.

5.6.13 List of References

1. Biodiversity Conservation in Sri Lanka: A Framework for Action (1999) http://www.cbd.int/doc/world/lk/lk-nbsap-01-en.pdf (Last accessed: 16/10/2012)
2. Biodiversity Conservation in Sri Lanka: A Framework for Action: Addendum (2007) http://www.cbd.int/doc/world/lk/lk-nbsap-oth-en.pdf (Last accessed: 16/10/2012)
3. The Strategic Plan for Biodiversity 2011- 2020 and the Aichi Targets http://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-en.pdf (Last accessed: 16/10/2012)

5.7 Project Idea for Multiple Technologies.

Project Idea:

'Climate change adaptation for biodiversity: a ridge to reef approach in building climate resilience along the Mahaweli River'

5.7.1 Introduction/Background

General sector information:

Sri Lanka is one of the most biologically diverse countries in Asia, with its biodiversity considered to be the richest per unit area in the region with regard to mammals, reptiles, amphibians, fish and flowering plants. However, the country's biodiversity is facing many threats, with areas both inside and outside protected areas having many issues. These threats will be no doubt be compounded with the changing climate. Research around the world has shown that current observations provide a clear signal that change is already underway.

Biodiversity will be impacted by climate change as there will be shifts in species distributions, often along elevational gradients. The changing climate will impact the timing of life-history events or phenology, decoupling coevolved interactions. It can affect demographic rates (survival and fecundity) and reduce population size. Extinction of range-restricted or isolated species and direct loss of habitat due to sea-level rise, fire frequency, altered weather patterns and direct warming of habitats will occur; while there will also be increased spread of wildlife diseases, parasites and increased spread of invasive and non-native species. Thus, the ability for conserving biodiversity with changing climate will be increasingly tied to the ability to manage climate change, and to manage the biotic changes associated with it. Therefore it is vital that the government, conservation organizations and other agencies develop adaptation strategies and technologies to facilitate the adaptation of ecological systems to altered climate regimes. Models of future climate and biological systems provide additional insights, while research into the current changes also provides vital information.

Climate change will no doubt be a threat to Sri Lanka's biodiversity as well. Although it is unlikely that all impacts of climate change on biodiversity are 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.

The Sector Vulnerability Profile (SVP) for the biodiversity sector (which is a supplementary document to Sri Lanka's National Climate Change Adaptation Policy) has looked at the impact of climate change on this sector. It states that, as an island nation, Sri Lanka is vulnerable to the risk of sea level rise and increased

frequency of storms that can bring major impacts on coastal biodiversity. Additionally, analysis of climate data indicate a change in rainfall regimes, and a trend for increasing air temperature, which can also have impacts on the country's biodiversity.

According to the review, some of the impacts relating to possible impacts include salinization of low lying areas, loss of coastal land, increased coastal erosion and loss of ecosystems, and impacts to marine species due to warming and acidification. Rising temperature, elevated carbon dioxide concentrations and changes in rainfall regimes will also impact forests and terrestrial species. It is expected to cause changes in onset of flowering and fruiting, breeding and reproduction, with implications for species survival and ecosystems. Forest ecosystems and species in fringe areas between the major climatic zones are expected to be most vulnerable to impacts of climate change. Additionally elevated carbon dioxide levels can cause changes in forest structure, while species loss can occur due to structural and compositional changes in habitats, leading to the deterioration of ecosystem services. Variability of rainfall regimes that cause changes in hydrological cycles will affect wetlands and associated species, while degraded watersheds due to the degradation of Wet Zone forests in the past, will be more vulnerable to climate change.

Specific problem to be overcome:

Climate change will no doubt affect Sri Lanka's biodiversity. Around the globe scientists accept that climate change is already having an impact on biodiversity. In Sri Lanka too this is likely to be the case. However, research, studies and projects have been limited on the subject. The Technology Needs Assessment Project in Sri Lanka has identified biodiversity as one of the priority sectors for adaptation. Under this several consultation workshops were held with stakeholders engaged in the biodiversity conservation sector. Stakeholders participated in identifying and eleven (11) technologies to conserve biodiversity with changing climate. The methodology used to prioritize the technologies was the Multi Criteria Decision Analysis (MCDA) Approach.

The prioritized technologies in order are: (1) restoration of degraded areas inside and outside the protected area network to enhance resilience; (2) increasing connectivity through corridors, landscape/matrix improvement and management; (3) improve management, and possibly increase extent of protected areas, buffer zones and create new areas in vulnerable zones; (4) focus conservation resources and carryout special management for restricted range, highly threatened species and ecosystems and (5) ex-situ conservation for highly threatened species and possible reintroduction.

Thus there is an urgent need to carry out the above interventions if climate change impacts on biodiversity are to be minimized, and for biodiversity to adapt accordingly.

Project location:

The project will be implemented at a number of sites - Knuckles Conservation Forest, Wasgamuwa National Park, Somawathiya Sanctuary, Flood Plains National Park and Pigeon Islands National Park – spanning four districts in three provinces.

5.7.2 Objectives

To increase the resilience of biodiversity for climate change adaptation, by taking a ridge to reef approach in building resilience. This will be done through localised climate change modeling, biodiversity surveys, restoration, improving connectivity and by conserving highly threatened restricted range species.

5.7.3 Outputs of the Proposed Project

Phase 1

i. Results of the climate change modeling for a pilot area in the Knuckles Conservation Forest – including the identification of the most vulnerable ecosystems and species.
ii. Preliminary activities necessary for restoration and conservation of the most vital ecosystems and species carried out.

Phase 2

iii. Detailed climate change modeling along the ecosystems adjacent to the Mahaweli River – which will include various forest types, wetlands, coastal and marine ecosystems.
iv. Selected vital ecosystems restored.
v. Selected highly vulnerable species are conserved.
vi. Connectivity improved by working with local communities, landowners and plantations.
vii. Training and capacity building carried out on climate change adaptation strategies for those working in the biodiversity sector.
viii. Results shared and publicized to enable replication.

5.7.4 Relationship to the country's sustainable development priorities

This project is directly in line with the Climate Change Policy of 2012. Additionally, the Sri Lanka country project of the above-mentioned Technology Need Assessment of UNEP/UNFCCC has also identified biodiversity adaptation as a prioritised sector. The ADP funded Sector Vulnerability Profile (SVP) for the biodiversity sector (which is a supplementary document to Sri Lanka's National Climate Change Adaptation Strategy) has also identified biodiversity adaptation as a national priority.

The Action Plan for Haritha Lanka Programme has identified its Mission 2 to be 'Saving the Fauna, Flora

and Ecosystems' and Mission 3 to be 'Meeting the Challenges of Climate Change'. The Mahinda Chintana: Vision for the Future, which is the Development Policy Framework of the Government of Sri Lanka has identified that the conservation of fauna and flora is important in Chapter 7. The environmental priorities and targets mentioned in this chapter include:

- Forest Targets
  - Forest coverage is at least 30 percent
  - 1.9 million ha planned by 2016
- Reforestation and rehabilitation Targets
  - 50 percent reduction in barren and degraded land
  - 90-100 percent regeneration of depleted upland forest
- Protected Areas and Wildlife Conservation Targets
  - 25 percent of total land area protected
- Coastal and Marine Protection Targets
  - National system of marine protected areas to be established
  - Wetland areas to be protected
  - Rate of mangrove and wetland loss to be reduced by 10 percent and 90 percent, respectively

5.7.5 Project Deliverables

- A detailed report encompassing the research, modeling and restoration work carried out, as well as the outputs of the study.
- Training for local scientists and key stakeholders.

5.7.6 Project Scope and Possible Implementation

The project and its findings, once publicized, can aid the implementation of similar projects in the future, as well as inform policy makers and key stakeholders involved in the management of these areas.

5.7.7 Project activities

The project will use the 'ridge to reef' approach to conservation by selecting the Mahaweli River. It will select the section of the main river spanning from the highlands of Knuckles to the sea in Trincomalee. This area spans several districts, ecosystems and will include protected and other areas as well.

The project will be carried out in two Phases. Phase 1 will include a pilot detailed study on climate change impact modeling to identify impacts on biodiversity conservation in the Knuckles region. This modeling exercise will require specialist technical input for which external support will be sought for training of local

scientists. Highland areas are especially sensitive to climate change, and are also important to facilitate elevational migration of biodiversity which is vital for adaptation. This phase will also include preliminary activities relating to restoration of vital ecosystems and highly threatened species, as identified by the modeling exercise.

Phase 2 will feature expanding the exercise from the 'ridge' of Knuckles to the 'reef' of Pigeon Islands, which will include several ecosystem types. Interventions will include restoration, facilitating connectivity, conservation of highly threatened species, all based on the results of climate change modeling. It would also include training and capacity building on climate change adaptation strategies for those working in the biodiversity sector, and sharing and publicizing results to enable replication.

This would probably be the first comprehensive intervention to conserve biodiversity from the intended impacts of climate change, which will be done based on appropriate scientific studies and model.

List of project activities

1. Detailed pilot climate change modeling in the Knuckles area (external technical input will be necessary)
2. Preliminary activities for pilot restoration of selected ecosystems
3. Preliminary activities for pilot conservation of highly threatened/vulnerable species
4. Expanding climate change modeling using the ridge to reef approach
5. Restoration of vital ecosystems
6. Conservation of highly threatened species
7. Facilitating connectivity between different types of land use
8. Training and capacity building
9. Sharing and publicizing results

5.7.8 Timelines for the Proposed Activities – See table 5.12

Table 5.12: Timelines for the Proposed Activities of the Project 6

Activity	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phase I												
1. Detailed pilot climate change modeling in the Knuckles area (external technical input will be necessary)												
2. Preliminary activities for pilot restoration of selected ecosystems												
3. Preliminary activities for pilot conservation of highly threatened/vulnerable species												
Phase 2												
1. Expanding climate change modeling using the ridge to reef approach												
2. Restoration of vital ecosystems												
3. Conservation of highly threatened species												
4. Facilitating connectivity between different types of land use												
5. Training and capacity building												
6. Sharing and publicizing results												

5.7.9 Budget/Resource requirements

Table 5.13: Approximate Cost for Implementation of the Proposed Activities of Project 6

Activity	Cost (US$)
Phase 1	
i. Detailed pilot climate change modeling in the Knuckles area (external technical input will be necessary)	46,000
ii. Preliminary activities for pilot restoration of selected ecosystems	23,000
iii. Preliminary activities for pilot conservation of highly threatened/vulnerable species	23,000
Phase 2	
iv. Expanding climate change modeling using the ridge to reef approach	115,000
v. Restoration of vital ecosystems	77,000
vi. Conservation of highly threatened species	77,000
vii. Facilitating connectivity between different types of landuse	77,000
viii. Training and capacity building	19,000
ix. Sharing and publicizing results	18,000
Total	**US$ 475, 000**

Total activity cost 403,750

Project Management Cost (15%) 71,250

Total cost of the project would be USD 475,000

Source of funding: 80% Donor and 10% Local

Co-financing: 10% to be explored

All staff and administration costs have been incorporated into the activities.

The government sector institutions will utilize most of its current staff for the implementation of this project. It will assign a few staff on a full or part time basis depending on the requirement of the project. If necessary, technical specialists will be recruited, although it is expected that IUCN and universities will provide this specialist input.

5.7.10 Measurement/Evaluation

Climate Change Secretariat in partnership with Biodiversity Secretariat of the Ministry of Environment will develop a monitoring and evaluation framework and appoint a suitable entity to do the periodic monitoring and evaluation to be used in learning and sharing.

5.7.11 Possible Complications/Challenges

- In accuracies in climate change modeling.
- Barriers to the implementation of conservations activities.

5.7.12 Responsibilities and Coordination

The project will primarily be a conservation intervention, which will include components where the project will work closely with local communities and landowners. The main stakeholders will include the implementing partners such as the Climate Change Secretariat, Ministry of Environment, Forest Department, Department of Wildlife Conservation, Coast Conservation and Coastal Resource Management Department, National Aquatic Resources Research and Development Agency, Ministry of Fisheries and Aquatic Resources Development and Central Environmental Authority; while technical input will be given by environmental organizations and universities. It will work with local communities and landowners in the area, who along with the general public will be beneficiaries, as they will all benefit from conserved biodiversity and its ecosystem services.

Forest Department, Mahaweli Authority of Sri Lanka, Department of Wildlife Conservation and NARA will be the key implementing agencies with technical support from universities and conservation agencies. Biodiversity Secretariat of the Ministry of Environment will be the Project Execution Agency.

5.7.13 List of References

1. Biodiversity Conservation in Sri Lanka: A Framework for Action (1999) http://www.cbd.int/doc/world/lk/lk-nbsap-01-en.pdf (Last accessed: 16/10/2012)
2. Biodiversity Conservation in Sri Lanka: A Framework for Action: Addendum (2007) http://www.cbd.int/doc/world/lk/lk-nbsap-oth-en.pdf (Last accessed: 16/10/2012)
3. Frankham, R., Ballou, J. and Briscoe, D (2010) Introduction to Conservation Genetics: Second Edition. Cambridge University Press, New York.

4. IUCN (2001) IUCN Red List Categories and Criteria version 3.1 http://www.iucnredlist.org/static/categories_criteria_3_1#critica (Last accessed: 16/10/2012)
5. Jacob, V.J. and Alles, W.S. (1987) Kandyan Gardens of Sri Lanka. *Agroforestry Systems* Volume 5, Number 2, 123-137, DOI: 10.1007/BF00047517.
6. Portfolio of Strategic Conservation Sites/Protected are Gap Analysis in Sri Lanka, Ministry of Environment and Natural Resources, 2006
7. The Strategic Plan for Biodiversity 2011- 2020 and the Aichi Targets http://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-en.pdf (Last accessed: 16/10/2012)
8. The Strategic Plan for Biodiversity 2011- 2020 and the Aichi Targets http://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-en.pdf (Last accessed: 16/10/2012)

ANNEX I

List of Stakeholders Involved and their Contacts

MEMBERS OF THE NATIONAL TNA COMMITTEE

No	Designation	Institution
1.	Secretary	Ministry of Environment – Chairman
2.	Addl. Secretary (Environment & Policy)	Ministry of Environment
3.	Director (Policy Planning)	Ministry of Environment
4.	Director (Air Resources Management & International Resources)	Ministry of Environment
5.	Director (Biodiversity)	Ministry of Environment
6.	Director (Sustainable Environment)	Ministry of Environment
7.	Director (Climate Change)	Ministry of Environment
8.	Director General	Department of External Resources
9.	Director General	Department of National Planning
10.	Secretary	Ministry of Agriculture
11.	Secretary	Ministry of Water Supply and Drainage
2.	Secretary	Ministry of Fisheries and Aquatic Resources Development
13.	Secretary	Ministry of Health
14.	Secretary	Ministry of Economic Development (Tourism)
15.	Secretary	Ministry of Transport
16.	Secretary	Ministry of Power and Energy
17.	Secretary	Ministry of Local Government and Provincial Council
18.	Secretary	Ministry of Technology and Research
19.	Director	Industrial Technology Institute of Sri Lanka

FOOD SECTOR

List of Stakeholders

No	Name	Institution	Address
1.	Dr.(Mrs.) A.P Bentota, Additional Director	Oil Crops Research & Development Institute	Department of Agriculture, Angunukolapelassa
2.	K.N. Kannangara, Senior Research Officer	Field Crop Research & Development Centre	Department of Agriculture, Aralaganwila
3.	Dr. W.M.A.D.B. Wickramasinghe, Director	Natural Resource Management Centre	Department of Agriculture, Sarasavi Mawatha, Peradeniya.
4.	Mr. K.M.A. Kendaragama, Research Officer	Natural Resource Management Centre	Department of Agriculture, Sarasavi Mawatha, Peradeniya.
5.	W.R.R.T. Wickramarachchi, Research Officer	Horticultural Crop Research & Development Institute	Gannoruwa, Peradeniya
6.	Dr. S.P. Nissanka, Head, Department of Agricultural Crop Science	Faculty of Agriculture University of Peradeniya	University of Peradeniya, Sarasawi Mawatha Peradeniya
7.	Mr. S.A.M. Azmy	Head, Environmental Studies Division	NARA, Crow Island, Col. 15
8.	Mr. M.M.m. Aheeyer, Research Officer	HARTI	114 Wijerama Mawatha, Colombo 7
9.	Dr. R.M. Herath, Ag. Economist	Socio Economic & Planning Centre	Department of Agriculture, Peradeniya
10.	Mrs. Nirushs Ayoni, Ag. Economist	Socio Economic & Planning Centre	Department of Agriculture, Peradeniya
11.	S. N. Jayawardana, Agronomist	DZLISPP	303, Gattuwana Rd, Kurunagala
12.	W.M.P.K. Walisinghe, Asst. Director	Hadabima Authority	PO Box 09, Gannoruwa Rd, Peradeniya
13.	Dr. Damayanthi Galanina, Entamologist	Horticultural Crop Research & Development Institute	Gannoruwa, Peradeniya

14.	Yasantha Munasinghe	Asst. Director	NPD
15.	K.G.R.G.R. Wickramawardane	Asst. Director	NPD
16.	Asitha Senevirathna	Addl. Secretary	Ministry of Industry & Commerce
17.	Mr. H.M. Bandaratillake	Team Leader/ TNA Project	Ministry of Environment
18.	Dr. R.D.S. Jayathunga	Director/ Climate Change,	Ministry of Environment
19.	Ms. Anoja Herath	TNA Coordinator	Ministry of Environment
20.	Ms. Kema Kasthuriarachchi	Environment Management Officer	Ministry of Environment
21.	Ms. Surani Pathirana	Environment Management Officer	Ministry of Environment

HEALTH SECTOR

List of Stakeholders

No	Name	Institution	Contact Address
1.	Dr. M.S.D. Wijesinghe	Environmental & Occupational Health, Ministry of Health	P.O. Box 385, Ven. Baddegama Wimalawansa Thero Mw, Colombo-10
2.	Dr. Thushara Ranasinghe	Consultant Community Physician, Ministry of Health	P.O. Box 385, Ven. Baddegama Wimalawansa Thero Mw, Colombo-10
3.	Ms. Nilusha Kariyawasam,	Env. Planning Officer Urban Development Authority (UDA)	'Sethsiripaya' 6th & 7th floors Battaramulla
4.	Ms. Padma Wijesinghe	Planning Officer UDA	'Sethsiripaya' 6th & 7th floors Battaramulla
5.	Ms. G.D. Dayani	Env. Planning Assistant UDA	'Sethsiripaya' 6th & 7th floors Battaramulla.
6.	Ms. Sarojini Jayasekara	Deputy Director Central Environmental Authority	104, Hector Kobbekaduwa Mw, Battaramulla
7.	Ms. Christine Dasanayake	Scientific Officer National Science Foundation	47/5, Maitland Place, Colombo-7
8.	Dr. A. Balasuriya	Senior Lecturer in Community Medicine, Faculty of Medicine	Defence University of Sri Lanka Kandawela Estate, Ratmalana,
9.	Ms. Kanchana Weerakoon	Founder/ President Eco Friendly Volunteers (ECO-V)	42/3/I, Nadee Uyana, Gangarama Road, Boralasgomuwa
10.	Dr. Mahesh Gunasekara	International Federation of Red Cross	Dharmapala Mawatha, Colombo-7
11.	Dr. E.C. Salvador	Technical Officer/ EHA WHO	226, Bauddhaloka Mawatha, Colombo-7
12.	Ms. A. Kavitha	Asst. Director, NPD	
13.	Dr. Inoka Suraweera	Consultant Community Physician, MOH	Ministry of Health

WATER SECTOR

List of Stakeholders

No	Name	Institution	Contact Address
1.	Eng. P.M. Jayadeera	Deputy Director (Irrigation) Department of Irrigation	P.O.Box 1138 Bauddhaloka Mawatha Colombo
2.	Mr. R.S.C. George	Deputy General Manager	National Water Supply and Drainage Board
3.	A.N.D.S. Waidyarathne,	Asst. Director (D)	National Water Supply and Drainage Board
4.	Mr. Asoka Ajantha	Project Manager Practical Action of Sri Lanka	5, Lionel Edirisinghe Mawatha Kirulapone, Colombo 5
5.	Ms. M.L. Nimanthi Manjula	Civil Engineer	Mahaweli Authority of Sri Lanka
6.	Mr. T. Samarathunga	Director	Mahaweli Authority of Sri Lanka
7.	Mr. I.G. Madduma Bandara,	DSWRPP project (Dam safety & water resources planning project)	2nd floor, MASL building,No. 500, T.B. Jaya Mawatha,Colombo 10.
8.	Dr. H. Manthitillake	International Water Management Institute (IWMI)	Head, 127, Sunil Mawatha, Pelawatta, Battaramulla
9.	Mr.M.M. Aheeyar	Head (EWRM) Hector Kobbekaduwa Agrarian Research & Training Institute	114, Wijerama Mawatha, Colombo 7
10.	Mr. S.A.M. Azmy	Head/ Environmental Studies Division (NARA)	NARA, Crow Island, Col. 15
11.	Dr. P.D. Ranasinghe	Assistant Medical Officer of Health (AMOH)	MOH Office Homagama
12.	Mr. W.D. Dharmasiri	Director, Ministry of Agriculture	Ministry of Agriculture Battaramulla
13.	Dr. S.M. Wijesundara	Food Sector Expert/ TNA Project	TNA Project Ministry of Environment
14.	Mr. H.M. Bandaratillake	Team Leader/ TNA Project	TNA Project Ministry of Environment

15.	Ms. Anoja Herath	TNA Coordinator	TNA Project Ministry of Environment
16.	Ms. Surani Pathirana	Environment Management Officer (EMO), TNA Project	TNA Project Ministry of Environment
17.	Ms. Nilmini Ranasinghe	Environment Management Officer	Ministry of Environment

COASTAL SECTOR

List of Stakeholders

No	Name	Institution	Contact Address
1.	Mr. R.A.S. Ranawaka	Senior Engineer (R &D) , Department of Coast Conservation	4 th Floor, New Secretariat Building, Maligawatta, Colombo 10
2.	Mr. K. Sugathapala,	Head, Human Settlement Division, National Building Research Organization	National Building Research Organization 99/1 Jawatta Road Colombo 05
3.	Mr. S.A.M. Azmy	Head/ Environmental Studies Division, NARA	NARA, Crow Island, Col. 15.
4.	Ms. Vishaka Hidellage,	Regional Director, Practical Action	5, Lionel Edirisinghe Mawatha Kirulapone, Colombo 5
5.	Dr. Terney Predeep Kumara	Head, Dept of Oceanography & Marine Geology	Faculty of Fisheries & Marine Sciences & Technology University of Ruhuna
6.	Asitha K. Senevirathne	Addl. Secretary Ministry of Industry & Commerce	Ministry of Industry & Commerce, Colombo
7.	Mr. H.M. Bandaratillake	Team Leader/ TNA Project	TNA Project Ministry of Environment
8.	Ms. Anoja Herath	TNA Coordinator	TNA Project Ministry of Environment
9.	Ms. Surani Pathirana	Environment Management Officer (EMO), TNA Project	TNA Project Ministry of Environment
10.	Ms. Nilmini Ranasinghe	Environment Management Officer	Ministry of Environment

BIODIVERSITY SECTOR

List of Stakeholders

No	Name	Institution	Contact Address
1.	Mr. Anura Sathurusinghe	Conservator of Forest (Research & Education)	Forest Department Sampathpaya, Battaramulla
2.	Mr. B.M. Sooryabandara	Development Assistant	Forest Department Sampathpaya, Battaramulla
3.	Mr. R.A.S. Ranawaka,	Senior Engineer (R&D) Department of Coast Conservation	Department of Coast Conservation New Secretariat Building, Maligawatta, Colombo 10.
4.	Mr. S.A.M. Azmy	Head/Environmental Studies Division, NARA	NARA Crow Island, Colombo. 15
5.	Ms. D.M.T.K. Dissanayake	SEO, Central Environment Authority (CEA)	104. Denzil Kobbekaduwa Mw, Battaramulla
6.	Mr. Sunil Maithripala	Asst. Director, CEA	104. Denzil Kobbekaduwa Mw, Battaramulla
7.	Mr. Pradeep Rajadewa	CEA	104. Denzil Kobbekaduwa Mw, Battaramulla
8.	Mr. Ravi Deraniyagala	President, Wildlife and Nature Protection Society of Sri Lanka	No. 86, Rajamalwatte Road, Battaramulla
9.	Mr. Dinal Samarasinghe	Young Zoologist Association	Anagarika Dharmapala Mawatha, Dehiwala.
10.	Mr. Sameera Karunarathne	Young Zoologist Association	Anagarika Dharmapala Mawatha, Dehiwala.
11.	Mr. Gayan Pradeep,	Asst. Programme Manager Green Movement of SL	Green Movement of SL No. 09, 1st Lane, Wanatha Rd, Gangodawila, Nugegoda
12.	Ms. Christine Dasanayake	Scientific Officer National Science Foundation	National Science Foundation 47/5, Vidya Mawatha, Colombo 7

13.	Mr. Vimukthi Weerathunga	Environmental Foundation	Environmental Foundation Havelock Road, Colombo 5
14.	Ms. I.C. Vandabona	Environmental Officer Centre for Environmental Justice	Centre for Environmental Justice 20A, Kuruppu Road Colombo 08.
15.	Mr. W.K. Rathnadeera	South Asia Co-operative Environment Programme (SACEP)	SACEP, Anderson Road, Colombo - 5
16	Dr. Mayuri Wijesinghe	University of Colombo	Department of Zoology, Faculty of Science, Uni. Colombo, Colombo. 03.
17.	Ms. Mayuri Malawarachchi	PA, Department of National Botanic Gardens,	Department of National Botanic Gardens, P O Box 14, Peradeniya
18.	Mr. Kanchana Weerakoon	Eco Friendly Volunteers	
19.	Mr. Hasula Wickramasinghe	Biodiversity Secretariat Ministry of Environment	Ministry of Environment Battaramulla.
20.	Dakshini Perera	Biodiversity Secretariat	Ministry of Environment
21.	Leel Randeni	Biodiversity Secretariat	Ministry of Environment