Country Paper: Sri Lanka

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INTRODUCTION

Climate Change would increase the intensity, scale and spread of already present challenges in the livelihoods of vulnerable communities and development programs of the country. The ability to face these challenges is available within the key sectors, which contribute to the national economy and development of the country.

Sri Lanka has identified following priority sectors for undertake adaptation measures in order to address the impacts of climate change.

- Agriculture
- Coastal Zone
- Water resources
- Health
- Transport
- Forestry
- Human Settlements and Public Utilities.

AGRICULTURE

The contribution of the agriculture, fishery and forestry to the GDP continue to decline during the past decade from 21.3 % in 1999 to 12.1 in 2008 as shown by the **table 1** (CBSL, 2008). In Sri Lanka, agriculture continues to be the main land use practice and the sector employees 32.7 of total employment in addition to indirect and part-time employment. Despite the slow growth and declining trends to the GDP contribution, the agricultural sector remains as the backbone of the economy in Sri Lanka. Of the non-plantation agriculture, paddy is the dominant crop in terms of land use, government support and output produced. The status of the key variables are given in the **table 2.**

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The present land use pattern and its changes during the decade 1998-2008 are given in the **table 3.** A reasonable reduction of the area occupied by the tree crops could be observed during the period, despite the increase of the total agricultural land. One salient feature is unsatisfactory performances in the other field crop sector making heavy import bill for most of the food commodities.

Table 1. GDP Contribution by Agricultural Sector

Sector	**1999**	**2000**	**2008**
Agriculture, Forestry and Fishing	21.3	20.5	12.1
Agriculture	16.6	15.9	10.9
Tea	1.4	1.4	1.2
Rubber	0.4	0.4	0.2
Coconut	1.7	1.8	1.4
Paddy	3.5	3.2	1.8
Other Agriculture	9.6	9.1	6.1
Forestry	4.4	4.3	-
Fishing	2	1.9	1.1

Table 2. Performances of the Agricultural Sector

Variable	**Value**
Percentage Employed in Agriculture	32.7
Agricultural Land area (000 ha)	2356
Sown Extent – paddy (000 ha)	1053
Harvested Extent -paddy (000 ha)	1033
Average Yield of paddy (kg/ha)	4175
Total paddy production (000 MT)	3875
Self Sufficiency Ratios of Paddy	97.47
Total Tea production (000 MT)	318.7
Total rubber production (000 MT)	129.24
Total coconut production(mil. nuts)	2,909
Cultivated extent-tea (000 ha)	212.715
Cultivated extent –rubber (000 ha)	116.478
Cultivated extent –coconut (000 ha)	394.836

Table 3. Land Use Pattern in Agriculture

Crop	**1998**		**2002**		**2008***	
	Proportion	**Area (000 ha)**	**Proportion**	**Area (000 ha)**	**Proportion**	**Area (000 ha)**
Paddy	41.80%	685	43.80%	852	.60%	1052
Coconut	25.20%	413	20.30%	394	16.70%	394
Rubber	9.20%	150	5.90%	116	5.20%	122

Tea	11.00%	180	10.90%	212	9.40%	221
Maize	1.65%	27	1.18%	23	2.16%	51
Chilli	1.16%	19	0.82%	16	0.59%	14
Ground nut	0.79%	13	0.46%	9	0.30%	7
Green Gram	0.85%	14	0.57%	11	0.34%	8
Cowpea	0.91%	15	0.57%	11	0.38%	9
Big onion	0.43%	7	0.15%	3	0.13%	3
Other crops	7.13%	117	15.19%	295	20.16%	475
Total agri. land	100%	1640	100%	1942	100%	2356

Source: Department of Census and Statistics, Sri Lanka

The domestic agricultural sector already suffers from a number of issues including high costs of production, land scarcity, inadequate irrigation facilities, land fragmentation and marketing problems. Although the fertilizer subsidy introduced a several years ago brought some relief to the paddy farmers, indiscriminate use of fertilizer give rise to a number of environmental problems.

Impacts of Climate Change on Agriculture

The agriculture is one of the most vulnerable sectors as this primary production activity is highly linked with the natural resources and the environment. The effect of climate change on agriculture is due to three major impacts, namely temperature rise, rainfall variation and carbon fertilization effects. Review of literature related to the impacts of the climate change on agriculture reveals that there is wide range of predictions available covering either of these aspects. Moreover, the secondary effects such as pest and diseases as well as farmers adaptation to the climate change were not well investigated.

Table 4. Climate Effects and their Impacts on Non-plantation Agriculture Sector

Climate Effect	**Impacts**	
	Physical Impacts	Socio-economic Impacts
Rise in atmospheric temperature	• Heat stress on crops • High rate of evapo-transpiration	Drop of productivity, yield income for farmers
Changes in precipitation patterns	• Scarcity of water for paddy and other crops in RF deficit areas • Drainage problems in excess RF areas	Drop of productivity, yield and income for farmers Loss of cultivable area for agriculture
Sea level rise	• Development of salinity in coastal paddy lands due to salt intrusion	Loss of cultivable area for agriculture

Concentration of C02	• Increase in crop performance due to enhanced photosynthesis	Raise in productivity, yield and income for farmers
Extreme events	• Frequent exposure to drought in RF deficit areas • Frequent exposure floods in excess RF areas	Crop damage and loss of income for farmers

Table 5. Climate Effects and their Impacts on Plantation Sector

Climate Effect	**Impacts**	
	Physical Impacts	**Socio-economic Impacts**
Rise in atmospheric temperature	Increased performance of crops in the optimal range and decline thereafter	Fluctuation of productivity, yield and income with rising temperature
Changes in precipitation patterns	Increased performance of crops in the optimal range and decline thereafter	Fluctuation of productivity, yield and income with changes in precipitation
Concentration of C02	Increase in crop performance due to enhanced photosynthesis	Raise in productivity, yield and income
Extreme events	Exposure to high incidence of extreme events, esp. droughts	Yield drop and income losses

Impact of climate change on rice production

Varietals and technological development in the past were based on the assumption of unlimited availability of water, no temperature stress, less problems of soil toxicity, different pest and disease pressures, and unlimited availability of inputs at subsidized low cost. This scenario is changing for the worse with economic concerns that have reduced the subsidies and increased the costs of inputs and now the challenges from climate change which is creating un-conceived scenarios for the plant breeder and agronomist. The changes in annual rainfall are small but highly unpredictable. The number of consecutive dry and warm days has increased and cold nights have decreased. The future challenges to increase rice production in the context of climate change are:

- uncertainty in weather (high air temperature, increased frequency of water stress periods),
- availability and quality of irrigation water, and
- degrading of the soil environment (increased salinity).

These would be further aggravated by climate change. In addition, non-climate related challenges are the increased cost of fertilizers and agro-chemicals and movement of the labour force away from farming.

When we talk about Agriculture sector, climate change would impact at a macro level in the production system and also at the plant level. The latter should be addressed by plant breeders

and agronomists to provide solutions for the farmer. The major interactions at the plant level with climate change are, increased atmospheric carbon dioxide, temperature and water stress.

The draft SNC suggests that following **adaptation options** with regard to the Agriculture Sector.

Adaptation measures for rice cultivation

Agronomic management

Dry zone: Reduce irrigation water loss
Adopt 'Kakulan' or 'Manawari' cultivation practices
Introduce lowland rice cultivation with saturated soil instead of continuous submerged.
Practice aerobic rice cultivation

Wet zone: The negative impacts of climate change are less compared to the dry zone. The potential offered by the availability of water should be exploited. Erratic rainfall and onset of monsoons is a problem. In the coastal areas, rise in the sea-level leading to submergence and sea-water intrusion would increase coastal salinity in the paddy fields.

Future Research needs

Develop varieties tolerant to high temperature and limited water availability (ie. high water use efficiency), and varieties with submergence and salinity tolerance for the coastal regions.
In brief, a new generation of rice varieties are needed with:

- Tolerance to high temperature and salinity
- Water and fertilizer efficient
- Weed smothering ability
- Resistance to pests and diseases
- Different cultivation technologies to meet decreased water availability
- Post-harvest impacts of climate change

Adaptation Measures for Tea Plantation

The framework for an Adaptation strategy for the tea industry is to :

- exploit beneficial impacts of climate change
- minimize the adverse effects
- adopt a no regrets approach, and
- practice economically viable options.

These strategies would be implemented through improvement of the crop, soil and aerial environment.

Crop Improvement

1. Use of drought tolerant cultivars and grafted plants with drought tolerant characteristics, in drought prone regions.

2. Intercropping with other tree cash crops, such as rubber and coconut
   High intensity intercropping would reduce the ambient temperature around tea bushes and increase land utilization efficiency.

3. Planting a basket of cultivars

4. Selection of suitable land for new and replanting.

5. Diversification of marginal lands to “thatch banks” by planting rehabilitation grasses, and used as a source of green manure to improve soil.

6. Low yielding lands with poor soil condition to be diversified to fuel-wood or timber plantation (for eventual carbon trading).

Soil Improvement and Irrigation

1. Soil and moisture conservation – physical and agronomic practices
2. Improvement of soil organic carbon levels – implementing Sloping Agriculture Land Technology (SALT), burying tea prunings, using compost.
3. Rainwater Harvesting
4. Irrigation during dry spells.

Aerial Environment

Planting and management of shade trees to reduce ambient temperature

This can be achieved by planting high and medium shade trees according to recommendations and management of shade trees according to weather patterns.

Adaptation measures for rubber plantation

Technological adaptations

- Of the rubber cones selected for agro-climate variability, clones RRISL217 and RRISL215 were identified as highly stable for all environments and the clone RRIC100, for the small-holders in non-traditional areas.
- Planting material – different young buddings are used for propagation. Of these young buddings in polybags gave 100% establishment success and the highest girth of 48.6 cm.
- Seeds for nurseries – erratic seed fall affects nursery management. The field should be well maintained and cleaned before seed-fall with a good seed bearing clone eg. RRIC100.
- Soil and moisture conservation – establishment success is improved by 85 – 98% with a application of organic matter at the rate of 50g per polybag.
- Increase in potassium fertilization – higher girth and tappability is achieved with increase in potassium applied.

Adaptation measures for coconut plantation

In a study in two regions in the low-country by the CRI, with different climates (wet region and intermediate region), the influence of climate on coconut yield was found to be different. Therefore the assessments of impacts and adaptation to climate change for coconut, should be

carried out separately for each coconut growing region. Rainfall alone was not sufficient to explain climate change over time.

Breeding program

- Selection for tolerance to high temperature and drought.
- Screening for varieties using water relations, biochemical parameters (carbohydrate and sugar content).
- Evaluation of existing varieties and new crosses developed using indigenous germplasm.
- Creating new hybrids using exotic germplasm.

Screening for reproductive survivability under temperature stress

- Duration of exposure to stress
- Pollen quality
    - Screening varieties for in vitro pollen germination at temperatures of 20 – 42 C and look for varietal differences at maximum, minimum and optimum temperatures. Screening experiments showed varietal differences in pollen germination for Tall, San Ramon and DM varieties with a temperature optimum of 28 C.
- Fruit set
- Effect of water and temperature stress on fruit quality.

Agronomic practices

A quantification of different management practices is necessary.

- Soil moisture conservation: mulches, ground cover crops
- Improve soil organic matter.
- Irrigation
- Rain water harvesting

Adaptation measures to arrest land degradation

Soil and water conservation measures
Run-off water harvesting
Land-use planning

WATER RESOURCES

Water is a fundamental and the single most important natural resource affecting all the sectors. Climate change would affect the hydrologic cycle and thereby the availability of water. The water sector is in a peculiar position: while water is a vital resource affected by climate change, in its gaseous form as water vapour it is a potent greenhouse gas contributing to global warming. Warming of the atmosphere increases the capacity of the atmosphere to hold moisture, which in turn increases the rate of evaporation. Increased moisture in the atmosphere contributes to warming and more intense precipitation, but not distributed equally. Thus a self-sustaining vicious circle is created. Global warming is accelerating the hydrologic cycle, thus increasing rainfall intensities, frequencies, and temporal distribution leading to floods and soil erosion. Rainfall variations and increased evaporation leads to increased severity of droughts. There would be changes in run-off due to changes in water evaporation and transpiration with changes in the availability of soil moisture. This will in turn affect stream-flow and ground water table recharge.

Climate change would challenge, existing water management systems. Planning for fluctuations and uncertainties in resources is usually part of the management process. The present challenge is to mainstream climate change knowledge into the planning process. Thus reliable future scenarios are necessary for planners to examine options.

The present status

At present 77% of the population of Sri Lanka has access to safe drinking water of which, 33% have access to piped water. Ground water is available to 10% of the population through hand pumps and tube wells. The total annual piped water production at present is about 424 MCM and about 520 MCM production is expected in 2012 (Figure1). Out of this annual production, 63% is distributed in the Western Province which is about 2% of the annual discharge of the Kelani and Kaluganga rivers.

Drinking water

The lack of access to safe drinking water is an important factor contributing to high morbidity from diarrhoeal diseases in Sri Lanka. This is situation is aggravated during climate extremes when either safe water is unavailable in rural areas in the dry zone or during excessive rainfall causing floods and contamination of sources of water. In general about 75% of the households have access to safe drinking water, which varies across sectors. About 75% of the urban population and 14% of the rural population have access to pipe borne water.

Working in line with Millennium Development Goals, the NWSDB plans to achieve a coverage of 85% of the population with access to safe drinking water by 2015 and 100% by 2025. (NWSDB Corporate Plan, 2007-2011). The occurrence of droughts is an obstruction to achieving these targets.

Impacts and consequences of climate change on water resources

Since rainfall is the major source of water in Sri Lanka, changes in the rainfall pattern due to climate change will affect water availability for drinking purposes. Increased evaporation due to temperature rise will create drinking water scarcity and reduction of soil moisture, particularly in the dry regions. Salination of coastal lands due to sea level rise will also be a threat to fresh water sources. Water scarcity will be aggravated by anthropogenic pollution due to lack of dilution. Floods and droughts may also lead to disaster situations.

Adaptation measures

<u>Ecosystems</u>
Rehabilitation of ancient tank system distributed over the dry zone to retain more water and recharge ground water aquifers.
Preservation of marshy lands mainly in the wet zone, to ensure that surface water flows at a slower rate.
Trans basin diversion of rivers.

<u>Community</u>
Dedicated drinking water storage tanks for the wet zone.

Studies on such reservoirs for Attanagalu oya, Kelani Ganga, Kaluganga and Maha oya are in progress. This will help to control flood and drought conditions in the wet zone and to maintain ground water and soil moisture conditions throughout the year.

Institutional

Catchments preservation to reduce soil erosion and improve soil moisture retention

- Avoid planting 'Pine tree' plantations and expansion of tea cultivation, which are not favorable for soil moisture retention, in the highlands.
- Ensure pollution control by providing better sanitation and preventing industrialization in the catchment areas.
- Preservation of natural forest in the hills and forestation with trees inherent to Sri Lanka
- Implementing traditional means of soil erosion control

Individual

- Ensure proper land use to reduce run-off coefficient.
- Implement appropriate soil conservation techniques.
- Initiate rainwater harvesting as a tool for overcoming droughts and diseases such as chronic renal failure.
- Ground water improvement with promotion of small scale treatment units to eliminate iron, manganese etc.

Adaptation through Rain water harvesting

Domestic Use

The most significant impact of the domestic rainwater harvesting system in Sri Lanka is the ensured supply of water in the homestead. Rain water harvesting has brought much relief to people during times of drought, water scarcity and recently to those affected by the devastating tsunami of 2004.

Due to the temporal and spatial variation in rain fall in Sri Lanka some areas experiences extreme dry spells between monsoons or on occasions a total failure of the monsoons. Several dry zone districts of Sri Lanka experience prolonged drought, causing tremendous hardships to people. The beneficiaries of rain water harvesting systems constructed in Hambantota, Moneragala and Anuradhapura were able to use rainwater stored in the tanks for as long as 5 -6 months during this period.

Some of the social and economic benefits identified by households using rain water harvesting systems are;

- Easy access to clean drinking water
- Less time spent on collecting water
- Time saved (average 1.5 hrs per day) is used for social and economic activities
- Skills enhancement in the village
- Less reliance on external water providers
- More water security at household level
- Better sanitation due to more water availability
- Enhanced income through use of rain water for home gardening, animal rearing and brick making etc.

- Reduction in diarrheal disease
- Better quality water, especially in areas with high levels of Fluoride in ground water, saline water (after the tsunami) and brackish water.

Recommendations for the future:

- Wide scale promotion of rainwater harvesting for domestic and agriculture use in as a climate change adoptive measure in vulnerable areas.
- Using rain water for drinking purposes should be encouraged in dry zone districts where the groundwater is both mineralized and contaminated, especially in areas where a high incidence of kidney problems due to polluted ground water has been reported.
- Rain water harvesting should be encouraged as a supplementary water source in urban areas to reduce water bills, save on energy, save on water treatment costs and to reduce flooding in some areas.
- The policy and legislation which are in place should be implemented and monitored for effectiveness.
- To encourage householders to adopt rain water harvesting by offering incentives such as tax rebates, low interest loan ect.
- Incorporate rain water harvesting in all public and commercial buildings with large scale use of pipe borne water.
- Potential areas for ground water recharging should be identified and encouraged
- Rain water harvesting system components for urban houses should be made available locally.
- Professionals should use innovative designs incorporate rain water harvesting in new buildings

Adaptation options in the irrigation sector

Irrigation systems are normally designed considering the crop water requirement of the selected crops, for the scheme. However, due to changes in the climate the water management system has to be redesigned with new design variables and performance should be assessed. Factors such increased carbon-dioxide on crop growth, effects of high temperature, availability of water, extreme climate events etc. which influence agricultural performance has to be take into account.

Additional investments may be needed for new dams, reservoirs, canals, wells, pumps and piping to develop irrigation networks in new locations to cater to new demands.

Flood management would have to be reviewed with inflows to reservoirs and landslides in hilly areas, with a change of approach in flood control operations.