Research Studies: Working Paper Series No.14
December 2009

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**National Library of Sri Lanka-Cataloguing-In-Publication Data**

Senaratne, Athula
Mainstreaming Climate Change for Sustainable Development in Sri Lanka: Towards a National Agenda for Action / Athula Senaratne, Nethmini Perera and Kanchana Wickramasinghe.—
Colombo : Institute of Policy Studies, Sri Lanka, 2010. —
45 p ; 21 cm

ISBN 978-955-8708-60-6 Price:

i. 551.6 DDC 21 ii. Title
iii. Climatology 2. Climate change

**ISBN 978-955-8708-60-6**

Price

Please address orders to:
Institute of Policy Studies of Sri Lanka
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## Table of Contents

## List of Tables



## List of Figures

## Acknowledgements

First, we extend our immense gratitude to Dr. Saman Kelegama, Executive Director of IPS for his guidance and endless encouragement throughout the entire duration of this study.

This study was undertaken with the funding support of the National Commission for UNESCO, Sri Lanka. In this connection we gratefully acknowledge the generous help provided by the Secretary General of the National Commission for UNESCO, Mr. R.P. Perera and his staff to make this project a success.

We express our sincere thanks to Mr. M.A.R.D. Jayatilake, Secretary, Ministry of Environment and Natural Resources (MENR), Dr. W.L. Sumathipala, Director, Ms. Anoja Herath, Assistant Director and Ms. T. Inoka, Environmental Management Officer of the Climate Change Secretariat for the cooperation extended in organization of the national workshop.

This study is primarily based on information gathered in a national level workshop on climate change. A special thank goes to all resource persons and the participants from various relevant organizations for their valuable inputs provided in the workshop (List of persons and organizations are given in the annex of this report).

Special vote of thanks goes to Ms. Sharmini De Silva of IPS (Secretary), who was the live wire of all organizational activities of the national workshop.

We acknowledge the assistance provided by researchers of IPS, namely, Dr. S.P. Samaratunga (Research Fellow, Agricultural Economics Policy Unit), Mr. G.D. Dayaratne (Manager, Health Unit), Mr. Manoj Thibbotuwawa (Research Officer), Mr. Anushka Wijesinha (Research Officer) and Ms. Sunimalee Madurawala (Research Officer).

We also thank the staff of the Support Services Units of IPS, namely, Ms. Iloka Wickramasinghe (Director, Finance & Administration), Mr. Haren Kodagoda (Head, IT Unit), Mr. Nuwan Kahandawala Arachchi (IT Unit), and Mr. Amesh Thennakoon (Publications Officer) for all their support in organization of the national workshop.

Despite knowledge, assistance and encouragement from all those who are mentioned above, we, the authors assume the sole responsibility for any remaining errors or omissions in this work.

## Executive Summary

Scientific evidence from numerous sources indicate that global climate change is actually taking place. This implies that the present generation and many to come will have to face impacts of climate change. Scientists are unanimous that pending changes in climate patterns would be global in scope and scale. It is widely agreed that developing countries would face greater hardships and within them also, poorer communities are more vulnerable. Various studies have underscored the importance of effective mitigation measures 'to avoid the unmanageable' and the necessity of appropriate adaptation 'to manage the unavoidable'.

Sri Lanka, being a tropical island of significant poor population located in a disaster prone region, is highly vulnerable to climate change in terms of physical as well as socio-economic impacts. The country needs to develop a strong national agenda to confront the challenge on which the nation's entire future hopes for sustainable development depend on. In spite of that, the present readiness of the country to face the climate change impacts can hardly be considered adequate. In the backdrop, this study undertakes a policy analysis that could guide developing a national agenda for mainstreaming the activities on climate change in the overall national development context of the country.

Data for the study was collected from both primary as well as secondary sources. The main source of primary information was a national workshop conducted with the participation of several experts from relevant government agencies and academia. In addition, information and opinions were gathered through informal, unstructured discussions with certain stakeholders too. Information from these primary sources was supplemented with information from a variety of secondary sources. A qualitative analysis of information collected from various sources was undertaken.

A review of existing information on climate conditions in Sri Lanka and effects of global warming on local climate was made. Being a small tropical island, there is no significant annual variation in temperature due to the latitude of Sri Lanka. However, significant regional variation could be observed due to changes in altitude. Precipitation (rainfall: RF) is the major parameter that gives rise to variability of climatic conditions during the annual cycle. There are three major sources of RF in Sri Lanka, namely, monsoonal, convectional and depressional. Based on variability of precipitation within the year, four climatic seasons with typical features can be identified. They are: first inter-monsoon season (FIM), southwest monsoon season (SWM), second inter-monsoon season (SIM), and northeast monsoon season (NEM). In addition, cyclones and depressions affect the local climate significantly. They can develop into catastrophic events occasionally, claiming for losses of human life and physical property.

Climate change in Sri Lanka has been studied using two major approaches, namely, statistical analysis of past climate data and projection of future climate conditions with the help of climate models. Analysis of past records have highlighted that air temperature in Sri Lanka has been rising all over the country during the last century. The warming trend has accelerated during the recent decades. Experts suggest that enhanced greenhouse effect could have partly been responsible for rising air temperature together with local effects such as urbanization, deforestation and land use changes. Effects observed in precipitation do not indicate a clear trend as in the case of air temperature. However, negative deviation has indicated for average annual RF in the latter part of the century since 1970s, nearly for all years. The decline was mainly reported in NEM followed by FIM whereas changes were negligible in SWM and SIM. The variation of RF also has increased, again the highest variation being in NEM. Moreover, records indicate

that occurrence of extreme events such as droughts and floods increased despite the slight drop in incidents of cyclones and depressions during the latter half of the last century.

Models project that mean annual temperature of the country will increase steadily, which is consistent with trends observed in analysis of past data. Models further suggest that annual precipitation in the country will increase in the future, which is not fully consistent with the negative RF trend experienced during the recent decades. In addition to changes in temperature, precipitation and extreme events, there are two other climate related effects that are identified to be highly important in Sri Lanka, namely, sea level rise and increased concentration of $CO_2$ in the atmosphere.

It has been identified that impacts on six major areas could be critically important. They are, namely: impacts on agriculture and irrigation, impacts on coastal zone, impacts on forests and natural eco-systems, impacts on human settlements and infrastructure, impacts on human health and impacts on energy and industry. A logical presentation of impacts in these areas has been made using simple effect-impact matrices to identify the relationship between climate effects and impacts.

Information gathered from different sources indicates that a few main gaps act as major barriers against formulating and implementation of effective actions against climate change at the national and other levels of activity. They are, namely: lack of agenda and priorities, information gap, coordination gap and resource mobilization gap. While lack of information, poor coordination and limited resources have their own drawbacks, lack of agenda overrides them all. If sensible agenda is available, even the limited information, facilities and resources could have been put into more efficient use than at present.

A framework for a 'National Agenda' that aims at mainstreaming the climate change for sustainable development is proposed in detail. Success of mainstreaming climate change in national development would largely be determined by the effectiveness of measures taken to overcome the major gaps discussed. The main role expected from the national agenda is to create conditions necessary to overcome the major gaps. This is an essential prerequisite to proceed from the backward position where we now stand as far as climate change is concerned. The framework proposed here covers six major aspects, namely: national vision on climate change, national policy on climate change, strategic action plan (national strategy), coordinating mechanism, climate change information system and mechanism for resource mobilizations. National agenda for climate change is the combination of these components.

# 1. Introduction

Many scientists now believe that human induced climate change is actually taking place. As Michel Jarraud, Secretary General of the World Meteorological Organization summed up in the release of the 4th Assessment Report (AR4) of Inter-governmental Panel for Climate Change (IPCC), it is (now) a question of when and how much and not if. This implies that the present generation and many to come in the future are likely to face the impacts of climate change.

Main causes of climate change have been well comprehended. It has been established that accumulation of Green House Gases (GHG) in the atmosphere, especially carbon dioxide due to fossil fuel burning, is the main contributing factor for global warming and resultant changes in climate. In addition, methane and nitrous oxides from agriculture, chlorofluorocarbons (CFC) from industry and carbon stocks released due to deforestation are also responsible to a lesser degree.

Scientists are unanimous that pending changes in climate patterns would be global in scope and scale. Studies have predicted that developing countries are likely to face greater hardships and within them also the poorer communities are more vulnerable (Stern, 2007). Sri Lanka is a developing nation with a significant poor population. As a tropical island located in the South Asia region, it frequently experiences disaster prone weather extremes. Combination of these factors: being a tropical island of significant poor population and located in a disaster prone region, makes Sri Lanka a highly vulnerable country to climate change in terms of physical as well as socio-economic impacts.

## 1.1 Facing the Threat of Climate Change: Mitigation and Adaptation

The Fourth Assessment Report (AR4) of IPCC and other global surveys underscored the importance of a few broad strategies to confront the challenge of climate change impacts (IPCC, 2007; Bierbaum et al., 2007; Stern, 2007). That includes:

- Increased vigilance over changes in climate patterns for early detection of hazards;
- Effective cooperation on mitigation measures that can reduce current levels of GHG emissions (To avoid the unmanageable), and;
- Minimization of damage due to inevitable impacts through appropriate measures of adaptation (To manage the unavoidable).

As far as mitigation of climate change is concerned, it is apparent that the world community should act together to avoid building up of GHG in the atmosphere to unmanageable levels. The main options available in this regard include phasing out emission intensive energy from fossil based sources, raising the efficiency of generation of energy from existing sources, increasing the share of energy from renewable sources and controlling deforestation. The United Nations Framework Convention of Climate Change (UNFCC) is striving to build a global consensus on mitigation measures through a process of international negotiations. The main objective of this effort is to reduce current level of GHG emissions in relation to a particular point of reference. Reference level of emissions currently being used in

global negotiations is emission levels at 1990. Experience during the past years has indicated that climate negotiations could be an arduous, time consuming process.

Scientific studies predict that even if the global community would manage to reduce GHG emissions, still some degree of climate change impacts will be inevitable due to already accumulated GHG emissions. Therefore, all countries need to introduce suitable adaptation measures to face inevitable impacts while also cooperating with each other to reduce the build up of emissions through effective measures of mitigation. Adaptation may involve a wide range of activities that would help to reduce the vulnerability of communities who are likely to face impacts of climate change. However, there are some essential preconditions for achieving successful results from adaptation measures. Firstly, it is necessary to implement appropriate mitigation measures in an effective manner. Otherwise, adaptation would become a prohibitively costly exercise. Secondly, countries need to increase the alertness over climate hazards through enhanced monitoring.

## 1.2 Action against Climate Change and Uncertainty

Being a global phenomenon, impacts of climate change loom over every conceivable level; global, regional, national as well as local levels. Therefore, measures to confront the climate change have to be implemented at different levels. Certain measures are essentially global in scope and international cooperation is an indispensable condition for success. Below the level of global action, a large space is left for regional, national and local level actions as well. One cannot over-emphasize the importance of national level action due to a number of reasons. Firstly, many mitigation and adaptation activities have to be practically implemented at the national level. Secondly, it is the most effective decision making level, also having an important role to play in coordinating decisions taken at the above (international, regional) and below (sub-national, local) level. Even the activities pertaining to the global agenda have to be coordinated and implemented through national governments. National action on climate change has to deal with mitigation as well as adaptation measures. Unless national actions fall in line with the global agenda, achieving desired outcomes of international actions would also be impossible. Despite the critical importance of national level action, however, many countries have yet to streamline their national agendas on climate change and Sri Lanka is not an exception.

Despite early signs of climate change and projections made by global studies, there is a large uncertainty over many effects of climate change and so are the physical and socio-economic impacts of them. The uncertainty over impacts of climate change naturally leads to uncertainty over decisions on actions to prevent, adapt to or mitigate those impacts too. Hence, uncertainty is a key challenge that has to be faced in making any policy decision relating to climate change. A policy dilemma is involved here as no one can accurately predict future scenario(s) while decisions also cannot be delayed awaiting more information before it becomes too late. Given the nature of the uncertainties involved, initiating effective action against climate change is essentially an information-driven process. Taking the policy risks faced by decision makers into consideration, experts have suggested the necessity of an 'adaptive approach' when deciding on actions against climate change impacts (TERI and IISD, 2006; Walker,

Rahman and Cave, 2001). This implies that any agenda for facing the threat of climate change has to evolve over time with the emergence of new information and knowledge, on a continuous basis.

## 1.3 Necessity of a National Agenda on Climate Change

Sri Lanka's contribution to green house gas (GHG) emissions is relatively low compared with the developed world or fast growing developing economies such as China, India or Brazil. This implies that the potential contribution that can be made by Sri Lanka to achieve global targets for reduction of GHG emissions is limited. However, this does not imply that the country should ignore its responsibility to cooperate in global efforts of mitigation to reduce GHG emissions. Despite the low level of current emissions compared with other countries, there are signs that the country's emissions are increasing rapidly due to growing dependence of transport and power generation sectors on fossil fuels.

On the other hand, notwithstanding the low contribution to global warming, the country's high vulnerability to impacts of climate change is readily evident even from the limited available information. Presumably, the island nation is susceptible to sea level rise. The 2004 tsunami has indicated that a large extent of densely populated, low lying coastal area could be highly vulnerable to a future rise in the sea level. Weather pattern of the region is under the influence of strong seasonal monsoons and turbulent weather areas such as the Bay of Bengal. Therefore, the country is frequently subjected to disaster prone weather extremes such as droughts, floods and cyclones. Predictions by global studies on climate change suggest that both the intensity and frequency of such extreme events would increase in the future. Water supply of the country is highly dependent on monsoons. As a significant population of the country, especially the majority of rural poor, is dependent directly on weather-reliant livelihoods such as agriculture and fisheries, any adverse change in already volatile weather patterns are likely to create chaotic conditions. Among the community groups that are more vulnerable to climate change impacts are residents in coastal areas, farmers in the dry zone, fishing community, workers in the estate sector and small scale producers of export crops. Chapter Four presents a detailed account of climate change impacts that can potentially be faced by Sri Lanka, projected on the basis of currently available information.

Being a vulnerable country, Sri Lanka should develop a strong national agenda to confront the consequences of climate change on which the nation's entire future hopes for sustainable development depend on. Like many developing countries, however, Sri Lanka is also at the initial stage of developing such an agenda and the present readiness of the country to face the climate change impacts can hardly be considered adequate. The process should enable creating a broader consensus over the major issues and their priorities and setting up a plan of action based on strategic importance of respective issues and urgency of action. It demands a more comprehensive approach that can cover macro policies as well as appropriate sectoral actions with necessary inter-linkages among them. In other words, it needs to mainstream the national agenda on climate change with other national policies and programs at all levels of decision making and implementation.

Adaptation should come as a priority in the national agenda for climate change in Sri Lanka. Unlike the case of mitigation measures where countries have to cooperate with each other, many adaptation and capacity building measures have to be undertaken locally and nationally. Accordingly, it needs to concentrate on identification of areas of adaptation, selection of suitable adaptation measures, undertaking necessary capacity building, mobilizing resources and enhancing the monitoring of climate hazards. Technically, required adaptation measures may spread over a wide range of activities such as protection of low lying coastal areas from sea level rise, development of disaster resilient crop varieties, relocation of the most vulnerable communities, improvement of building designs to face weather extremes etc.

Two major problems that have to be faced in developing such an agenda are lack of information and uncertainty over potential future impacts of climate change. In spite of these problems, certain actions may not be able to be postponed until adequate information is available. Therefore some kind of framework for decision making under uncertainties and limited information is necessary to identify strategic priorities and initiate necessary actions. Given the limited information available at the national level and difficulties in adapting large-scale global models to a small physical and economic entity such as Sri Lanka, at the current juncture more sophisticated modeling attempts are not practical. What is more realistic is a broad decision making framework that can help to anticipate likely scenarios so that priority areas can be selected with potential timeframes and cost and benefits attached with feasible actions. Further, such a framework should be operational with limited or adapted information with suitable sensitivity checks to address associated uncertainties and limitations of data. In this connection, there is a tremendous responsibility over the shoulders of researchers, scholars and academics, who should provide necessary guidance to policy makers.

## 1.4 Objectives of the Study

In the backdrop, this study undertakes a policy analysis that could guide developing a national agenda for mainstreaming the activities on climate change in the overall national development context of the country. In fact, it does not intend to develop an 'Agenda (or Plan)' in the sense that include all details of programs, projects and activities to confront potential impacts of climate change with precise timeframes and budgetary allocations for them. We presume that such an agenda is not realistic, feasible and timely under the current level of knowledge and information available. Rather, it envisages creating a broader consensus over the major impacts based on strategic importance of them and identifying a suitable framework that can accommodate them in a national agenda in logical order.

Specific objectives of the study can be stated as follows:

1. Review the existing information on climate change in Sri Lanka to identify major effects on climate due to global warming, their potential impacts, vulnerable sectors and strategic importance of key issues/impacts
2. Analyze the major gaps that constrain the formulation and implementation of meaningful action against climate change impacts thereby assessing the limitations of current adaptation and mitigation activities

3. Identify a suitable framework for a national agenda on climate change that can address the major gaps, provide the guidance for necessary policy support and initiate action against impacts of climate change on the basis of their strategic importance

### 1.5 Organization of the Report

The next chapter presents details of data sources and method used in the study. It is followed by an overview of climate conditions in Sri Lanka and a review of existing information on global warming effects on local climate. Section four presents key impacts of climate change that can be anticipated under the projected climate change effects. This section is followed by an analysis of major gaps that constrain the action against climate change impacts. The final section provides an outline for national agenda that can mainstream the issue of climate change in the overall context of sustainable development of Sri Lanka.

## 2. Data Sources and Method

This chapter provides details on data sources and method used in the study. The study was conducted over a period of nine months starting from March 2009.

### 2.1 Data Sources

Data for the study was collected from both primary as well as secondary sources. The main source of primary information was a national workshop conducted with the participation of several experts from relevant government agencies and academia. In addition, information and opinions were gathered through informal, unstructured discussions with certain stakeholders too. Information from these primary sources was supplemented with information from a variety of secondary sources.

#### 2.1.1 National Workshop

A three day workshop was conducted on the theme of 'Mainstreaming Climate Change for Sustainable Development in Sri Lanka' in Dambulla, on August 18-20, 2009. A number of key officials and academics were invited for the workshop as resource persons and participants. The forum of the workshop provided following sources of valuable information:

- Resource persons' presentations on specific topics on climate change
- Panel discussions held after each technical session of presentations
- Output of four working groups participated by experts on respective sectors

The technical agenda of the workshop and list of resource persons and participants are given in the appendices.

### 2.1.2 Key informant discussions

In addition to information gathered in the workshop, investigators were benefited by informal discussions they had with key stakeholders during the course of the study. These were unstructured discussions usually held in informal settings. Outputs were recorded mainly as discussion notes.

### 2.1.3 Secondary information

Secondary information included a wide range of sources such as: past research, reports, seminar proceedings, data/statistics published by relevant organizations, information available from organizational websites, administrative and policy documents etc. Information from these sources supplemented the information gathered from primary sources with additional details, data and insights etc.

Table 2.1 summarizes the information collected from above sources.

**Table 2.1**
**Information Gathered from Different Sources**

| Data source | Type of information gathered | Remarks |
|---|---|---|
| National workshop | • Expert opinions on scientific, economic and social aspects of climate change<br>• Current information on effects on local climate, anticipated impacts, vulnerable sectors and community groups<br>• Potential strategies for overcoming impacts on vulnerable sectors<br>• Expert views on major gaps in the current level of preparedness, assessment of needs, directions on policy, capacity building requirements etc. | Three day workshop covered expert presentations, panel discussions and a working group session |
| Informal discussions | • Views and opinions on major gaps and ways of overcoming them<br>• Scope and scale of necessary policy support<br>• Priorities according to the informants' views | Include discussions with a number of persons under informal conditions |
| Secondary sources | • Data and statistics on climate change<br>• Findings of scientific investigations on different sectors<br>• Insights on climate change effects, potential impacts, vulnerable groups, possible measures of mitigation and adaptation etc. | Information from secondary sources supplemented the primary data |

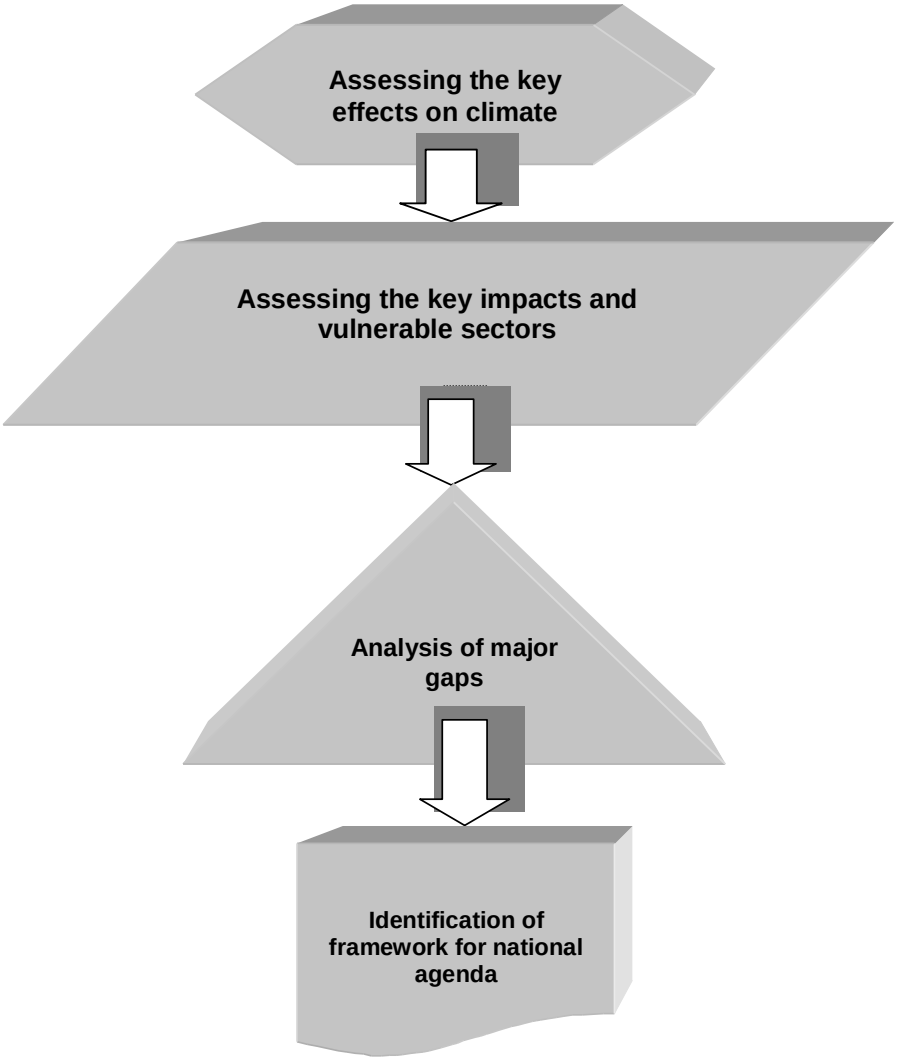
## 2.2 Analysis and Organization of Information

A qualitative analysis of information collected from various sources was undertaken. This involved tabular techniques for compiling, organization and analyzing data collected from different sources which were not readily compatible with each other. No statistical analysis or quantitative analytical techniques were used in the process, mainly due to lack of such quantitative information pertinent to the objectives of the study.

The complexity of the problem, uncertainty of issues involved, limited nature of data availability and incompatibility of information from different sources has made the processing of information an enormously difficult task. This was handled through keeping with the objectives of the study by using techniques of analysis and synthesis of information in a creative manner. This was guided by the tentative procedure for information processing given below.

**Figure 2.1**

**Schematic Representation of Analyzing, Synthesizing and Organization of Information**



As already mentioned the proposed framework is not a rigid 'plan of action' implemented through a hierarchical system of management but a broad agenda for coordinated action by the relevant stakeholder organizations. It will provide necessary guidance for designing concrete actions to face the challenge of climate change through coordinated implementation. It is expected to provide direction for respective organizations to develop their own activities that can be implemented through suitable mechanisms of coordination among themselves.

# 3. Climate Change in Sri Lanka: A Review of Existing Knowledge and Information

## 3.1 An Overview of Climate in Sri Lanka

Weather and climate are closely related concepts. Weather describes the state of atmosphere in a given geographical location over a short period of time (i.e., daily, hourly etc.). Climate is the average state of weather taken over relatively a lengthy period of time in months to years. Both climate and weather are determined by meteorological parameters. Among the key meteorological parameters are temperature, precipitation, pressure, duration and intensity of sunshine, humidity and direction and velocity of wind. Based on the variation of climatic conditions observed globally, the world has been divided into a number of climatic zones. Accordingly, Sri Lanka is located in a tropical climatic zone. In tropical climates, considerable variation can be observed in parameters of RF, wind and pressure whereas variation of temperature from season to season is usually not significant. In this section, we summarize the general pattern of climate observed in Sri Lanka. This review is mainly based on Chandrapala (2007: a & b), Basnayake (2007 & 2004), Abhaysinghe (2007) and Jayatialke et al. (2004).

### 3.1.1 Temperature

Being a small tropical island, there is no significant annual variation in temperature due to latitude in Sri Lanka. Therefore, the island does not experience an annual cycle of distinctive seasons with contrasting temperature differences as in temperate countries. However, slight variation of monthly average temperature could be observed due to seasonal movement of sun and influence of rainfall. Accordingly, in many areas, the coolest period is December-January. March-April and August are relatively warm months. In a given day, maximum and minimum temperatures are usually recorded in the afternoon and before dawn of the sunlight, respectively.

Despite low variation in temperature over time in a given locality, significant regional variation could be observed due to changes in altitude. Geo-morphology of Sri Lanka consists of a central highland area surrounded by a lowland plain which gradually slopes down to the coastline in all directions. In lowland plain areas, average annual temperature varies in the narrow range of 26.5–28.5 C (avg. 27.5 C). In contrast, a significant variation in average temperature can be observed in highland areas as temperature falls quickly with rising altitude. It has been estimated that temperature drops by 0.5° of C for every 100 m rise in altitude. Accordingly, coolest average temperature around 15.9 C is recorded from Nuwra Eliya which is above 1800 msl. During the period of December-January, temperature in Nuwara Eliya sometimes falls below the 0° C giving rise to ground frost during early hours of the morning.

### 3.1.2 Precipitation

Precipitation (rainfall: RF) is the major parameter that gives rise to variability of climatic conditions during the annual cycle. There are three major sources of RF in Sri Lanka, namely, monsoonal, convectional and depressional. Country has a mean annual RF around 1861 mm with significant variation in regional distribution that range from 900 mm to 5000 mm. According to the distribution pattern of RF from three sources, the Southwestern quarter and certain areas of central highlands (western slope of central highlands) receive the highest RF. Certain areas in this region (e.g., Yatiyantota, Ginigathhena, Watawala) have recorded annual RF over 5000 mm. In contrast, coastal areas in Southeastern (e.g., Yala, Palatupana) and Northwestern (e.g., Mannar) quarters receive the lowest annual RF of less than 1000 mm.

Based on variability of precipitation within the year, four climatic seasons with typical features can be identified. Table 3.1 summarizes the annual cycle of seasons based on precipitation.

**Table 3.1**
**Seasonal Variation in Climate according to the Temporal Distribution of RF**

| Season | Period | Avg. RF | % |
|---|---|---|---|
| 1. First inter-monsoon season (FIM) | March-April | 268 mm | 14% |
| 2. Southwest monsoon season (SWM) | May- September | 556 mm | 30% |
| 3. Second inter-monsoon season (SIM) | October-November | 558 mm | 30% |
| 4. Northeast monsoon season (NEM) | December-February | 479 mm | 26% |
| **Total** | | **1861 mm** | |

Key features of respective RF seasons can be summarized as follows.

**First inter-monsoon season (FIM): March–April:** Southwestern quarter and certain parts of central highlands receive RF over 250 mm whereas many other areas receive around 100 -250 mm. Following conditions can be observed during the season.

- Warm and uncomfortable conditions
- Thunderstorm type rains during afternoon or evening
- Hazardous lightning associated with thunderstorms
- RF may be intense with flash floods
- Produce mild tornadoes (8-10 per season)

**Southwest monsoon season (SWM): May–September:** A considerable pressure gradient exists in the direction of southwest-northeast direction creating strong westerly or southwesterly wind streams

(monsoons) with considerable amount of water vapour. As a result, mid-elevation western slopes of central highlands receive over 3000 mm. Southwestern coastal belt and central highlands receive around 1000-1600 mm and 800 mm, respectively. Climatic conditions generally experienced during the season are:

- Windy weather easing off the warmth
- Rains are experienced at any time during the day and night
- Long lasting rains may result in floods in low-lying areas and land slides in hilly areas
- Frequency of thunderstorms, lightning and tornadoes is significantly low

**Second inter-monsoon season (SIM): October-November:** Unlike FIM, influence of weather systems like depressions and cyclones in the Bay of Bengal is common during the SIM, creating strong winds with widespread rains, sometimes leading to floods and landslides. SIM is the season with most evenly balanced RF in Sri Lanka. Many areas receive over 400 mm. Slopes in the southwestern quarter receive the highest RF around 750 -1200 mm. Usually the following conditions can be observed during the season.

- Warm and uncomfortable conditions
- Thunderstorm type rains during afternoon or evening
- Hazardous lightning associated with thunderstorms
- RF may be intense with flash floods
- Produce mild tornadoes (8-10 per season)

**Northeast monsoon season (NEM): December–February:** Air streams are originating in north India or in the northeast Asian landmass (the China-Russia region). Stream from north India is cold and poor in moisture whereas stream from northeast Asian landmass collects large mass of moisture. Different characteristics of wind streams create different weather conditions over different areas in the country. Dry and cold wind blowing from the Indian land mass create cool, dry weather over many parts leading to:

- Pleasant and comfortable weather with rather cold hours in the morning
- Cloud free skies during the day full of sunshine
- Mist, fog and dew in the cool morning hours
- Sometimes temperature may go below 0° C, depositing ground frost in high elevation areas (e.g., Nuwara Eliya)

In contrast, moist wind blowing from the northeast Asian landmass produces seasonal RF in Northern, North central and Eastern parts of the country. Highest RF figures are recorded in north-eastern slopes of the hill country and eastern slopes of the Knuckles/Rangala range. Sometimes, thundershowers develop over the central mountains and are pushed to the western and southern region during the late evening and early night. These may be associated with:

- Hazardous lightning associated with thunderstorms
- Strong winds that can damage life and property

### 3.1.3 Cyclones and depressions

Cyclones and depressions affect the local climate significantly. They occur frequently in the Bay of Bengal area and contribute to precipitation in surrounding local areas. They can develop into catastrophic events occasionally, claiming for losses of human life and physical property. Sri Lanka comes under the influence of these extreme events mainly during the October-November period when the SIM is in action. They mainly affect Eastern and Northern areas and occasionally inflict damages all over the island.

## 3.2 Climate Change Effects in Sri Lanka: A Review

All climatic parameters are variable over time. In fact, a major feature of RF in Sri Lanka is high year to year variability. Therefore, variability of climatic parameters can not be considered as a measure of climate change unless statistically significant. Climate change in Sri Lanka has been studied using two major approaches, namely;

- statistical analysis of past climate data, and
- projection of future values for key climate parameters with the help of climate models.

These approaches have their advantages and disadvantages. Samarasinghe (2009) summarized information generated from both approaches in the national workshop conducted in Dambulla for this study. In the forthcoming section, a brief review of such studies is presented.

### 3.2.1 Changes observed in past record

Among the widely quoted studies on past changes in climate in Sri Lanka is Chandrapala (1996) that compared meteorological data on temperature and precipitation over two periods of 1931-1960 and 1961-1990. A recent study by Jayawardena, Sonnadara and Jayawardena (2005) tested RF data from 15 meteorological stations for statistically significant trends over short (36 to 50 years) and long period (98 to 130 years) horizons. Jayatilake et al. (2004) discussed extensively about changes in RF and temperature observed over two periods of 1931-1960 and 1961-1990. Chandrapala (2007: a & b) subsequently extended his analysis for the period of 1961-2005 where he compared recent decades of 1981-1990 and 1991-2000. An attempt is made here to summarize the key findings of these studies.

#### 3.2.1.1 Effects on temperature

These studies have highlighted that air temperature in Sri Lanka has been rising all over the country during the last century. The warming trend has accelerated during the recent decades, especially since mid-1960s. Since 1970 onwards, mean air temperature remained continuously above the average since 1930 except for a few years. Rate of increase of mean air temperature in Sri Lanka during the period of 1961-1990 was 0.016° C per year (1.6° C per 100 years) which is above the global average. The highest rate of increase was reported from Puttalam (0.021° C per year or 2.1° C per 100 years). Increasing trend was reflected in both in nighttime minimum and daytime maximum air temperature figures (Basnayake, 2007). Rise in air temperature was manifested in a number of ways as follows (Samarasinghe, 2009).

- Cold days and nights decreased
- Warm days and nights increased
- Consecutive dry days increased

According to Basnayake (2007) enhanced greenhouse effect could have partly been responsible for rising air temperature whereas local effects such as urbanization, deforestation and land use changes are also having some impact.

#### 3.2.1.2 Effects on precipitation

Effects observed in precipitation do not indicate a clear trend as in the case of air temperature (Jayawardena, Sonnadara and Jayawardena, 2005). However, statistically significant trends were reported for Colombo (positive), Kandy and Badulla (negative) in the long period analysis. In the short period analysis, 13 out of 15 stations recorded decrease in RF on average with stations in Kandy, Galle, Diyatalawa and Batticaloa having statistically significant negative trends. This situation is confirmed by the two period comparative analysis of Chandrapala (1996) also. Accordingly, annual average of rainfall in the country has decreased by 144 millimetres, during the period 1961 -1990 compared with 1931 -1960 period (Table 3.2). This is a 7 per cent drop. Moreover, negative deviation has indicated for average annual RF in the latter part of the century (since 1970s) nearly for all years (mean calculated since 1880).

The decline was mainly reported in NEM (19 per cent) followed by FIM (10.5 per cent). Changes were negligible in SWM and SIM. The variation of RF also has increased (standard deviation increased from 234 to 263 mm) during the period of 1961- 1990. Again the highest increase in variation of RF occurred during the NEM. In contrast, RF in SWM became more stable having a coefficient of variation which actually decreased in the latter period.

Spatially, the highest changes in annual RF were reported from Matale, Kandy, Amapara, Badulla and Nuwara Eliya (all negative). Except Colombo and Matara, all other districts reported negative changes in annual RF. Changes in distribution pattern indicates shifting of demarcation of RF zones, parts of earlier wet zone getting into intermediate zone and parts of earlier intermediate zone getting into dry zone (Jayatilake et al., 2004).

**Table 3.2**
**Changes in Variation of RF**

| Season | Coefficient of variation % | |
|---|---|---|
| | **1931-1960** | **1961-1990** |
| 1. First inter-monsoon season (FIM) | 23 | 27 |
| 2. Southwest monsoon season (SWM) | 21 | 16 |
| 3. Second inter-monsoon season (SIM) | 22 | 23 |
| 4. Northeast monsoon season (NEM) | 31 | 42 |
| **Annual** | **12** | **14** |

#### 3.2.1.3 Extreme events

Global studies indicate that significant increase of extreme events could be expected due to enhanced green house effects (IPCC, 2006). However, available information indicates a mixed situation about extreme events in Sri Lanka. According to Samarasinghe (2009) past records indicate that frequency of cyclones and depressions has decreased during the last few decades, which attained a peak around the middle of the last century. However, other sources indicate that occurrence of floods, droughts, thunderstorms, lightning damages and tornadoes has increased during the recent decades (Basnayake, 2007). Certain extreme events are closely associated with precipitation, either with heavy RF events (i.e., floods) or with lack of RF over long periods (i.e., droughts).

### 3.2.2 Future projections based on modelling exercises

Climate systems are complex, dynamic systems and therefore projection of their behaviour into the future is a difficult task. Analysis of past records can give us some indication about ongoing trends, but they cannot be extrapolated into the future, in a reliable manner. As a result, scientists keep more faith on projecting climate futures using Global Circulation Models (GCM) under different scenarios of emissions assumed to simulate conditions expected in future. IPCC developed a set of scenarios to represent future emissions that came to known as storylines A1, A2, B1 and B2. They are widely being used for modelling purposes world over. Usually, global projections provided by GCM cannot be used readily for small geographical units like Sri Lanka. Therefore 'downscaling' techniques have been developed to generate more localized projections of climate parameters using GCM. Recently, a few such efforts have been made in Sri Lanka also. We describe projections made by one widely quoted effort by Basnayake (2004). This study has used a model developed by the Hadley Centre in UK known as HadCM3, under the A2 scenario storyline, taking 1961-1990 values as the baseline.

#### 3.2.2.1 Projections on temperature change scenarios

According to the model projections, mean annual temperature of the country will increase steadily throughout the century (Table 3.3). This result is consistent with the trend observed in the past data for last few decades. By 2100, mean annual temperature will rise by 2.4° C than the baseline (1961-1990).

**Table 3.3**
**Future Projections for Change in Mean Annual Temperature**

| Year | Change in T° (Increment over the baseline) |
|---|---|
| 2025 | 0.4° C |
| 2050 | 0.9° C |
| 2075 | 1.6° C |
| 2100 | 2.4° C |

#### 3.2.2.2 Projections on rainfall change scenario

Model projections suggest that annual precipitation in the country will increase in the future (Table 3.4). Increase in RF is predicted for both SWM and NEM. While the increase projected for SWM is substantial, RF rise indicated for NEM is modest. This result is not consistent with the overall drop and decreasing trend observed in the annual RF in many stations during the last few decades.

**Table 3.4**
**Future Projections for Change in Annual RF**

| Year | Change in RF (Increment over the baseline) | |
|---|---|---|
| | SWM | NEM |
| 2025 | 173 mm | 23 mm |
| 2050 | 402 mm | 54 mm |
| 2100 | 1061mm | 143 mm |

### 3.2.3 Other climate related effects

In addition to changes observed and projected for temperature, precipitation and extreme events, two other climate related effects are identified to be highly important in terms of their impacts over Sri Lanka. They are, namely, sea level rise and increased concentration of $CO_2$ in the atmosphere. Researchers have predicted that these two effects have the potential to create significant impact over different sectors.

#### 3.2.3.1 Sea level rise

Sea level rise is one of the most widely discussed effects of climate change. Being an island with a densely populated low-lying coastal belt running round the country, Sri Lanka's vulnerability to sea level rise is quite apparent. Despite the fact that it is one of the most feared effects of climate change discussed by many, few scientific efforts have so far been made to assess the level of threat imposed by the issue. Tsunami in 2004 indicated the level of vulnerability of low-lying coastal areas to a future rise in sea level. One study has estimated that sea level rise could result in significant land losses and inundation of coastal water bodies/ecosystems (Table 3.4).

**Table 3.5**
**Projections of Land Losses and Inundations due to Sea Level Rise**

| Sea level rise scenario (m) | Estimated land loss ($km^2$) | Estimated area of inundation ($km^2$) |
|---|---|---|
| 0.30 | 6.0 | 41.00 |
| 1.00 | 11.5 | 91.25 |

**Source:** Weerakkody quoted by Hettiarachchi and Samarawickrama (2009).

Assessing the sea level rise needs regular and systematic monitoring. It was learnt that NARA has recently initiated a monitoring program for sea level rise. However, it needs to have observations over a significant number of years before making any conclusions regarding the matter.

#### 3.2.3.2 Concentration of $CO_2$

Concentration of $CO_2$ is the major reason which is responsible for the global climate change. It has been estimated that $CO_2$ concentration in the atmosphere has increased from 280 ppm at the beginning of the industrial revolution to 380 ppm at present, which can be considered as a significant increase. Climate change is one consequence of rising concentration of $CO_2$ triggered through a mechanism involving enhanced greenhouse effect. Besides its indirect impacts through the climate change, concentration of $CO_2$ in the atmosphere has direct impacts over life forms, especially due to its vital role in photosynthetic process for biomass production. Researchers have predicted a number of impacts that can directly be attributed to rising $CO_2$ level in the atmosphere.

### 3.2.4 Climate change effects in Sri Lanka: a summary

In the backdrop, it is appropriate here to summarize climate change effects indicated by analysis of past records, model projections and expert opinions. It seems information from all sources is consistent on the fact that air temperature is rising all over the country. However, such an unambiguous opinion cannot be formed regarding changes in precipitation as past records and model projections do not fully agree with each other. Expert opinions suggest that conditions would be such that RF would increase in areas where there is already high RF while RF patterns would become more and more erratic in areas with low RF. This implies that RF distribution in the country will become more polarized in future with excess RF areas and deficit RF areas. Based on these changes in temperature and precipitation, it is logical to presume that the country would face more extreme events such as droughts (RF deficit areas) and floods, thunderstorms, tornadoes (RF excess areas). Besides these effects on major climate parameters, little is known or projected about effects on other important climate parameters that make an important role in defining the 'micro climate' in a given locality such as direction and velocity of wind, relative humidity (RH), solar radiation, cloud cover, evapo-transpiration. To some extent, effects on these parameters may be guessed on the basis of changes in major parameters (e.g., temperature rise would increase evapo-transpiration). However, implications are not that clear and simple in all cases.

In addition to the climate parameters discussed above, there is a consensus among researchers about the importance of sea level rise and increase in $CO_2$ level in the atmosphere. While scarce local information is available on these effects, experts seem to base their guesses on findings from global research on climate change and scientific common sense from their knowledge on allied fields.

## 4. Potential Impacts of Climate Change

The previous chapter discussed the effects of global warming on climatic conditions in Sri Lanka. However, possible impacts of such climate effects have hardly been assessed in a systematic manner. Most of the impacts discussed in the literature seem to be intellectual guesses rather than being based on any scientific inquiry. A few exceptions could be found in the plantation and agricultural sectors (Wijeratne, 1996 and 2009; Seo, Mendelsohn and Munasinghe, 2005; Silva et al., 2007). Given the complexity of the issues involved and the uncertainty that prevails over all aspects of climate change, this situation is not a surprise. Besides, lack of reliable data also imposes further limitations. Therefore in this section, we try to compile and summarize impacts discussed by a number of experts on key areas. The basic aim of this exercise is to view the problem from the policy makers' point of view, with a view of identifying a suitable framework for policy action.

Based on the discussion in the previous chapter, it seems that five main effects associated with global warming are likely to create major impacts over several sectors of the economy. They are:

- Rise in atmospheric and oceanic temperature
- Changes in precipitation patterns
- Sea level rise
- Increased concentration of $CO_2$ in the atmosphere
- Rising intensity and frequency of extreme events.

However, we acknowledge the fact that there could be other important climate effects with significant impacts, of which we know little about at present.

In this chapter, an attempt is made to compile the information collected from various sources in logical order to identify possible impacts of the above mentioned effects on six selected areas, namely:

- Impacts on agriculture and irrigation
- Impacts on coastal zone
- Impacts on forests and natural eco-systems
- Impacts on human settlements and infrastructure
- Impacts on human health
- Impacts on energy and industry

In the forthcoming sections these impacts are presented in the form of simple effect- impact matrices so that relationship between climate effects and impacts can be identified clearly.

### 4.1 Impacts on Agriculture and Irrigation

Agriculture and irrigation are the most important sectors as far as food security of the country's growing population is concerned. Therefore, understanding impacts of climate effects on agriculture and irrigation is critically important. Besides, agriculture and irrigation are two sectors which are heavily dependent

on climate conditions. Given the fact that these are quite complex sectors that involve several crops, number of farming systems, agro-ecological zones and numerous water bodies and irrigation structures scattered all over the country, only the broad impacts of major climate effects are examined here.

### 4.1.1 Impacts on agriculture

According to Table 4.1, the overall potential impact on agriculture due to major climate effects appears to be negative. Except for rising $CO_2$ level in the atmosphere, which has a positive impact over crop production due to enhanced photosynthetic effect, all other effects seem to have a negative impact on agriculture. Rise in temperature and deficit of RF in different locations could lead to drop of productivity of crops and decrease in yield and income for farmers. Moreover, salinity caused by sea level rise, drainage problems due to excess RF in certain areas could lead to loss of productive land for agriculture while extreme events could cause crop damages and income losses to farmers.

**Table 4.1**
**Climate Effects and their Impacts on Non-plantation Agriculture Sector**

| Climate Effect | Impacts | | Remarks |
|---|---|---|---|
| | Physical Impacts | Socio-economic Impacts | |
| Rise in atmospheric temperature | • Heat stress on crops<br>• High rate of evapo-transpiration | Drop of productivity, yield and income for farmers | A few studies have been conducted on different aspects of impacts of climate change on non-plantation agriculture including socio-economic studies |
| Changes in precipitation patterns | • Scarcity of water for paddy and other crops in RF deficit areas | Drop of productivity, yield and income for farmers | |
| | • Drainage problems in excess RF areas | 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 $CO_2$ | • 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 | Crop damage and loss of income for farmers | |
| | • Frequent exposure to floods in excess RF areas | | |

### 4.1.2 Impacts on irrigation

Impacts on agriculture and irrigation are interconnected with each other. As in the case of agriculture, climate change has a negative impact over the irrigation sector in the country that can result in the reduction of cultivated area and cropping intensity, production losses due to irrigation failures and

extra expenses for rehabilitation and maintenance. In fact, the major part of the irrigation system in Sri Lanka, is located in dry and intermediate zones of the country. Therefore, it is susceptible to deficits and variability of RF expected in the dry zone. Silva et al. (2007) projected that average RF in the dry zone could decrease by 17 per cent and 9 per cent under A2 and B2 scenarios with additional evapo-transpiration losses of 3.5 per cent (A2) and 3.0 per cent (B2) demanding 23 per cent (A2) and 13 per cent (B2) more irrigation water for paddy by 2050. This implies that surplus water due to excess RF conditions projected for the wet zone (where upper watershed areas are located) has to play a supplementary role in future.

**Table 4.2**
**Climate Effects and their Impacts on Irrigation Sector**

| Climate Effect | Impacts | | Remarks |
|---|---|---|---|
| | Physical Impacts | Socio-economic Impacts | |
| Rise in atmospheric temperature | • Rapid decline of water storage due to high rate of evaporation | Reduction of cultivated area and low cropping intensity | Facing the climate shocks is a regular activity in the irrigation sector. Significant amount of data is available. Yet limited attempts were made to analyze them. |
| Changes in precipitation patterns | • Scarcity of water for irrigation in RF deficit areas | Reduction of cultivated area and low cropping intensity | |
| | • Drainage problems in excess RF areas | Cost of drainage improvement facilities | |
| Extreme events | • Lack of water for irrigation due to frequent droughts in RF deficit areas | Crop damages and production losses due to failure of irrigation | |
| | • Damages to irrigation structures due to frequent floods in excess RF areas | High cost of rehabilitation and maintenance of irrigation structures | |

## 4.2 Impacts on Plantation Sector

The plantation sector is one of the important sources of foreign exchange earnings in Sri Lanka. Three major plantation crops are tea, rubber and coconut. Altogether, they cover an area of 745,000 ha. A large population is dependent on these crops for livelihood and income, directly and indirectly. Tea and the majority of rubber cultivations are located in the wet zone while coconut is cultivated in wet, intermediate and dry zone areas. All three of them are rain-fed crops with heavy dependence on RF. They are sensitive crops for climate conditions, especially for temperature and RF and, production is quite vulnerable to extreme events of dry spells, droughts and excessive RF. Moreover, they are susceptible to outbreaks of pathogens and pests, incidents that are also dependent on climatic conditions. Researchers have identified optimal range of climatic parameters within which they perform best and critical environmental conditions beyond which their growth and production are affected adversely (Table 4.3).

**Table 4.3**
**Optimal Range of Climate Parameters and Critical Environmental Conditions for Major Export Crops**

| Crop | Optimal Range | | Critical Environmental Conditions |
|---|---|---|---|
| | RF (mm) | Temperature (°C) | |
| Tea | 2500-3000 | 18-25° | 1200 > RF > 3000 |
| Rubber | 1650-3000 | 23-28° | 500 mm RF over 6 months |
| Coconut | > 1500 | 27° | dry spells over 2 months |

**Source:** Wijeratne (2009).

Unlike paddy and other agricultural crops which have more negative impacts due to climate change, mixed impacts are indicated for plantation crops. It is predicted that rising $CO_2$ level in the atmosphere will have a positive impact on all three crops. Given the fact that the majority of cultivations are located in the wet zone, they are not susceptible for water deficits. Significant land area of tea and rubber located in up and mid-country is under cool climate conditions, having the prospect of gaining from rising temperature within the optimal range. However, low country tea could be affected negatively due to rising temperature and excessive RF (Wijeratne, 2009). Similarly, coconut plantations in dry and intermediate zones also are vulnerable to water deficits. Overall, mixed impact can be expected for the plantation sector due to effects of climate change. However, gains could be further moderated by outbreaks of pests and pathogens and loss of fertility due to soil erosion under heavy RF in up and mid-country areas.

**Table 4.4**
**Climate Effects and their Impacts on Plantation Sector**

| Climate Effect | Impacts | | Remarks |
|---|---|---|---|
| | Physical Impacts | Socio-economic Impacts | |
| Rise in atmospheric temperature | Increased performance of crops in the optimal range and declie thereafter | Fluctuation of productivity, yield and income with rising temperature | Significant number of studies have been conducted on climate change impacts. Facilitated by reliable data on production and weather parameters. |
| 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 $CO_2$ | 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 | |

## 4.3 Impacts on Coastal Areas

Impact on coastal zone due to sea level rise is a widely discussed issue. This is especially important in the context of Sri Lanka with tragic experience of the 2004 tsunami. A closely associated issue is impacts of climate change on the fisheries sector.

### 4.3.1 Impacts on coastal zone

Impacts on the coastal zone due to sea level rise can be viewed as a pending catastrophe, the scale of which is yet unknown. At least five major physical impacts of immense socio-economic consequences have been predicted by experts.

**Table 4.5**
**Climate Effects and their Impacts on Coastal Zone**

| Climate Effect | Impacts | | Remarks |
|---|---|---|---|
| | Physical Impacts | Socio-economic Impacts | |
| Sea level rise (SLR) | Inundation of low-lying areas | Destruction and damage to:<br>• Coastal settlements<br>• Coastal infrastructure<br>• Tourism assets<br>• Other productive assets<br>• Cultural/historic/relirious assets<br>Disturbance to coastal livelihoods (e.g., fisheries tourism, local industries) | Effects on coastal zone have widely been discussed and potential impacts identified. Certain measures of adaptation are |
| | Shore line retreat<br>Increased coastal erosion | Loss of land for human settlement and economics activity | already implemented. However, |
| | Salt water intrustion into coastal water bodies | Loss of agricultural land due to salinity<br>Decline of water quality for human consumption | systematic studies to understand the true nature of |
| | Sand bar formation in river mouths and coastal water bodies | Disturbance to local communities and livelihoods | the problem are imited. |
| | Alteration of coastal eco-systems<br>• Landward shift of wetlands<br>• Changes/damages to species and habitats<br>• Disturbance to eco-system services | Negative impacts on dependent peripheral communities due to:<br>• Loss of income sources<br>• Loss of other livelihood suports | |
| Extreme events | Overtopping of SLR with cyclones, depressions, thunderstorms etc. | Damage to coastal infrastruture and assets<br><br>Disturbance to coastal livelihoods | |

Among the major physical impacts are: inundation of low-lying areas, retreat of shore line, increased coastal erosion, salt water intrusion of coastal water bodies and agricultural lands, sand bar formation in river mouths and alteration of coastal eco-systems, all of which have negative repercussions with potentially immense losses to social welfare. These physical impacts are over-topped by the impacts of extreme events, frequency and intensity of which are likely to increase significantly in the future. About 65 per cent of urban population of the country is resident in the 1700 km long coastal belt, and the industrial and service sectors of the economy are concentrated along the western and southwestern stretches of the coastline. Fisheries and tourism industries are overwhelmingly dependent on coastal resources. Moreover, a major part of the country's infrastructure network is built along the coastal belt, radiating from its hub located in the western coast. These facts underscore the overall vulnerability of the country and its economy to the sea level rise that has the potential to undermine the nation's efforts for sustainable development in a serious manner.

### 4.3.2 Impacts on fisheries sector

Closely associated are the impacts of climate change on the fisheries sector. In this connection, awfully little is known and scientific investigations are scarce. Table 4.6 presents some of the views expressed by various professionals on climate change impacts on the fisheries sector. Other than uncertain repercussions of rising oceanic temperature, overall impact of change in precipitation, sea level rise and extreme events seem to be all negative.

**Table 4.6**
**Climate Effects and their Impacts on Fisheries Sector**

| Climate Effect | Impacts | | Remarks |
|---|---|---|---|
| | Physical Impacts | Socio-economic Impacts | |
| Rise in oceanic temperature | • Changes in distribution growth and reproduction of fish stock<br>• Alteration of species composition of fisheries | Rise of uncertainty over all aspects of fish production and livelihood of fishermen | One of the least understood areas of climate change impacts. |
| Changes in precipitation patterns | • Disturbance to fishing due to heavy RF events | Reduction of number of fishing days and drop of income of fishers | Systematic studies or data are scarcely available. |
| Sea level rise | • Abandoning and relocation of fishing infrastructure facilities (e.g., harbours) | Loss of abandoned structures and cost of relocation | |
| Extreme events | • Disturbance to fishing due to cyclones, thunderstorms etc. | Reduction of number of fishing days and drop of income of fishers<br>Damage to life and productive assets of fishers | |

## 4.4 Impacts on Forests and Natural Eco-systems

Distribution of natural eco-systems such as forests as well as faunal and floral species housed in them is largely determined by temperature and precipitation. Therefore, changes in precipitation and temperature will have definite impact over the distribution of natural vegetation in the country. Among the major potential physical impacts are changes in the species composition and alteration of bio-diversity of which the real consequences are quite uncertain. However, given the relatively rapid rate of change in climatic parameters due to global warming compared with gradual evolutionary changes, negative impacts such as extinction of species, degradation of bio-diversity, species migration and outbreaks of pest/pathogens etc., cannot be ruled out. Fernando (2009) predicted that changes in precipitation and temperature would result in expansion of dry mixed evergreen forest and thorny scrub land while land area under wet lowland, evergreen forest and wet sub-montane forests will go down. Increased temperatures in combination with long dry spells/droughts can trigger in forest fires, which is a hazard presently non-existent in Sri Lanka. Like in the case of agricultural crops, forests and other natural vegetation will benefit from increased $CO_2$ in the atmosphere due to high bio-mass production. While there are numerous uncertainties associated with impact on forest and other natural eco-systems, it is not unreasonable to anticipate a number of adverse impacts also. These will create negative impacts on local communities while alteration of eco-system services can affect the society as a whole. Among others, loss of eco-system services they fulfill in upper watershed areas can create serious repercussions on sustainable development of the country over the long run.

**Table 4.7**
**Climate Effects and their Impacts on Forests and Natural Eco-systems**

| Climate Effect | Impacts | | Remarks |
|---|---|---|---|
| | Physical Impacts | Socio-economic Impacts | |
| Rise in atmospheric temperature<br><br>Changes in precipitation patterns | Changes could take place in distribution of eco-system types resulting in:<br>• Extinction of species (fauna & flora)<br>• Degradation of bio-diversity<br>• Migration of species<br>• Outbreak of pests and pathogens<br>• Spread of invasive species | After the dependent peripheral communities due to:<br>• Loss of income sources<br>• Loss of other livelihood supports<br>• Damages due to human-animal conflicts<br><br>Loss of eco-system services may affect the whole society | Strictly limited information available on impacts on eco-systems |
| Concentration of $CO_2$ | Increased wood/timber and NTFP output due to high bio-mass production | Increased income and other livelihood support for local communities | |
| Extreme events | Long dry spells & high air temperature could lead to forest fires | Damage to life and property of local communities<br><br>Loss of income and other livelihood support | |

## 4.5 Impacts on Human Settlements and Infrastructure

Climate is a major factor that determined decisions on human settlements from early days. Impacts of climate effects seem to constrain the choice available for human settlements and associated infrastructure significantly. Recent patterns of settlement in Sri Lanka have greatly favoured coastal plains for urban expansion and dry zone plains for agricultural colonization. Projected effects on climate are such that both these choices will be endangered due to reasons given in Table 4.8.

**Table 4.8**
**Climate Effects and their Impacts on Human Settlements and Infrastructure**

| Climate Effect | Impacts | | Remarks |
|---|---|---|---|
| | Physical Impacts | Socio-economic Impacts | |
| Rise in atmospheric temperature | • Increased incidence of heat stress | Negative impacts on life comfort and associated cost<br><br>Damage to infrastructure facilities | Very limited scientific assessments have been made. However, some attention has been given in preparation of physical/regional plans etc. |
| Changes in precipitation patterns | • Scarcity of water in RF deficit areas<br><br>• Floods, drainage problems and vulnerability to landslides in excess RF areas | Increased problems of water supply to settlement units<br><br>Land scarcity for human settlements due to high vulnerability to floods, landslides and water logging | |
| Sea level rise | • Loss of land due to inundation and coastal erosion | Scarcity of land for human settlement in coastal areas<br><br>Migration to inland areas<br><br>Damage to coastal infrastructure and other assets | |
| Extreme events | • Occurrence of disaster incidents | Damage to human life and infrastructure facilities | |

## 4.6 Impacts on Human Health

Climate change could have direct and indirect impacts on human health. Direct impacts include health conditions resulted by direct exposure to climate change effects. Examples are heat strokes due to rise in temperature, accidents/injuries due to hazards caused by extreme events etc. It seems, however, that indirect impacts could be far more harmful than direct impacts. Indirect impacts are caused by conditions created due to altered state of climate parameters. Examples are malnutrition due to food insecurity resulted by droughts, spread of vector borne diseases due to outbreak of vector population under altered temperature conditions and spread of water borne diseases due to scarcity of clean

water. Awareness and attention on health impacts due to climate change seem to be very low, even among medical professionals. As a result, even though Sri Lanka has been experiencing conditions akin to impacts described in the Table 4.9 during the last few decades such as outbreak of vector borne diseases, attention has rarely been directed to investigate impact of climate effects on them.

**Table 4.9**
**Climate Effects and their Impacts on Human Health**

| Climate Effect | Impacts | | Remarks |
|---|---|---|---|
| | Physical Impacts | Socio-economic Impacts | |
| Rise in atmospheric temperature | • Increased heat stress and High rate of evapo-transpiration | Increased morbidity and mortality due to heat shocks/strokes | Health impacts of climate change is a least understood area in Sri Lanka despite numerous international studies. Many impacts mentioned are currently being experienced but little attention to climate change aspects. |
| | • Spread of vectors into new areas | High incidence of vector borne diseases | |
| Changes in precipitation patterns | • Threat of food insecurity due to scarcity of water of agriculture | Increased incidence of malnutrition and associated health problems | |
| | • Scarcity of clean water for human consumption | Increased vulnerability to water borne diseases and skin diseases | |
| Extreme events | • Disaster conditions due to floods, droughts etc. | Rapid outbreak of diseases among the vulnerable | |
| | • Accidents & injuries due to extreme events | Increased morbidity and mortality due to accidents and injuries | |

## 4.7 Impacts on Energy and Industry

Even though energy and industry are two widely discussed topics in climate change discussions, quite often focus is on reduction of emissions and mitigation measures rather than understanding potential impacts due to climate change effects on them. Therefore, limited information is available on the impacts of climate change on energy and industry. However, close attention on the issue highlights that climate effects could have significant impacts on the energy and industry sectors in Sri Lanka as they stand vulnerable to many effects discussed above.

### 4.7.1 Impacts on energy

Significant impacts are indicated for hydropower generation in Sri Lanka. While the rising temperature can create negative impacts on increased evaporation and reduced stream flow, many hydro power generation facilities are located in upper watershed areas where substantial increases in RF are projected. As a result, many hydro power generation facilities will have an overall gain from the effects indicated

for RF. Similarly, rising $CO_2$ level in the atmosphere could create a positive impact on bio-mass energy component through increased bio-mass production. However, negative impacts are indicated due to sea level rise and extreme events, both of which would have adverse impacts over facilities of energy generation and distribution. Of them, impacts of sea level rise are particularly important as many thermal and coal power generation facilities are currently being constructed along the coastal belt. Some experts have predicted negative implications over wind and solar power development prospects of the country due to climate effects such as increased cloud cover and alteration of wind patterns (Joseph, 2009). However, given the limited knowledge on those climate effects as well as limited experience on wind and solar prospects in Sri Lanka, the outcome seems quite uncertain.

**Table 4.10**
**Climate Effects and their Impacts on Energy Sector**

| Climate Effect | Impacts | | Remarks |
|---|---|---|---|
| | Physical Impacts | Socio-economic Impacts | |
| Rise in atmospheric temperature | • Reduced inflow into reservoirs<br>• High rate of evaporation | Reduction of hydro power generation potential | Issues of energy and climate change have mainly been discussed in the context of emission reduction and mitigation measures. Little understanding exist on potential impacts on energy sector due to main climate effects. |
| Changes in precipitation patterns | • Increased precipitation in upper watershed areas | Increase in hydro power generation potential | |
| Sea level rise | • Inundation of coastal areas and increased coastal erosion | Damage to coastal energy infrastructure<br>Relocation of generation facilities (esp. coal and thermal) in coastal zone | |
| Concentration of $CO_2$ | • Increased bio-mass production due to enhanced photosynthesis | Increased potential for production of bio-mass energy | |
| Extreme events | • Droughts | Reduction of hydro power generation potential | |
| | • Floods, cyclones and other disaster incidents | Damage to energy infrastructure | |

### 4.7.2 Impacts on industry

It is difficult to make an assessment on potential impacts of climate change over the industry sector in Sri Lanka, as almost all accounts on industry are focused on emissions and energy issues. However, logical organization of facts would help to identify at least a few potential impacts. Accordingly, a reasonable guess can be made on possible supply constraints on agro-based raw materials in future. As discussed under impacts on agriculture, rising temperature and reduced precipitation could have negative impacts on agricultural production in certain areas of the country. Similarly, as significant

number of industrial facilities and rural industries are presently located in the coastal belt of the country, it is logical to assume they will be affected adversely due to sea level rise in the future. Moreover, extreme events could be expected to create problems through direct damages to industrial facilities and through resulting in supply constraints of inputs.

**Table 4.11**
**Climate Effects and their Impacts on Industry**

| Climate Effect | Impacts | | Remarks |
|---|---|---|---|
| | Physical Impacts | Socio-economic Impacts | |
| Rise in atmospheric temperature | • Reduction of agricultural production | Supply constraints on agro-based raw materials | As in the case of energy, industry also is mainly discussed in the context of emission reduction and mitigation measures. Little understanding exists on potential impacts on industry due to main climate effects. |
| Changes in precipitation patterns | • Water scarcity in deficit RF areas | High overhead and maintenance cost for industrial water supply | |
| Sea level rise | • Loss of land due to inundation and coastal erosion | Reduction of potential for exploiting industrial opportunities in coastal zone<br><br>Damage to existing industrial facilities in coastal zone and cost of relocation | |
| Extreme events | • Droughts<br>• Floods and other disaster incidents | Supply constraints on agro-based raw materials<br>Damage to industrial facilities and high cost of rehabilitaiton | |

## 5. Analysis of Major Gaps

Information gathered from different sources helped to recognize that action against climate change is constrained by a number of factors. In the national workshop, a consensus was reached that the following gaps act as major barriers against formulating and implementation of effective actions against climate change at the national and other levels of activity. They are, namely:

- Lack of agenda and priorities
- Information gap
- Coordination gap
- Resource mobilization gap

### 5.1 Lack of Agenda and Priorities

Despite certain activities initiated by the Ministry of Environment and Natural Resources (MENR), the issue of climate change has failed to attract adequate attention of policy makers of the country so far.

As a result, no priority or strategic importance has been assigned for this important global issue and there is no consensus over major impacts/problems/issues to be addressed though policies, plans, programs and projects. This cannot be considered as a favourable situation for a vulnerable country like Sri Lanka. While lack of information, facilities and resources could be partially responsible for this situation, lack of agenda overrides them all. If sensible agenda is available, even the limited information, facilities and resources could have been put into more efficient use than at present.

Climate change is a complex cross cutting issue that can generate different impacts over several sectors. There are common issues as well as sector specific issues. Common issues should be handled by a broad national agenda while sector specific issues need to be addressed by sectoral agendas. All sub-national agendas (i.e., sectoral, provincial) should be integrated into a broad national agenda in meaningful manner so that necessary linkages will be made in an effective manner. Therefore, an integrated national agenda on climate change is an essential first step for moving forward.

Participants in the national workshop put forward the following suggestions to overcome the gap created by lack of agenda.

- Preparation of a unified agenda that can simultaneously address common national issues and interests of different sectors, regions etc.
- Policy guidance for formulating plans/programs/projects according to the unified agenda
- Prioritization of resource allocation for different sectors according to the strategic importance and urgency of action
- Revision of existing polices, plans, strategies and updating them to address climate change issues (e.g., Forestry Sector Master Plan, Fisheries Development Plan, National Environment Act, Renewable Energy Policy)
- Assessment of planned activities to avoid duplication and increase the efficiency of management
- Establishment of a strong mechanism for coordination of activities of the different stakeholders according to a unified national agenda

## 5.2 Information Gap

Initiating effective action against climate change is necessarily a process driven by information. In this connection, information collected at national and local levels are quite important. Current availability of information is not adequate for launching effective programs against threats posed by climate change. There have been few initial attempts to generate information on local effects of climate change through downscaling global models. In addition, past meteorological data has been analyzed to a certain degree to identify the nature of changes taking place in local climate. However, Information on impacts of climate change on various sectors/communities is largely based on intellectual speculation rather than any scientific studies. This situation warrants little room for designing meaningful actions against impacts of climate change in the country.

Formulating effective actions against climate change requires information on various aspects such as: future variation of climate parameters and patterns of their change; sensitivity of various eco-systems/ species to changing climate patterns; scale and time horizons of physical and socio-economic impacts over vulnerable resources, livelihoods and local areas; degree of vulnerability of local communities and adaptive capacity of communities.

Despite the scarcity of information, there are a few positive features also regarding the situation of information availability. Firstly, the country is covered by a fairly extensive network of meteorological data collection stations maintained by the Department of Meteorology with the assistance of other agencies also. Secondly, Sri Lanka possesses a well established network of scientific research organizations dealing with a number of essential fields of scientific enquiry relating to climate change. These organizations possess significant profile of expertise and facilities necessary to undertake studies on different aspects of climate change. Despite such strengths, however, a well coordinated research program that can inform policy makers on appropriate actions is yet to emerge.

Table 5.1 provides certain details about specific information needs of different sectors identified by expert groups in the national workshop. Whereas this cannot be considered as a complete list, it provides some idea about information requirements of different sectors.

Following recommendations were made by expert groups to overcome the information gap on climate change.

- Facilitation of research and development by allocation of more government funds
- Conducting more research on impacts of climate change on vulnerable sectors
- Empowerment of relevant organizations to collect data on climate change
- Setting up of a data gathering and sharing mechanism on different resource systems
- Establishment of monitoring systems to identify, quantify and assess the impacts of climate change on different eco-systems and species
- Collection of baseline data for disaster risk assessment
- Creation of awareness on essential aspects of climate change

## 5.3 Coordination Gap

The impacts of climate change are spread over multiple sectors as well as different geographical areas of the country. These multi-sector, multi-regional nature of impacts imply that no single ministry, department, authority or provincial/local government body can take the sole responsibility of national agenda for climate change in Sri Lanka. Further, responsibility cannot be confined to government organizations alone. Private sector, community organizations, non-governmental organizations as well as the donor community also has a major role to play here. Essentially, it should be a coordinated effort by all relevant stakeholders who would cooperate to form a broad strategic alliance against the threat of climate change. Therefore, national agenda climate change needs a strong mechanism for coordination of activities by stakeholders involved.

**Table 5.1**
**Information Needs of Key Sectors**

| Sector | Major Information Needs/Gaps |
|---|---|
| Agriculture, Irrigation & Plantation | • Information on availability and accessibility of water in different agro-ecological zones<br>• Information on vulnerability of different crops and livestock varieties<br>• Information on appropriate agro-technology appropriate management techniques for adaptation<br>• Detailed analysis of available hydro-meteorological data<br>• Land resource availability for agriculture and other allied activities<br>• Information on vulnerability of agricultural communities |
| Forestry & Wildlife | • Data on forest health and vitality<br>• Data on carbon stocks of different species<br>• Information on impacts on food and water availability for wildlife<br>• Impacts on aquatic and terrestrial biodiversity |
| Coastal, Fisheries & Aquatic Resources | • Quantitative information on sea level rise and its impacts on coastal zone<br>• Data on stocks of fish and sustainable yield<br>• Information on impacts on fish stocks due to changes in relevant climate parameters |
| Human Settlements, Infrastructure & Disaster Management | • Quantitative estimates on climate change impacts on human settlements<br>• Baseline data to make damage and risk assessments |
| Health | • Assessments on impacts of climate shocks on human health issues<br>• Information on non-communicable diseases |
| Energy & Industry | • Better awareness on Clean Development Mechanism<br>• Scope and potential for development of local renewable energy<br>• Information on the cost and benefits of the application of renewable energy in the industrial sector<br>• Better awareness on demand side management of energy in households and commercial establishments |
| Water Supply & Drainage | • Information on impacts of climate change on availability and accessibility of clean water for human consumption |

While the policy decisions are the responsibility of government agencies, implementation of these decisions needs close coordination with the private sector, community, NGOs and donors. In addition to central government, provincial agencies also bear decision making powers over certain issues and they have to interact with central government agencies for implementation of them. This involves a cumbersome process of coordination among numerous agencies for formulation, implementation and

monitoring of a national agenda. In reality, this is a task that should be achieved through significant expense of time and resources.

There were a few recommendations made by expert working groups to improve the coordination of activities by different stakeholders.

- Establishment of a coordination mechanism and body for inter-agency coordination i.e., public, corporate, community and NGOs
- Create an inter-agency platform for discussion and allocation of responsibilities and handling issues
- Improvement of vertical coordination between national and provincial agencies
- Enhance the efficiency of coordination by identification of 'who is doing what' responsibility
- Improve coordination with international agencies to share the knowledge base and good practices, leading to enhance the national capability

## 5.4 Resource Mobilization Gap

A major constraint faced by developing countries such as Sri Lanka for overcoming the challenges of climate change is scarcity of necessary resources. The government, the main stakeholder at the final count, is burdened with numerous fiscal and monetary difficulties to find extra resources for facing climate change issues. At present, the government faces daunting challenges of the post-conflict era that include safeguarding the interests of national security, resettlement and rehabilitation of internally displaced persons (IDPs), rehabilitation of conflict affected areas and integration of backward areas to the national economic development. In the face of politically more urgent priorities, conventional channels of public finance alone cannot be relied upon to meet the resource needs of national agenda on climate change. Therefore, major stakeholders have to identify innovative methods of resource mobilization to face the challenge of climate change.

Relevant agencies should identify feasible avenues of resource mobilization available from various sources while key fiscal and monetary agencies are also playing a facilitative role. In this connection, professionals attached to various stakeholder agencies have to play a leading role by formulating plans, programs and projects to mobilize necessary resources. Particular attention should be given to utilize opportunities available in international cooperative mechanisms such as Clean Development Mechanism (CDM), innovative arrangements of public-private partnerships, innovative market based instruments against climate change impacts.

Following are a few suggestions to enhance resource mobilization capacity of stakeholders involved.

- Allocation of public funds with a long-term vision of sustainable development to match the true priority of the problem that deserves
- Rationalization of distribution of funds available from existing channels ensuring that funds are directed to right areas and priorities

- Establishment of a mechanism for proper distribution of resources among and within public organizations
- Allocation of resources more on preventive actions than curative actions
- Making investments geared towards long-term benefits through resource enhancement and capacity building
- Taking necessary steps to function the carbon fund to full potential

# 6. Mainstreaming Climate Change for Sustainable Development: Towards a National Agenda

The discussion in previous chapters has two main messages.

- Climate change poses a serious threat in Sri Lanka that can undermine all national efforts for sustainable development
- Sufficient measures of national action that can match the level of threat are yet to emerge

Given the complexity and scale of the problem, climate change needs to be mainstreamed in all efforts of national development. In this final chapter we propose a framework for a National Agenda on Climate Change that aims at mainstreaming the climate change for sustainable development of the country.

Success of mainstreaming climate change in national development would largely be determined by the effectiveness of measures taken to overcome the gaps discussed in the previous chapter. Therefore, the main role of the national agenda is to create conditions necessary to overcome these gaps. This is an essential prerequisite to proceed from the backward position where we now stand as far as climate change is concerned. Overcoming these gaps in successful manner would enhance the prospects for achieving the long-term goals of sustainable development of the country too.

## 6.1 National Agenda for Mainstreaming the Climate Change

The term 'mainstreaming' implies achievement of certain status in the policy making process by fulfilling a few essential conditions. The expected conditions could briefly be described as follows.

**Comprehensive:** National agenda should be comprehensive enough to address all necessary aspects of the complex issues of climate change

**Prioritized:** Action against climate change should be given a priority status among other issues that compete for policy makers' attention

**Routinely Attended:** Issues pertaining to climate change should be addressed on a regular basis taking required decisions/actions at the right time

**Informed:** Decisions should be taken after consultation of the best available information at the time of decision

**Well Coordinated:** All actions should be taken with appropriate level of coordination among relevant stakeholders

**Provided with Sufficient Resources:** Necessary resources for the agenda should be ensured in adequate amounts in timely manner

It is the role of national agenda to ensure that these conditions will be fulfilled so that climate change issues will be integrated into the national development effort successfully.

## 6.2 The Framework: Outline and the Approach

In this section a broad conceptual framework that could help to achieve the goal of national agenda is proposed. The framework proposed here covers the following aspects.

- National vision on climate change
- National policy on climate change
- Strategic action plan (national strategy)
- Coordinating mechanism
- Climate change information system
- Mechanism for resource mobilizations

National agenda for climate change is the combination of these components.

### 6.2.1 The approach of the national agenda

The agenda on climate change should adopt an adaptive, anticipatory and integrated approach to face the impacts of climate change.

**Adaptive**: Uncertainty is a key challenge that has to be faced in making any policy decision relating to climate change. A policy dilemma is involved here as no one can accurately predict the future due to lack of information and uncertainty whereas decisions also cannot be delayed awaiting more information before it is too late. Therefore, an adaptive policy making process should be involved here. This implies that: (a) policies should be robust enough to be effective under a wide range of future scenarios, and (b) decision making and implementation should be flexible enough to allow for adjustment according to emerging conditions.

**Anticipatory:** Climate change is an ongoing process. Policy makers can either take decisions in advance anticipating future impacts (anticipatory approach) or they can wait till impacts appear (reactive approach). Given the uncertainty involved in the whole issue of climate change, a reactive approach carries an immense risk. Therefore national policy on climate change, to the extent possible, should take an anticipatory approach.

**Integrated:** Climate change is a complex phenomenon and likely to create cross cutting impacts over different sectors and geographical areas. Therefore, policies should be integrated so that they can handle a broad range of interrelated impacts that spread over a number of sectors/geographical areas.

## 6.3 National Vision on Climate Change

National vision should express the aspirations of citizens and the government in facing the threat of climate change impacts. A tentative statement to express the national vision is given below.

**Vision (A Tentative Statement)**

Safeguard the national interests and achieve the objectives of sustainable development through appropriate, timely measures of adaptation and mitigation against the threat of climate change thereby minimizing the damage to human life and national assets
while,
fulfilling Sri Lanka's role as a member of global community to attain the common goal of low carbon intensive path to economic development.

National policy taken together with a strategic action plan is the guiding light that shows the path to achieve the long-term aspirations envisaged by the national vision. The point of departure for this goal-oriented journey is current conditions of vulnerability. Figure 6.1 illustrates this point.

**Figure 6.1**
**Relationship of the National Policy and National Vision**


## 6.4 National Climate Change Policy (NCCP)

NCCP articulates the broad principles which will guide all actions at national, sectoral and local levels as well as Sri Lanka's involvement in regional and global efforts against the threat of global climate change. It will include guiding policies covering a number of key interest areas relevant to climate change.

### 6.4.1 Scope of the policy

Climate change is a complex issue with cross cutting impacts over the whole society. The NCCP should be able to address complex aspects of climate change from an overall perspective (covering both micro and macro perspectives). In this connection, some direction is necessary to organize national action. Therefore, the following scope is proposed for NCCP.

- **Major policy components:** Accordingly, NCCP will have two major components, namely; (i) Adaptation Policy, and (ii) Mitigation Policy.
- **Thrust areas:** Within the two major policy components several thrust areas will be identified for formulation of policies, strategies and implementation of them. Thrust areas should be defined with an understanding of technical aspects pertaining to anticipated impacts of climate change. Many impacts of climate change are related to each other in one way or other. Criteria for defining a thrust area should be 'comprehensive enough to cover all major issues involved and convenient enough to organize necessary actions on a practical basis'. Tentatively, the following thrust areas can be identified under each policy component.

  **Mitigation Policy: Thrust Areas**

  - Energy
  - Transport
  - Industry
  - Forestry

  } Adaptation requirements of these sectors should also be taken into consideration

  **Adaptation Policy: Thrust Areas**

  - Agriculture and Food Security
  - Health and diseases
  - Water resources
  - Coastal and marine resources
  - Terrestrial eco-systems and bio-diversity
  - Human settlement and infrastructure
  - Extreme events and disasters
  - Export crops and plantations
  - Tourism and recreation

- **Key Areas of Interest (KAI)** – In each thrust area, there are a number of interest areas on which policy guidance is necessary. They can be identified as 'key areas of interest (KAI)'. NCCP should provide a statement of general guidelines and principles to be adhered under each KAI when actions are contemplated on a given thrust area. Tentatively the following key areas of interest (KAI) are identified for drafting necessary guiding policies.
  - Stakeholders, roles and responsibilities
  - Institutional development and coordination
  - Resource mobilization
  - Information generation and dissemination
  - Research and development
  - Education and awareness
  - Environment and natural resources management: implications on current policies
  - Risk and disaster management
  - Technology transfer and standards
  - International cooperation and negotiations
  - Indigenous knowledge and local resource management
  - Cultural and lifestyle adjustments

## 6.5 The Strategic Action Plan (National Climate Strategy; NCS)

National Climate Strategy (NCS) is a rolling plan. It is not a statement of principles but a selection of practical interventions identified by relevant stakeholders to overcome threats anticipated in a given thrust area. The interventions should be designed in an integrated manner covering a selected thrust area overall with the consultation and participation of all stakeholders concerned. Selection and implementation of activities in the strategy should be guided by broad principles laid down by the NCCP.

Unit of planning involved here should be the thrust area. Accordingly, a broad selection of interventions that are logically designed to overcome impacts anticipated in a given thrust area will be identified by relevant stakeholders with time targets and budgetary needs. NCS is the compilation of strategies (action plans) developed for all thrust areas. While being adhered to the broad principles laid down by the NCCP, strategies under each thrust area should be decided by relevant stakeholders independently, on the basis of technical merit of interventions. Suitability of any intervention should be assessed on a criteria based on effectiveness, efficiency, equity and environmental sustainability.

## 6.6 Coordinating Mechanism

Given the comprehensive nature of national agenda, it should be coordinated properly at all stages of formulation and implementation. To achieve this, a 'coordinating mechanism (CM)' should be established as an essential component of the national agenda. Based on the structure proposed for the national agenda, CM should include following major bodies of coordination.

- **National Focal Point (NFP):** NFP has to coordinate activities taking place in all thrust areas. In addition, it has to implement interventions that deal with common interests shared by many thrust areas. Examples are implementation of national policy, management of common funds and organization of information systems. According to the current institutional set-up, Climate Change Secretariat of The Ministry of Environment and Natural Resources is the agency that best suits for the task concerned. It is necessary to strengthen the capacity and position of this agency through providing necessary resources and enhancing its recognition through legal and policy measures.
- **Climate Cells for Thrust Areas:** A climate cell should be established for each thrust area to coordinate activities within the thrust area. It should be represented by members of state agencies, private sector, community organizations and NGOs who are key stakeholders of a given thrust area. For instance, the climate cell of the coastal sector should be represented by state agencies such as Coastal Conservation Department, Fisheries Department, NARA and private, community and non-government organizations involved in the coastal sector. The climate cell of a given thrust area should coordinate all activities pertaining to formulation, implementation and monitoring of activities of that thrust area.

NFP should establish a system of standing committees which include representatives from climate cells of different thrust areas. These committees should take decisions relating to subjects of common interest such as allocation of common funds, sharing of information that would be implemented by the staff of the NFP.

## 6.7 Climate Change Information System (CCIS)

As already discussed, initiating effective action against climate change is essentially an information driven process. Experts from all disciplinary backgrounds recognized that there is a major gap in information on climate change and filling this gap is an essential prerequisite. This implies that success of mainstreaming climate change through the national agenda will largely be dependent on availability of information. Therefore, it is necessary to establish a Climate Change Information System (CCIS) to fill the existing information gap. This should be established in the NFP with the collaboration of other major information and research agencies. The following tasks have to be fulfilled by the CCIS.

- Collection and compilation of data on climate change and associated impacts from various sources
- Analysis of data from various sources to generate necessary technical and policy information
- Establishment of a network of information providers and users
- Development of a cost effective mechanism for sharing and exchange of information using modern IT facilities
- Dissemination of information through appropriate media including public information channels

CCIS should essentially be a cooperative effort of professionals from various relevant disciplines. Its activities should be coordinated by the NFP with the participation of representatives form climate cells of different thrust areas.

## 6.8 Mechanism for Resource Mobilization

Resource mobilization is a major gap faced by climate change programs in Sri Lanka. Therefore success of the national agenda depends heavily on devising an effective mechanism for resource mobilization. In the first place, lack of agenda itself is a major problem faced in mobilizing resources for climate change action. Hence, initiating the proposed national agenda itself, therefore, would partly fulfill an essential condition for attracting resources for climate change activities. However, it is not a sufficient condition to acquire necessary resources. Therefore, a proactive mechanism should be set up in the agenda to attract more resources.

A resource mobilization mechanism that can fulfill the following functions should be established within the organizational structure of national agenda.

- Attracting resources already available from scattered sources (e.g., facilities made available by various donors) by designing strategic action plans in a creative manner to tap them
- Organizing existing facilities (e.g., facilities in research institutes, government agencies) into more effective use by identifying, cataloguing, pooling and properly channelling them to purposes of the agenda
- Establishment of a system of common funds dedicated for specific purposes (e.g., adaptation, mitigation) that can be used to accumulate, allocate and distribute resources in an efficient manner

- Organizing resource sharing arrangements among different stakeholders so that more effective use of resources, especially under-utilized resources (e.g., scientific instruments, expert knowledge and technical skills, information resources) can be achieved
- Devising innovative mechanisms for raising funds through climate change interventions themselves by applying market-based instruments

Above are only a few strategies for mobilizing resources and more innovative ways of fund raising that may be developed through enhanced coordination among stakeholders. NFP should take the leadership of devising the resource mobilization strategy of the national agenda with the cooperation of climate cells of respective thrust areas also.

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# Appendices

## National Workshop on Mainstreaming Climate Change for Sustainable Development 19 - 21 August 2009, Dambulla

### List of Technical Topics and Presenters

**Session I: Science & Economics of Climate Change Adaptation**

| | | |
|---|---|---|
| 01 | Science of Climate Change Adaptation | Dr. W.L. Sumathipala |
| 02 | Economics of Climate Change Adaptation | Dr. L.H.P. Gunaratne |
| 03 | Long Ranged Forecast of Climate Change for Sri Lanka | Mr. G.B. Samarasinghe |

**Session II: Climate Change Adaptation: Irrigation & Water Supply**

| | | |
|---|---|---|
| 04 | Adaptation to the Threats of Climate Change: Irrigation Sector of Sri Lanka | Mr. H.M. Jayatillake |
| 05 | Adaptation to the Threats of Climate Change: Water Supply & Drainage | Mr. Sumitha Sumanaweera |

**Session III: Climate Change Adaptation: Agriculture & Forestry**
**Climate Change Adaptation: Health Sector**

| | | |
|---|---|---|
| 06 | Adaptation to the Threats of Climate Change: Agriculture | Dr. B.V.R. Punyawardena |
| 07 | Adaptation to the Threats of Climate Change: Plantation Sector with Special Reference to Tea | Dr. M.A. Wijeratne |
| 08 | Adaptation to the Threats of Climate Change: Forestry & Wildlife | Mr. Sarath Fernando |
| 09 | Adaptation to the Threats of Climate Change: Healthcare & Diseases | Dr. Ranjan Wijesinghe |

**Session IV: Climate Change Adaptation: Urban Development and Infrastructure & Disaster Management**

| | | |
|---|---|---|
| 10 | Exploring the 'Knowns' and 'Unknowns' of Climate Change Effects & Adaptation in Urban Development and Infrastructure | Dr. Jagath Munasinghe |
| 11 | Adaptation to the Threats of Climate Change: Disaster Management | Ms. Anoja Seneviratne |

**Session V: Climate Change Adaptation: Fisheries and Aquatic & Coastal Sectors**

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| 12 | Adaptation to the Threats of Climate Change: Fisheries & Aquatic Resources | Mr. S.A.M. Azmy |
| 13 | Adaptation to the Threats of Climate Change: | |
| | Presentation 1- A Strategic Approach towards Planning and Management of Impacts of Sea Level Rise in Sri Lanka | Prof. S.S.L. Hettiarachchi & Prof. S.P. Samarawickrema |
| | Presentation 2 – Role of Coast Conservation Department in Climate Change Adaptation | Mr. Anil Premaratna |

**Session VI: Climate Change Adaptation: Energy & Industry**

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|---|---|---|
| 14 | Adaptation to the Threats of Climate Change: Energy | Mr. P.G. Joseph |
| 15 | Adaptation to the Threats of Climate Change: Industry | Mr. Asitha Seneviratne |
| 16 | Presentation & Discussion on Virtual Network | Mr. Haren Kodagoda |

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ISBN 978-955-8708-60-6