

Climate Change due to Global Warming: A Global Challenge in Sri Lanka Perspective

1. What is Climate Change?

Climate Change, according to the Intergovernmental Panel on Climate Change (IPCC)¹, refers to "a statistically significant variation in either the mean state of the *climate* or its variability, persisting for an extended period -typically decades or longer. Climate change may be due to natural internal processes or external forcing or to persistent *anthropogenic* changes in the composition of the *atmosphere* or in *land use*".

The *United Nations Framework Convention on Climate Change* (UNFCCC)² defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is, in addition to natural climate variability, observed over a comparable time period" (Article 1, UNFCCC).

The Earth is getting warmer and over the past 100 years; the average temperature on the Earth has increased by more than half a degree Celsius. According to the IPCC, average global temperatures are expected to rise by 1.4 to 5.8 Celsius over the next century. Global mean sea levels are set to rise by 9 - 88 cm by 2100, flooding many low-lying coastal areas. Changes in rainfall patterns are also predicted, increasing the threat of drought or floods in many regions. The fourth assessment report of the IPCC released in March 2007, confirms that while the world's climate has always varied naturally, the vast majority of scientists now believe that rising concentrations of "greenhouse gases (GHGs)"³ in the Earth's atmosphere, resulting from economic and demographic growth over the last two centuries since the industrial revolution, are overriding this natural variability and leading to irreversible climate change.

1.1 Greenhouse gases (GHGs)

Water vapor is the most common greenhouse gas. Carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) are the greenhouse

gases which are closely associated with human activities, and particularly important to climate change. Carbon dioxide is currently responsible for over 60% of the "enhanced" greenhouse effect (i.e., rise in temperature on the earth by retaining energy by certain atmospheric gases. see Section 1.3 for details), which is responsible for climate change. Carbon dioxide is released to the atmosphere through natural processes of plant and animal life. Burning coal, oil, and natural gas is releasing the carbon stored in these "fossil fuels" at an unprecedented rate. Deforestation releases carbon stored in trees. Methane (CH₄) is not as abundant as carbon dioxide, but is a powerful greenhouse gas and more effective in trapping heat. It is generated when vegetation is burnt or digested under anaerobic conditions. Wetlands, rice fields, animal digestive processes, and decaying garbage are the main sources of methane in our atmosphere. Nitrous oxide (N₂O) is produced naturally in the environment, but human activities increase the quantities. Nitrous oxide is released when chemical fertilisers and manure are used in agriculture.

1.2 Greenhouse effect

Gases in our atmosphere, including water vapor, carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydro fluorocarbons (HFCs) and per fluorocarbons act like the glass panels of a greenhouse to keep the sun's heat in and help make our planet livable. Greenhouse gases (GHGs) control energy flows in the atmosphere by absorbing infra-red radiation. These trace gases comprise less than 1% of the atmosphere. Their levels are determined by a balance between "sources" and "sinks". Sources are processes that generate greenhouse gases; sinks are processes that destroy or remove them. Human activities affect greenhouse gas levels by introducing new sources or by interfering with natural sinks. Had there not been this natural insulation, the Earth's surface would have been much colder than it is now. In fact, the average temperature on the Earth would have been -18° Celsius, too cold to support the diversity of life we have today.

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1.3 Global warming

Global warming could be defined as increase of the mean global temperature due to anthropogenic activities that release greenhouse gasses to the atmosphere. Observed changes in the earth's surface temperature indicate that, during the 20th century, the global mean temperature had increased by 0.60C +/- 0.2 °C. According to the IPCC, it is 'likely'⁴ that the 1990's was the warmest decade and that it is 'likely', that 1998 was the warmest year since 1861. The diurnal surface temperature range had decreased, but the nighttime daily minimum temperatures had increased, at twice the rate of daytime maximum temperature, i.e. at the rate of about 0.2°C per decade.

2.0 Climatic Changes during the 20th Century due to Global Warming and their Impacts

The following are some of the climatic changes observed due to global warming during the 20th century:

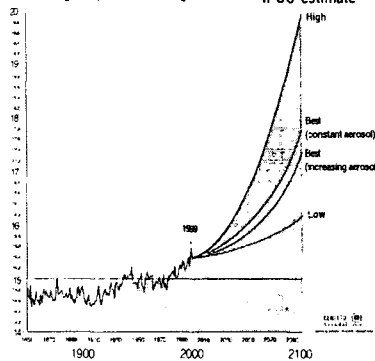
- Intensification of the hydrological cycle and the increase of precipitation by 0.5 - 1.0 % per decade over most mid and high latitudes in the Northern Hemisphere.
- Decrease of rainfall by 0.3 % per decade on the average, over much of the subtropical land areas. Over tropical lands, rainfall is likely to increase by 0.3% per decade.
- Increase in the frequency and severity of drought in recent decades in some parts of Asia and Africa.
- Increase in the frequency and intensity of El Nino events during the last 2-3 decades (e.g., the 1997-1998 El Nino event had caused considerable damage to human and physical systems).

It has been projected that that the global average temperature will increase by 1.4°C - 5.8°C between 1990 and 2100. The projected increases from 1990 to 2025 and from 1990 to 2050 are 0.4-1.1°C and 0.8°C -2.6°C respectively (Figure 1).

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Presently, he functions as the Director of the Climate Change and Global Affairs Division, and heads the Climate Change Secretariat of the Ministry of Environment and Natural Resources. He acts as the operational focal point for the UNFCCC and Kyoto Protocol and also the Designated National Authority for the Implementation of the Clean Development Mechanism. He is also the Director of the Air Resources Management Centre (AIRMac) and instrumental in the implementation of the Vehicle Emission Testing Program for Motor Vehicles.

Projected changes in global temperature :
global average 1856-1999 and projection estimates to 2100
Global average temperature in centigrade IPCC estimate



Source: Temperatures 1856-1999, climatic Research Unit, University of East Angles, Norwich, UK, Projections: IPCC report 1995

Figure 1: Projected Changes in Temperature in the 21st century

Source: Temperatures 1856-1999, climatic Research Unit, University of East Angles, Norwich, UK, Projections: IPCC report 1995

During the 20th century, the following changes have been observed due to climate changes:

- i. Rise of global sea level by an average annual rate of 1-2 mm
- ii. Decrease of snow cover by 10%.
- iii. Lengthening of the growing season by about 1-4 days per decade, during the last 4 decades in the Northern Hemisphere.
- iv. Early flowering of plants, arrival of birds and emergence of insects and advance of breeding season.
- v. Increased frequency of coral reef bleaching, especially during El Nino events.

3.0 Potential Impacts of Climate Change on Developing Countries

Though developed countries are primarily responsible for increasing levels of greenhouse gasses, it is the developing countries that are most susceptible to the adverse impacts of climate change due to their high population densities and low economic status. If no climate policy interventions are implemented, future climate changes would have highly disastrous impacts on developing countries such as Sri Lanka. Both natural and human systems are sensitive to, and sometimes highly vulnerable to climate change. Some of the adverse consequences of climate change in developing countries by 2025, if climate policy interventions are not adopted, are summarised in the Table 1.

Table 1
Adverse consequences of climate change, specially in developing countries, by 2025 – if no action is taken

Sector/Area	Potential Impacts
Physical and Human Systems	<p>Since there is a close interrelationship between climate change and hydrological cycle, warmer temperatures could lead to intensification of the hydrological cycle. These changes in turn would:</p> <ul style="list-style-type: none"> ◆ affect water supply, river runoff, and ground water recharge and storage; ◆ degrade water quality; ◆ lead to increases in extreme hydrological events such as floods and droughts; ◆ increase the demand for water for agriculture, power generation, domestic and industrial uses; ◆ cause sea level rise leading to salination of coastal aquifers.
Biological Systems	<ul style="list-style-type: none"> ◆ Changes in species distributions, population sizes, timing of reproduction or migration. ◆ Risks to unique and threatened systems. e.g., loss of biodiversity; coastal wetlands and unique habitats, increased frequency of coral bleaching and death, and changes in terrestrial ecosystems. ◆ Changes in diversity of plant and animal species. ◆ Increased frequency of ecosystem disturbance by fire and insect pests.
Agriculture and food security	<ul style="list-style-type: none"> ◆ Adverse impacts of increased temperature on annual and perennial crops and livestock. e.g., x Increase in temperature (greater than 35°C for more than 1 hour) could cause sterility in rice and reduced formation of tubers and tuber bulking in potatoes. ◆ Increased demand for irrigation systems in areas where rainfall is expected to be reduced. ◆ Increased CO₂ concentrations can stimulate crop growth and yield but will not be able to compensate for adverse effects of heat and drought. ◆ Destruction of crops by extreme events, declining incomes of farmers and increasing food prices. ◆ Declines in agricultural exports, fishing and agro-based industries.
Energy	<ul style="list-style-type: none"> ◆ Increased demand for energy for space cooling. ◆ Reduced reliability of energy supply in countries which are dependent on hydro-electricity and biomass.
Human settlements	<ul style="list-style-type: none"> ◆ Direct impacts on health, buildings and infrastructure. ◆ Indirect impacts on productive capacity. The most vulnerable settlements would be where people are heavily dependent on natural resources or those located along the coast or in areas subject to landslides, droughts and floods.
Health	<ul style="list-style-type: none"> ◆ Increased deaths and illnesses due to exposure to urban heat island effect. ◆ Loss of life, injuries and psychological trauma in cyclone, landslide and flood-affected areas. ◆ Expansion of areas of potential transmission of malaria, dengue and other vector-borne diseases. ◆ Increased incidences of water-borne and water-washed and respiratory diseases. ◆ Increased malnutrition
Industry	<ul style="list-style-type: none"> ◆ Agro-based industries and the tourist industry would be affected by electricity fluctuations and water shortages. ◆ Natural hazards would lead to loss of infrastructure and access to shipments.

Source:

Inter-governmental Panel on Climate Change (2001).

4.0 Global Initiatives to Counter Climate Change Issues

Scientists during the 1970s have warned governments about the increased concentration of greenhouse gases in the atmosphere, its effects on the earth and eco-systems, if current emission patterns continue. Fortunately, the world community took these warnings seriously and decided to investigate the problem and appointed IPCC - an intergovernmental negotiating body to develop an international policy instrument to address the issue of global warming.

4.1 United nations framework convention on climate change (UNFCCC)

The international negotiating body developed the United Nations Framework Convention on Climate

Change (UNFCCC), which was adopted at the Rio Summit in 1992. It entered into force on 21 March 1994, after receiving the requisite 50 ratifications. Sri Lanka became a party to it in 1994. The Convention now has 186 parties and is approaching universal membership.

The objective of the UNFCCC is to stabilise atmospheric greenhouse gas concentration at a level that will prevent dangerous human interferences with the climate system. In developing the UNFCCC, it was found that there are vast regional and country differences in the per capita emission of greenhouse gases as shown in Table 2.

Table 2.
Per capita emission of CO₂ in South Asian countries in 1990 and 1996 as compared to the USA

Country	Per capita carbon dioxide emissions (tonnes)	
	1990	1996
USA	5.18	5.37
Bangladesh	0.04	0.05
Bhutan	0.02	0.04
India	0.22	0.29
Maldives	0.19	0.31
Nepal	0.01	0.02
Pakistan	0.16	0.18
Sri Lanka	0.06	0.11

According to Table 2, the USA accounts for 25% of total annual global CO₂ emissions, which is about 36% of the total emissions of all industrialised countries. Therefore, the UNFCCC negotiated with the "Common but differentiated responsibility" principle – that is those countries which emit more emission should do more than those countries emitting less. Since the adoption of the UNFCCC in 1992, parties have continued to negotiate on decisions and conclusions that will reduce global greenhouse gas emissions. The adoption of the Kyoto Protocol in 1997 is a landmark event in such negotiations.

4.2 Kyoto protocol

The Kyoto Protocol to the United Nations Framework Convention on Climate Change strengthens the international response to climate change. Adopted by consensus at the third session of the Conference of the Parties (COP-3) in December 1997 in Kyoto, Japan, it contains legally binding emissions targets for 39 developed countries (Annex 1 countries) for the post-2000 period. The Kyoto Protocol promises to move the international community one step closer to achieving the Convention's ultimate objective of preventing "dangerous anthropogenic (man-made) interference with the climate system".

Under the Kyoto Protocol, developed countries commit themselves to reducing their collective emissions of six key greenhouse gases by at least 5.2% from their total GHG emission in 1990. This group target will be achieved through emission cuts of 8% by most Central and East European states and the European Union (the EU will meet its target by distributing different rates among its member states); 7% by the USA; and 6% by Canada, Hungary, Japan, and Poland. Russia, New Zealand, and Ukraine are to stabilise their emissions, while Norway may increase emissions by up to 1%, Australia by up to 8%, and Iceland 10%. Each country's emissions target must be achieved by the period 2008-2012. According to the Kyoto

Protocol, there are no emission reduction commitments for developing countries. Accordingly, Sri Lanka also has no commitment under the Kyoto Protocol.

On 16 February 2005, the Kyoto Protocol entered into force after receiving the threshold number of ratifications. Majority of the member countries of the UNFCCC ratified the Kyoto Protocol. However due to decline of the United States of America to ratify the Protocol, it was not operative until February 2005, when Russia ratified the protocol in the end of 2004. The United State of America has withdrawn from the Kyoto Protocol stating that it does not have a scientific basis.

4.3 Kyoto mechanisms

The Kyoto protocol introduced three flexibility mechanisms for developed countries to implement their emission reduction targets. They are Clean Development Mechanism (CDM), Joint Implementation (JI), and Emission Trading (ET).

4.3.1 Clean development mechanism (CDM)

Clean Development Mechanism (CDM) is defined in the Kyoto Protocol (Article 12) as a mechanism for North-South cooperation. The objective of the CDM is to "assist parties included in Annex 1 in achieving compliance with their quantified emission limitations and reduction commitments and to support "sustainable development" in developing countries. The CDM and associated carbon trading between developed and developing countries have received great international attention since it is the only mechanism that both developed and developing countries can participate.

4.3.2 Joint implementation (JI)

This mechanism would allow developed countries and their companies to cooperate on projects that reduce GHG emissions and share the Emission Reduction Units (ERUs). Only developed countries can implement JI projects and developing countries cannot participate.

4.3.3 Emission trading (ET)

Article 17 of the Kyoto Protocol allows developed countries (Annex B) to exchange emissions obligations, leading to Emission Trading (ET). Emission Trading is "a market-based approach to achieve environmental objectives that allows those reducing GHG emissions below what is required to use or trade the excess reductions to offset emissions at another source inside or outside the country.

4.4. Sustainable development criteria

The Kyoto Protocol specifies that the purpose of the CDM is to assist developing countries in achieving sustainable development. It is up to the developing countries to determine their own criteria and assessment process for sustainable development. In general, many countries use three main criteria for defining sustainable development, namely social, economic and environmental. Sri Lanka's Sustainable development criteria are also based on the above three principles.

5.0 Climate Change Impacts on Sri Lanka

Analyses have shown that the maximum and minimum temperatures in all metrological stations in Sri Lanka have clearly been increasing, with the highest increase of the minimum temperature being about 2.0 C at Nuwara Eliya. Analysis of rainfall data reveals that the variability has been increasing in most parts of the island resulting in water scarcities in the dry zone of Sri Lanka.

The Initial National Communication on Climate Change (INCC) prepared in 2000, by then Ministry of Forestry and Environment has identified that agriculture, water resources and human health services would be more vulnerable to climate change than other sectors in Sri Lanka and very few sectors, namely, agriculture, plantation and land use have developed suitable adaptation strategies to face this problem.

Tourism and fishery are two major sectors of the economy, which are directly linked to the sea and hence affected by sea level rise due to climate change. Sri Lanka's tourism industry is directly attached to the sea beach where majority of the tourist destinations are located. However, the impact of sea level rise on the tourism has not been assessed yet.

Impact on fishery sector due to climate change has several areas to be looked into. These include; the impact on production, change of fish varieties or type of fish available, fish yields or harvest, fish breeding grounds and breeding patterns due to increase of temperature, change of behaviours of fishes, etc. However, these impacts have not been assessed or quantified adequately, but it is certain that the temperature changes in the sea water and water level increase may have a significant impact on the Sri Lanka fishery sector.

Sea level rise and related scenarios will have major impacts on the coastal zone of the

country. Around 40% of the country's population lives in coastal areas. The human settlements, public utilities such as water supply, road and other infrastructure would be seriously affected due to climate change. At present the main water intakes for Colombo - Ambatale, Kalutara, etc. are experiencing salinity intrusion during dry periods. During a sea level rise, the salinity intrusion may aggravate and would pose a major problem in water supply to major coastal towns.

6.0 Sri Lanka's Efforts to Counter Climate Change Impacts

6.1 Ratification of the united nations framework convention on climate change (UNFCCC) -1994

Sri Lanka has associated with the world community in countering this global problem. Sri Lanka ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, and is participating with the efforts of the global community in a more constructive and positive manner.

6.2 Acceding the Kyoto protocol

Sri Lanka acceded to the Kyoto Protocol in 2002 and the Ministry of Environment & Natural Resources was designated as the National Focal Point for the implementation of the UNFCCC and the Kyoto Protocol in Sri Lanka. Sri Lanka has already established the related administrative mechanism to participate in the CDM under the Kyoto Protocol. The Ministry of Environment also acts as the Designated National Authority (DNA) for implementation of CDM in Sri Lanka.

6.3 Preparation of the greenhouse gas (GHG) inventory

In 1994, the Ministry of Environment carried out an assessment of GHG emissions within the country. Under this assessment, a GHG inventory for Sri Lanka was prepared based on all available data and other related information. Even today, this GHG inventory is the only document available on GHG emissions of the country.

6.4 Preparation of the first national communication on climate change

As a party to the UNFCCC Sri Lanka is obliged to prepare its national communications

on climate change periodically. This national communication should consist of national circumstances and vulnerability to climate change impacts, adaptation and mitigation options and programs, research and development and other related issues. Sri Lanka's first national communication on climate change was prepared in the year 2000, by then Ministry of Forestry and Environment and submitted to the UNFCCC.

6.5 Research on climate change

In 2002, Sri Lanka was able to carry out research to study impacts of climate change on Sri Lanka, under the Climate Change Enabling Activity Project¹. Some 54 studies related to agriculture, plantation industry, etc., were conducted under two research programs. In addition, the rainfall and temperature scenarios, impact on water quality, social impacts and impacts on upper watersheds were also studied. The outcomes of this activity were the identification of various adaptation and mitigation options for these areas.

6.6 Establishment of centre for climate change studies (CCCS)

The government of Sri Lanka established the Centre for Climate Change Studies (CCCS) attached to the Department of Meteorology, in 2001, to conduct research related to climate change and its impacts. Some researches have already been conducted at this centre, especially in the plantation crops; rubber, coconut and tea sectors.

6.7 National capacity self assessment for the implementation of the three Rio Conventions – NCSA²

The Ministry of Environment and Natural Resources as the national focal point for the three Rio Conventions (i.e., UN Convention on Biological Diversity - UNCBD, UN Convention to combat Desertification -UNCCD, and UN Framework Convention on Climate Change – UNFCCC) carried out an assessment during 2004-2006 on the national capacities available within the country to implement the three conventions. Under this exercise, the assessment was focused on three levels, namely individual, institutional and sectoral. This assessment highlighted the capacity requirements at all three levels to implement the Climate Change Convention together with other Rio Conventions. The Capacity Development Action Plan (CDAP) has identified the need for development of capacities at all levels to face the dangerous impacts of climate change.

6.8 Clean Development Mechanism (CDM) under the Kyoto protocol

As the national focal point for the implementation of the Kyoto Protocol in Sri Lanka, the Ministry of Environment and Natural Resources functions as the Designated National Authority (DNA) for the implementation of the CDM process. A separate CDM secretariat has been established within the Ministry. A national CDM policy and strategy has already been prepared by the Ministry with financial and technical assistance from the World Bank. A CDM project pipeline has already been developed. Under the national CDM policy, the priority sectors identified for CDM project development are renewable energy, forestry and plantation, waste management, industry and energy. At the moment several, CDM projects in the mini-hydro power sector have already been approved by the CDM/Executive Board/UNFCCC. There are many projects in the pipeline in different stages project development. It is expected that these projects would be able to get approved as possible CDM projects within the period 2008-2012 and obtain the benefits of carbon trading.

6.9 Establishment of Sri Lanka carbon fund

The Ministry of Environment & Natural Resources was able to establish the Sri Lanka Carbon Fund in 2008 to actively participate in the carbon trading business. The fund is a government-owned private company, which will facilitate CDM project development, financing and other related matters. It will also participate in carbon market scheme to obtain maximum benefit to the country via carbon trading.

6.10 Second national communication on climate change (SNC)

The Ministry of Environment and Natural Resources is now taking steps to prepare the SNC during 2007-2010. This communication is a national obligation to the global community /UNFCCC. Under this activity, it is expected to study and report on national circumstances, vulnerability, preparation of GHG inventory, adaptation and mitigation options, capacity assessment, research and development and other related issues. The communication shall be prepared in consultation with all the relevant government and private sector agencies, business community, research organisations and universities, Non-Governmental Organisations (NGOs), and the public. The Ministry has already established a project management unit to implement this project.

6.11 The national advisory committee on climate change

The Ministry of Environment and Natural Resources has appointed a National Advisory Committee on Climate Change (NACCC) in 2008, to advise the government on climate change and related issues. This committee which is chaired by the secretary to the Ministry of Environment and Natural Resources consists of all related government and private sector agencies, NGOs, and experts in climate change issues.

6.12 Establishment of the climate change secretariat

The Ministry of Environment and Natural Resources took the initiative in 2008 to establish the Climate Change Secretariat (CCS), within the Ministry to co-ordinate all the activities related to climate change and to carry forward the thrust to counter the climate change impacts much more effectively.

6.13. Activities carried out by other Agencies

Departments of Agriculture and Irrigation and various research institutes, universities and private sector plantation companies have also been working on collection and analysis of atmospheric data such as rainfall, temperature, etc. since the mid seventies. The National Aquatic Resources Development Agency (NARA) and Sri Lanka Ports Authority (SLPA) collect oceanographic data such as sea water levels, wave heights and other relevant data.

The Ministries of Agriculture and Plantations have been developing and implementing plans for adaptation to climate change for their sectors. However no proper sectoral policy mechanism has been developed to address this issue.

The Urban Development Authority (UDA) has developed adaptation plans and measures by formulating appropriate zoning and regulations for the areas sensitive to climate change and by developing urban greening programmes. The Rubber Research Institute (RRI) has been working towards developing drought tolerant clones. The Coconut Research Institute (CRI) has been developing adaptation plans and measures to cope with climate change.

The Tea Research Institute (TRI) has been developing suitable clones through hybridisation and selection by evaluating progenies for drought tolerance and pest/diseases resistance. The TRI has also been developing water

management techniques for young and mature tea and improved shade management for tea plantations. They have also been assessing socio-economic, growth and productivity impacts of climate change.

The adaptation strategies are yet to be developed in the health, forestry, industry and water resources sectors though their vulnerability to climate change has been assessed to some extent.

Very few organisations, namely Departments of Agriculture and Wild Life Conservation and Tea Research Institute have been introducing new technologies for adaptation. The National Engineering & Research Development (NERD) Centre, Industrial Services Bureau (ISB)/Kurunegala (for D/C mills and service stations) and the University of Moratuwa have also been involved in developing new technologies on mitigation.

Ministry of Healthcare and Nutrition has been working on identification of health impacts of climate change and developing national action plans to counter such impacts. The health impacts of high concern would be increase of vector-borne diseases such as dengue fever, malaria, and filarial diseases. There is a close relationship between rainfall, temperature, humidity and the incidence and spread of vector-borne diseases. The present control activities can maintain low incidence rates but with anticipated climatic changes and temperature rises, there is a danger that such diseases could increase in the future.

The Coast Conservation Department (CCD) is carrying out construction of coast protection bunds as an adaptation measure to protect the coastal zone from coastal erosion. In addition, the CCD is monitoring and controlling the mining of river sand. The National Sand Study conducted by the CCD in the 90's has allowed the Department to prepare policies to control excessive sand mining operation within the coastal zone³ to evaluate the impact of sand on the coast and to study sand required for the nourishment of the coast. This study has produced viable adaptation measures for sea level rise due to climate change.

7.0 Sri Lankas' Vulnerability to Climate Change

7.1 Vector-borne diseases

There is a close relationship between rainfall, temperature and humidity and the incidence and spread of vector-borne diseases. The present control activities can maintain low incidence rates, but with anticipated climate change, there is a danger that vector-borne diseases would increase in future.

7.2 Bio diversity

The most abundant insects in the dry zone are the harmful hard-bodied pests and vectors such as Coleopterans, Dipterans and Hemipterans whose population increases rapidly during the warm/hot months, while Hymenopteran species (beneficial ones) tend to decrease. Hence the species composition is likely to change with increasing temperature due to insect abundance, and severe damage to the natural biodiversity may occur. This requires urgent mitigatory measures.

7.3 Water resources

Water is a major constraint in the dry zone in Sri Lanka. The existing water scarce situation would be aggravated unless suitable adaptation measures are undertaken. An integrated water management strategy, including rehabilitation of abandoned tanks, enhancing storage capacity of operational reservoirs, introduction of less water-demanding crops, conservation of water, rainwater harvesting, trans-basin diversion of water, creating an awareness of water-related issues are some of such measures. In addition, the impact on present urban water supply systems is severe; Ambatale-Kelani Ganga, Kalutara, Gin Ganga, etc. are already experiencing salt-water intrusion during dry periods. This problem may be aggravated due to a possible sea level rise. Suitable adaptation and mitigation strategies should be followed to solve this problem.

7.4 National parks

Decreasing ground water availability and increased evaporation contribute to the spread of woody trees, mesquite and thorny shrubs that demand less water and to the forest dieback (e.g., death of weera trees, palu, malithan and mangrove species). This has become a serious problem since the early nineties. The need for the propagation of drought tolerant species and the practice of scientific water management are important in this regard.

8.0 Mitigations and Adaptation Options for Sri Lanka

8.1 Mitigation

Sri Lanka is considered a country rich with high level of biodiversity. The impacts of climate change on the country's biodiversity have not been assessed yet. But it has major impacts on various important ecosystems, such as wetlands, wildlife, forests and other such areas. The following are some of the biological options proposed to mitigate such impacts:

- ◆ Conservation of the existing carbon pools such as forests
- ◆ Carbon sequestration by increasing the size of the carbon pool by reforestation and afforestation of degraded forests, marginal croplands and fallow lands
- ◆ Identification of forest tree species that are most suitable for carbon sequestration, because reforestation provides an effective mechanism of carbon sequestration in the form of biomass. On the other hand, sequestered carbon can be used subsequently as a source of energy
- ◆ Quantifying the carbon fixing capability of rubber
- ◆ Adoption of agronomic practices such as application of organic fertilisers in rubber cultivation.
- ◆ Identifying high-yielding rubber clones that are tolerant to moisture stress.

8.2 Reduction of GHG gases – Methane emissions

- ◆ Paddy cultivation contributes 68% of the methane emitted from the agricultural sector in Sri Lanka. It is important to introduce rice varieties that produce minimum productive tillers with high yields to reduce methane emissions from paddy fields.
- ◆ Municipal solid waste generates CO₂ and CH₄, the two major GHGs. There is a need to dispose of wastes properly to reduce methane emissions.

8.3 Mitigation of the urban/heat island effect

Urban warming has resulted in significant increases in the cooling load of residencies, offices, institutions, etc. An in-depth study of energy consumption in residencies in Colombo indicated that conventional design options do not provide acceptable indoor comfort. Temperature rise due to climate change may aggravate the situation further. As such, there is a need for the following:

- ◆ Introduction of guidelines for building construction and landscape control ordinances, since energy efficient designs in building construction can reduce electricity consumption by about 50%.
- ◆ Changing the exterior colour (roofs and walls) from dark to light which could eliminate the need for increase thermal generation for cooling, particularly during peak hours.

- ◆ Facilitation of deeper penetration of sea breeze by discouraging construction of high-rise buildings along the sea coast and creating wind corridors perpendicular to the sea.
- ◆ Encouraging shading in street canyons.
- ◆ Development of neighborhood specific urban development controls.
- ◆ Permitting air movement through buildings and providing shading along streets.
- ◆ Changing of the orientation of windows north-south rather than east-west and reducing the size of glass facades in buildings so that it does not exceed 50% of the total area of the façade.
- ◆ In the Colombo City, vehicular air pollution is a serious problem. Implementation of vehicle emission control measures, growing selected tree species to reduce particulate matter are important measures which have to be implemented immediately.

8.4 Fuel switching

Fuel switching can be used to reduce CO₂ emissions by improving combustion efficiencies. Wood gasification technologies are considered to be emitting zero GHG and would save foreign exchange for fuel and increase the income of the rural poor through the production of fuel wood for boilers. The use of hot water boilers instead of steam boilers would ensure that there is a 40% reduction of both fuel usage annual GHG emissions.

8.5 Mini/micro hydropower projects

The establishment of mini/micro hydropower projects is one of the most sustainable alternatives to the usage of large-scale hydro electricity systems and fossil fuels in Sri Lanka. The success of these projects depends on the suitable site selections. The water yield for hydro power project is affected not only by the amount of rainfall but also land use practices in the catchments areas. The anticipated change in rainfall in the hill country would have a differential impact on water yield depending on type of natural vegetation cover and type of crops. This demands reforestation and proper forest management.

8.6 Adaptation options

8.6.1 Adaptation to scarcity of water resources – Rain water harvesting

Rainwater harvesting is an effective adaptation strategy to overcome the anticipated decline of rainfall in the dry zone. However, all the tanks used in the rainwater harvesting do not provide good quality water.

8.6.2 Adaptation to increase in vectors

There is a close relationship between climate and mosquito-borne diseases. Studies have shown that changing climatic conditions in the north western province can lead to increase in mosquito-borne diseases, though current vector control activities can maintain low incidence rates of dengue, malaria and Japanese encephalitis. In the north central province, surveillance by health authorities, continuation of current disease control programs, cleaning the environment with community participation and indoor residual spraying, conducting immunisation programs before the peak transmission periods should be implemented to control spreading of vectors.

8.6.3 Adaptation of paddy to elevated CO₂ levels

Field experiments could be conducted to select high-yielding new improved and traditional rice varieties that are highly responsive to high CO₂ levels, to be used in breeding programs.

The problem of water stress in paddy cultivation could be addressed by:

- ◆ Use of ultra short-term varieties that tolerate biotic and abiotic stress
- ◆ Adoption of suitable land and crop management technologies
- ◆ Adaptation of rain-fed paddy to rainfall variations – cultivation of short duration paddy in the Yala season and long duration paddy in the Maha season
- ◆ Adaptation/reduction of pest attacks on paddy – certain climatic conditions favours the outbreak of brown plant hopper (BPH) in the low country dry zone. Agronomic practices in paddy cultivation such as advancing the time of cultivation from May to March, introducing pest resistant varieties and the use of recommended insecticides could be adopted. There is also a need to establish a surveillance and forecasting system.
- ◆ Adaptation of rubber genotypes to suit different environments- Clones, RRISL 215 and RRISL 217 are highly adaptable to diverse environmental conditions with a high mean performance and are not sensitive to changes in environmental conditions. RRIC 100 is the most suitable clone for areas with low rainfall (Withange, 2004)
- ◆ In home gardens, cropping calendar should be altered to minimise irrigation water demand of crops.

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Footnotes

¹ IPCC- Intergovernmental Panel on Climate Change, a scientific intergovernmental body, was established in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Program (UNEP) to provide information about causes of climate change, its potential environmental and socio-economic consequences and the adaptation and mitigation options to respond to it. The Intergovernmental Panel on Climate Change and Albert Arnold (Al) Gore Jr. were awarded of the Nobel Peace Prize "for their efforts to build up and disseminate greater knowledge about man-made climate change and to lay the foundations for the measures that are needed to counteract such change".

² UNFCCC – United Nations Framework Convention on Climate Change was adopted in 1992 by the global community to stabilise the atmospheric greenhouse gasses at a level that would prevent dangerous anthropogenic interference with the climate system. Sri Lanka became a party to the UNFCCC in 1993.

³ Energy from the sun heats the earth's surface and the earth radiates this energy back into space. Some atmospheric gases such as water vapor, carbon dioxide, etc. trap some of this energy emitted from the earth, retaining heat somewhat like the glass panels of a green house. These gases are therefore known as greenhouse gases.

⁴ Likelihood refers to judgmental estimates of confidence used by TAR WG1, Likely- (66-90% chance) Very likely- (90-99% chance) Source: IPCC, 2001

⁵ Climate Change Enabling Activity Project (Phase II) implemented by the Ministry of Environment & Natural Resources in 2002 under funded by UNDP/GEF. Climate Change in Sri Lanka, Project Terminal Report (Vol I)

⁶ NCSA- National Capacity Self Assessment for the Implementation of the three Rio Conventions.) implemented by the Ministry of Environment & Natural Resources in 2004-06 funded by UNDP/GEF.

⁷ The Coastal Zone is described in the Coast conservation Act No 57 of 1981 as the area lying within a limit of 300m landward of the Mean High Water Line (MHWL) and a limit of 2km seaward of the Mean Low Water Line (MLWL); in the case of rivers, streams, lagoons, or any other water body of water connected to the sea either permanently or periodically, the landward boundary extends to a limit of 2km measured perpendicular to the straight base line drawn between the natural entrance points thereof and includes the waters of such rivers, streams and lagoons or any other body of water so connected to the sea.