PRESENT STATUS OF CLIMATE RELATED POLICY, LEGAL, INSTITUTIONAL AND RESEARCH INITIATIVES OF SRI LANKA

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ABSTRACT

The Ministry of Environment and Renewable Energy has developed policies and legal initiatives towards meeting the obligations of the United Nations Framework Convention on Climate Change (UNFCCC) where Sri Lanka is a party from 1993. These include the creation of new environment related policies such as National Environmental Policy (2003), National Forest Policy (1995), National Policy on Wildlife Conservation (2000) and the new amendments to the Forest Ordinance and Fauna and Flora Protection Ordinance. National Air Quality Management Policy (2000), National Watershed Management Policy (2004), National Policy on Wetlands (2006) and National Land Use Policy (2007). In addition, recently developed strategies and policies such as Sri Lanka Strategy for Sustainable Development (2008), National Action Plan for Haritha (Green) Lanka (2009), National Climate Change Adaptation Strategy for Sri Lanka 2011-2016 and National Climate Change Policy (2012) shows the importance that the Government places on environmental and climate change related issues. The National Climate Change Policy of Sri Lanka is aimed at mainstreaming climate change issues within the overall efforts towards sustainable development and it creates the conditions necessary to overcome the major gaps existing at present.

Besides, the National Council for Sustainable Development (NCSD) was formed in 2009 to provide leadership and guidance for sustainable development in the country. NSCD is responsible for producing an integrated policy and overseeing and guiding the implementation of the National Action Plan for Haritha (Green) Lanka Programme to ensure the sustainability of social and economic development programme while safeguarding the environmental integrity of the country.

Technology Needs Assessment has been carried out to identify measures and practices that might be implemented in different sectors of a country to reduce GHG emissions and vulnerability to climate change and contribute to overall development goals. In this assessment, appropriate technologies for climate change adaptation and mitigation have been identified for food, water, health, coastal, biodiversity, energy industry and transport sectors.

Research and development play an important role, in assessing vulnerability and impacts and developing adaptation and mitigation measures in dealing with climate change. Researches on climate change related areas have already been conducted by the Centre for Climate Change Studies (CCCS), Department of Meteorology especially in rubber, coconut and tea sectors with National Science Foundation (NSF) and Global Environment Facility (GEF) funds. Fifty eight researches have been funded by the GEF through the Ministry of Environment focused on impacts of climate change, vulnerability, climate change adaptation, technology transfer and technology needs assessment. In addition, many departments, statuary bodies, universities, research institutions, private sector plantation companies and civil societies have also started to carry out research studies, taking systematic observation of atmospheric data such as rainfall, temperature etc. and measure the oceanographic data such as sea water levels, wave heights and other relevant data. Further, climate change vulnerability assessments have been conducted for agriculture and fisheries, water, health, urban development, human settlement and economic infrastructure, biodiversity and ecosystem services sectors by the Climate Change Division of the Ministry of Environment and Renewable Energy.

INTRODUCTION

Climate change is the ultimate outcome of global warming. It is now universally recognized as the fundamental human development challenge of the global community. The Intergovernmental Panel on Climate Change (IPCC) has conclusively established that climate induced by global warming is the direct result of excessive emissions of greenhouse gasses due to human action, particularly due to uncontrolled combustion of fossil fuels. It is a certainty that the present and future generations have to live under the threat of climate change as all nations are affected by the phenomenon.

Having recognized global warming and associated climate change phenomenon, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted at the Earth Summit held in Rio de Janeiro in June 1992. As a legal instrument of the UNFCCC, the Kyoto Protocol (KP) was adopted in 1997. Aligning with the global community, Sri Lanka has ratified the UNFCCC in 1993 and acceded to the KP in 2002.

Being a developing island-nation subject to tropical climate patterns, Sri Lanka is highly vulnerable to climate change impacts, though the country is a negligible contributor to the global warming and climate change. Increasing the frequency and intensity of disasters such as droughts, floods and landslides, variability and unpredictability of rainfall patterns, increase in day and night temperatures and sea level rise are major climate change impacts that the country will experience in the foreseeable future. Any drastic changes in already volatile weather patterns are likely impact adversely on the socio - economic activities in the country.

Droughts, floods and landslides

Analysis of rainfall data reveals that the variability has been increasing in the past in most parts of the island resulting in water scarcities especially in the dry zone of Sri Lanka. Extreme weather events such as high intensity rainfall followed by flash floods and landslides, and extended dry periods resulting in water scarcity are now becoming common occurrences in Sri Lanka.

Temperature increase

Although Sri Lanka's GHG emissions are negligible compared to those of developed or developing countries, analysis of past records have highlighted that air temperature in the island has been rising throughout the country during the last century with a temperature increase of 0.016°C per year between 1961 and 1990, whilst the highest increase of minimum temperature being about 2.0°C at *Nuwara Eliya*. The night time annual average temperatures have increased at a faster rate than that of the daytime, up to a maximum of 0.02°C per year.

Sea level rise

Sea level rise is one of the most certain responses to global warming and presents a major challenge in the administration and management of coastal zones, on a global scale including that of Sri Lanka. Nearly, two third of Sri Lankan population is settled in the coastal regions and these regions play a vital role in the economic growth of the country as well as environmental concerns.

Investigations conducted in Sri Lanka have revealed that climate change will result in changes to critical forcing parameters of the coastal zone, which would affect the physical condition of the shoreline. Rising sea levels, change in wave patterns arising from changes in wind pattern and water depth, increased rainfall and the occurrence of extreme events more frequently, are some of these. Sea level rise on its own would lead to several issues such as inundation and displacement of low lying coastal areas and wetlands, coastal erosion and degradation of shorelines, salinization of estuaries and freshwater aquifers and changes and migration of coastal eco-systems and habitats.

Climate change brings extra burdens on the socio-economic development of a country as well as vulnerable communities, particularly the poorest, has already experienced, emphasizing and increasing their vulnerabilities due to the dependence of their livelihoods on climate sensitive natural resources and their weak social

protection structures and capacities. By directly depleting the resources that poor people depend on for their livelihoods, climate change makes it easier for people to fall into poverty and harder for the poorest to escape from it.

Climate change vulnerabilities cut across many sectors in the economy and threaten to compromise the significant achievements the country has recorded in the last 20 years in increasing incomes and reducing poverty as well as country's ongoing development drive. Investments currently being deployed for the ongoing development efforts are also at risk due to climate change. The sector vulnerability profiles developed for Sri Lanka in 2010 has identified agriculture and fisheries, water, health, urban development, human settlements and economic infrastructure, biodiversity and ecosystem sectors where climate vulnerabilities are expected to be critical. The significance of these sectors being highly vulnerable to the adverse effects of climate change are briefly overviewed as follows;

Agriculture and fisheries sectors

Agriculture plays a major role in the economy as source of income for the majority of rural poor, source of national growth, provider of opportunities for private investment, and a driver of related industries. In 2012, the agriculture sector contributed 11.1% to the national GDP and provided direct employment to 31.0% of the total labor force. Furthermore, it is estimated that the agriculture-related activities provide the major source of employment and livelihood for nearly 72% of the Sri Lankan population. In national income statistics, agriculture is defined to include crop production, animal husbandry, fisheries and forestry. The contribution to the GDP from agriculture sector comes predominantly from crop production, which accounted for 76% of the contribution of the sector in 2012.

Aquaculture has emerged as one of the key strategic sectors in view of the increasing demand for fishery products, and potential for income diversification and increasing utilization capacity of scarcely used or degraded lands. Reservoir-based fresh water fishery provides a significant contribution to food and nutritional security of the rural areas of the country. With the development of inland fishery, per-capita fish consumption in the land-locked regions such as Anuradhapura and Polonnaruwa districts in the north central province has exceeded the average national per-capita fish consumption. This has been primarily achieved especially through culture-based fishery (CBF) in medium size perennial reservoirs and small village tanks.

Agriculture and fisheries are highly dependent on specific climate conditions. Increases in temperature and carbon dioxide (CO_2) levels can be beneficial for some crops in some places. However, to realize these benefits, nutrient levels, soil moisture, water availability, and other conditions must also be met. Changes in the frequency and severity of droughts and floods could pose challenges for farmers. Meanwhile, warmer water temperatures are likely to cause the habitat ranges of many fish and shellfish species to shift, which could disrupt ecosystems. Overall, climate change could make it more difficult to grow crops, raise animals, and catch fish in the same manner at same places as we have observed in the past. The effects of climate change also need to be considered along with other evolving factors that affect agricultural production, such as changes in farming practices and technology.

Water sector

There are 103 distinct natural river basins that cover approximately 90% of Sri Lanka. River basins originating from the wetter parts of the up country are perennial, while many of those in the dry zone are only seasonal. According to the Agrarian Services Act No. 58 of 1979, reservoirs (tanks) having an irrigated command area of less than 80 ha are categorized as small or minor tanks. More than 90% of the small tank systems are clustered into cascades and these tank network systems have been built in water scarce areas by ancient kings mainly for agricultural purposes being conversant of the variability in rainfall centuries ago.

Water is mainly used for domestic, irrigation, hydropower generation and industrial purposes.

Protected wells, deep and tube wells, protected springs and pipe borne municipal supplies are considered as safe drinking water sources and water from unprotected wells, rivers, tanks and canals are considered as unsafe. According to *Mahinda Chintana–"Vision for the Future"* policy framework of 2010, 90% of people will have access to safe drinking water by year 2016. It further envisages 100% of urban population, 90% of rural population and 80% of estate sector to have access to safe drinking water by year 2016.

When the earth's temperature continues to rise, we can expect a significant impact on fresh water supplies. Warmer temperatures would increase the rate of evaporation of water into the atmosphere, in effect increasing the atmosphere's capacity to "hold" water. Increased evaporation may dry out leading to droughts in some areas and fall as excess precipitation on other areas resulting in heavy floods. Increases in heavy precipitation events could cause problems for the water infrastructure. Water quality could suffer in areas experiencing increases in rainfall. Heavy rain can increase the amount of runoff into rivers and lakes, washing sediment, nutrients, pollutants, trash, animal waste, and other materials into water supplies, making them unusable, unsafe, or in need of water treatment.

In addition, rising temperatures are melting glacial ice at an unprecedented rate. Current scientific research shows that climate change will lead to substantial sea-level rise due to melting of glaciers. Sea levels have already risen between 10 and 25 cm (global) over the last century. Freshwater resources along the coasts face risks from sea level rise. As the sea rises, saltwater moves into freshwater areas. This may cause to seek other sources of fresh water, or increase the need for desalination for some coastal freshwater aquifers used as drinking water supply. In addition, as more freshwater is removed from rivers for human use, saltwater will move farther upstream. Drought can cause coastal water resources to become more saline as freshwater supplies from rivers are reduced.

Health sector

In general, the health sector has a well-established preventive and curative care network throughout the country despite the fact that there are differences between the different geographical areas, especially with regard to the adequacy of human resources in the public health service sector. Although the public hospitals are satisfactorily equipped to provide communicable disease prevention services, their impact in controlling such diseases appear to be marginal.

There are 1,042 government hospitals in the country with 13,280 medical officers (doctors), and 26,629 nurses and other related staff. In addition, there are 147 private hospitals mainly in urban centers. There are 316 Medical Offices of Health (MOH) areas in the island. The preventive care services provided by the public health officials include maternal and child health, immunization, nutrition supplementation, health education, sanitation, communicable disease prevention and many other related services.

Many communicable diseases are under control and diseases such as Malaria and Japanese Encephalitis are almost eradicated. However, recently, Dengue has reached an epidemic level resulting in nearly 20,000 persons have been affected in 2011 out of which 155 have died of complications due to the disease. The main reason has been identified as irregular precipitation pattern and collection of clean water in an around the human dwellings.

Sri Lanka as a tropical country is vulnerable to direct effects of extreme, intense and frequent weather changes on human health. Indirectly, these conditions will influence human health through microbial contaminant pathways and transmission dynamics of vectors, which are common in Sri Lanka. The equilibrium of the ecosystem is liable to be changed along with the hydrological cycle and related impacts on agriculture as a consequence of climate change. This will have a significant impact on the nutritional status of the Sri Lankan population. As a country which depends on agriculture for food availability and having still not realized the

optimal potential in terms of nutritional status of the population, this would have severe repercussions in terms of growth and development of children, the productivity of the older age groups and future generations.

The changes in socio- economic status will also have significant bearings on the human health. Thus, it is obvious that the human health status of the Sri Lankan population is bound to be affected in great deal through changes in these proximal and distal determinants of health in the future due to climate variability. The broad categories of health outcomes that are anticipated to be increased are morbidity and mortality related to changing temperature, extreme weather related health effects, air pollution and its impacts, water borne and food borne diseases, vector borne diseases including rodent borne diseases, health effects of food and water shortage, mental and nutritional disorders and infectious diseases. Therefore, climate change and related extreme weather events are likely to have both direct and indirect impacts on health of the people.

Urban development, human settlements and economic infrastructure

In general, urban areas of Sri Lanka comprise of cities and towns that are characterized by higher population densities, physical development and other human-induced changes that make them different from the more rural settlements such as villages and hamlets. In the past, urban growth in Sri Lanka was mainly due to migration from rural areas, mostly to the Western Province. In more recent years, however, the emphasis given by successive governments for rural housing and other forms of rural development to uplift rural communities and to eliminate large urban-rural disparities in human settlements, has led to urbanization that is due to the growth of small and medium size towns around the major cities of the country.

With the rapid urbanization and the associated housing development, the urban environment is expected to considerably enhance the national economy. With accelerated urbanization, Sri Lanka would face the challenge of ensuring that such development is systematic, equitable and sustainable. As such, ensuring that the projected metro-regions, existing urban areas and other rural human settlements are developed sustainably with adequate housing and increasing their resilience/adaptation capacity to impacts of potential climate change would be in the national interest.

The density of human settlements and associated demands on the environment are increasing in many areas to unsustainable levels. The blocking out, fragmentation and selling of home garden lands for more single-family detached dwellings is increasing causing significant sprawl of settlements, which are often ill-serviced with infrastructure and totally devoid of tree canopy cover that could be expected to enhance environmental quality. Large expanses of human settlements without tree cover could also respond more adversely to a future rise in ambient temperature.

Investments in urban development, human settlements and economic infrastructure become a key issue to national development in Sri Lanka. Following the *Mahinda Chintana – "A Vision for a New Sri Lanka"* 10 Year Horizon Development Framework 2006-2016, many infrastructure projects have been carried out under the *Gama Neguma* and *Maga Neguma* Programmes. The Government has prioritized the development of metro-areas as well as rural areas, roads, electricity, water supply and sanitation, ports and aviation and transport for economic infrastructure development at national and regional levels under the *Randora* Infrastructure Development Programme. Optimizing benefits from these projects require sustainable urban development and human settlements and expansion of economic infrastructure and other development processes that take into account the environmental management. This includes addressing the ramifications of already felt and future climate change and measures for adaptation during National Physical Planning.

Biodiversity and ecosystems

Sri Lanka has a varied climate and topography, which has resulted in a rich globally significant biodiversity, distributed within a wide range of ecosystems. Sri Lanka along with the Western Ghats of India has been identified as one of the 34 biodiversity hotspots in the world. Biodiversity provides a multitude of ecosystem goods and services to people of the island, including watershed services, regulation of climate, carbon sequestration and supply of non-timber forest products such as rattan, wild foods, fruits, medicinal plants etc., among many others.

The threats to Sri Lanka's biodiversity have been identified, among which are habitat loss and fragmentation, habitat degradation, over exploitation of biological resources, loss of traditional crop and livestock varieties and breeds, pollution, human-wildlife conflicts, a burgeoning spread of alien invasive species and increasing human population density.

The Sector Vulnerability Profile (SVP) for the biodiversity sector, having a close look at the impact of climate change on this sector, indicated that Sri Lanka, as an island nation, is vulnerable to the risk of sea level rise and increased frequency of storms that can bring major impacts on coastal biodiversity. Additionally, analysis of climate data indicates a change in rainfall regimes and a trend of increasing air temperature, which can also have impacts on the country's biodiversity and natural ecosystems.

Climate related policy initiatives

The UNFCCC 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*". Climate change has been heralded as a threat to the global society. It has become a subject of intense interest to public policy decision makers internationally.

The most demanding challenge for the developing countries today is to develop their economies to provide a better quality of life taking into consideration the shrinking environmental space. Sri Lanka has to address these challenges considering the need for increasing investment for environment friendly infrastructure development, increased volatility to energy markets, problems related to food security, trade, commerce and industrial development together with the climate change challenges. Therefore, urgent action is necessary to take adaptive measures to build resilience of the country to face the adverse impacts of climate change. While taking adaptive measures as the priority, Sri Lanka is actively involving in the global efforts to minimize the greenhouse gas emissions within the framework of sustainable development and principles enshrined in the UNFCCC and it's KP.

The recent policy and legal initiatives undertaken towards meeting the obligations of the UNFCCC where Sri Lanka is a party from 1993, include creation of new environment related policies such as National Forest Policy (1995), National Policy on Wildlife Conservation (2000), National Air Quality Management Policy (2000), National Environmental Policy (2003), National Watershed Management Policy (2004), National Policy on Wetlands (2006), National Solid Waste Management Policy (2007), National Land Use Policy (2007). In addition, several major policy initiatives have been taken by the Ministry in charge of the subject of environment in terms of ensuring sustainable development in the country and to build resilience of the country to meet the adverse impacts of climate change and take appropriate remedial actions to mitigate GHG emission. These include (1) Sri Lanka Strategy for Sustainable Development in 2008 to ensure long term sustainability of the country, (2) National Action Plan of *Haritha* (Green) Lanka Programme in 2009 to address the critical environmental issues including climate change, (3) National Climate Change Policy of Sri Lanka in 2012 to adopt to the adverse impact of climate change and mitigate GHG emission as appropriately to the national circumstances, and (4) National Climate Change Adaptation Strategy for Sri Lanka 2011-2016 in 2010 to build resilience of the country to meet the adverse impacts of climate change.

Sri Lanka strategy for sustainable development

The Sri Lanka Strategy for Sustainable Development (SLSSD), which was developed by the Ministry of Environment and Natural Resources in 2008 aims to meet the country's various development needs as well as its development challenges and to mainstream environmental considerations in policy-making and policy implementation. According to SLSSD, Sri Lanka's vision for sustainable development is *"Achieving sustained economic growth that is socially equitable and ecologically sound, with peace and stability"*.

The SLSSD leads to achieve this vision through eradication of poverty, ensuring competitiveness of the economy, improving social development, ensuring good governance, and a clean and healthy environment. These five goals prioritize the challenges that have to be addressed in the path to achieving sustainable development. The general strategies adopted in the path to sustainable development are (1) Creating an economy for sustainable development, (2) Strengthening institutional structure for sustainable development, (3) Creating a policy framework for sustainable development, (4) Creating a regulatory framework for sustainable development and (5) Creating a knowledge base for sustainable development.

National action plan for *Haritha* (Green) Lanka

The National Action Plan for *Haritha* (Green) Lanka Programme (HLP) is to focus on addressing critical environmental issues, which if left unattended, would frustrate the nation's economic development programme. Actions to address key issues that would enable sustainable development are embodied in the strategies and proposed actions set out under the HLP. The implementation of the programme will be overseen by the Ministry of Plan Implementation, while the secretariat for the National Council for Sustainable Development (NCSD), which steers the implementation of the programme, is located within the Ministry of Environment.

"*Meeting the Challenge of Climate Change*" is the third among the ten missions that have been identified for action in the HLP. The National Action Plan for HLP has recommended a number of measures to be undertaken by 2016 on climate change adaptation and mitigation. For adaptation, the HLP has recommended carrying out health surveillance and identifying health risk areas when exposed to climate change and taking control measures, promoting growth of crop varieties not sensitive to temperature rise and responding positively for carbon dioxide increase, encouraging rain water harvesting, discouraging development activities near the coast and encouraging carbon trading. The mitigating options include introducing bio-fuels in the transport sector, improving efficiency in industrial and energy sectors and increasing forestation.

National climate change policy of Sri Lanka

Considering the severity and identifying the gravity of climate change impacts to the country, Ministry of Environment and Renewable Energy (ME&RE) has formulated the National Climate Change Policy of Sri Lanka (NCCPSL) in 2012 to provide guidance and directions for all stakeholders to addressing the adaptation to the adverse impacts of climate change and mitigation with nationally appropriate measures. The NCCPSL is aimed at mainstreaming climate change issues within the overall national efforts towards sustainable development and it creates the conditions necessary to overcome the major gaps existing at present.

The NCCPSL contains a vision, mission, goal and a set of guiding principles followed by broad policy statements under Vulnerability, Adaptation, Mitigation, Sustainable Consumption and Production, Knowledge Management and General Statements. Collaborative action at all levels is necessary to transform this policy into meaningful set of actions to meet the challenges of climate change. The Vision of the NCCPSL is "*a future where climate change will have no adverse consequences on Sri Lanka*" and the

Mission is "*Addressing climate change issues locally while engaging in the global context*". The policy goal is *"Adaptation to and mitigation of climate change impacts within the framework of sustainable development"*.

The major objectives of the NCCPSL are (1) Sensitize and make aware the communities periodically on the country's vulnerability to climate change, (2) Take adaptive measures to avoid/minimize adverse impacts of climate change to the people, their livelihoods and ecosystems, (3) Mitigate greenhouse gas emissions in the path of sustainable development (4) Promote sustainable consumption and production, (5) Enhance knowledge on the multifaceted issues related to climate change in the society and build their capacity to make prudent choices in decision making, (6) Develop the country's capacity to address the impacts of climate change effectively and efficiently, and (7) Mainstream and integrate climate change issues in the national development process. The Guiding Principles of the NCCPSL have been setup as (1) Climate change possesses an immediate and potentially irreversible threat to the life on earth and timely action is necessary to reduce vulnerabilities and build resilience in the country, (2) Steps taken to address climate change shall be environmentally sound, nationally appropriate, socially acceptable, and economically viable (3) Sustainable consumption and production can significantly address, (4) The current and future challenges of climate change (5) Ecosystems stability is ensured aiming at poverty eradication and Sustainable Human Development (6) A shared vision coupled with a shared responsibility of all the citizens is a necessity to effectively address the climate change problems/issues, and (7) Precautionary principles shall be followed in the absence of scientific based evidences in decision making.

National climate change adaptation strategy for Sri Lanka 2011-2016

The Ministry of Environment and Renewable Energy (ME&RE) has developed the National Climate Change Adaptation Strategy (NCCAS) including a prioritized framework for action from 2011 to 2016 periods aiming at moving Sri Lanka and its people systematically towards a climate change resilient future. The NCCAS mirrors and supports Sri Lanka's national development strategy as articulated in the *Mahinda Chintana – "Vision for the Future"* and is aimed at ensuring its success and sustainability. Accordingly, key findings of sector-based analysis were synthesized into an integrated framework, and structured into five Strategic Thrusts area namely (1) Mainstream Climate Change Adaptation into National Planning and Development, which includes cross cutting policy measures, capacity building, safeguards, monitoring programs, coordination mechanisms, etc, (2) Enable Climate Resilient and Healthy Human Settlement including housing, urban development and planning, public health, drainage, drinking water, urban wetlands, waste management, pollution control, etc., (3) Minimize Climate Change Impacts on Food Security including agriculture, fisheries, irrigation, nutrition, etc., (4) Improve Climate Resilience of Key Economic Drivers including tourism, transport, power, commercial agriculture, etc., and (5) Safeguard Natural Resources and Biodiversity from Climate Change Impacts including water resources management, biodiversity conservation, etc. Under each of the strategic thrusts, key thematic areas for action, along with priority adaptation measures, have been identified.

National climate change adaptation action plan

Based on the NCCPSL and National Climate Change Adaptation Strategy, the Ministry of Environment and Renewable Energy has taken steps to prepare the National Climate Change Adaptation Action Plan (NCCAAP). This Action Plan is mainly focused on major vulnerable sectors to climate change in the country including (1) Food security, (2) Water, (3) Health, (4) Biodiversity and ecosystem, (5) Human settlement infrastructure design and development and (6) Coastal and marine resources.

Technology Needs Assessment (TNA)

The developed country parties to UNFCCC are required, as per the Articles 4.3 and 4.5 of the UNFCCC, to promote, facilitate and finance the transfer of, or access to, environmentally sound technologies and know-how to developing country Parties, for enabling them to implement the provisions of the Convention. In order to assist developing countries and address their needs for Environmentally Sound Technologies (EST), at the request of UNFCCC, UNEP/GEF funded a Project on Technology Needs Assessment (TNA) implementing in order to identify and assess environmentally sound technologies that have synergy between reducing the impact of climate change and the rate of GHG emissions within national development objectives. The TNA represents a set of country driven activities that identify and determine the most appropriate mitigation and adaptation priority technologies for Sri Lanka.

The TNA has been carried out to identify measures and practices that might be implemented in different sectors of a country to reduce GHG emissions and vulnerability to climate change and contribute to overall development goals. In this Assessment, appropriate technologies for climate change adaptation and mitigation have been identified covering food security, water scarcity, health, coastal, biodiversity, energy, industry and transport sectors.

Climate related institutional initiatives

In 2009, the National Council for Sustainable Development (NSDS) was formed under the chairmanship of His Excellency the President of Democratic Socialist Republic of Sri Lanka to provide leadership and guidance for sustainable development in the country. The Council is charged with the responsibility of producing an integrated policy, and overseeing and guiding the implementation of the National Action Plan for *Haritha* (Green) Lanka Programme to ensure the sustainability of social and economic development programmes, while safeguarding the environmental integrity of the country. The NCSD is responsible for overall management and coordination of the programme. The Ministry of Environment and Renewable Energy acts as the Secretariat to the NCSD.

The Ministry of Environment and Renewable Energy has an obligation to facilitate the implementation of NCCPSL and related actions in collaboration with line agencies and relevant stakeholders. As the cross-sectoral nature of climate change issues requires mainstreaming climate change mitigation and adaptation aspects into the agendas of line ministries and agencies, the Ministry of Environment and Renewable Energy has established an Inter-Agency Coordinating Committee on Climate Change to integrate climate change adaptation and mitigation into relevant sectoral policies, strategies and action plans.

Collaborative actions at all levels are necessary to transform the NCCPSL into meaningful set of actions to meet the challenges of climate change. Therefore, two committees namely, (1) National Expert Committee on Climate Change Adaptation and (2) National Expert Committee on Climate Change Mitigation, have been established in order to advise the Ministry of Environment and Renewable Energy and provide guidance to conduct activities related to climate change adaptation and climate change mitigation in Sri Lanka, respectively.

Climate related research initiatives

In carrying out the commitments stated under the Article 4, paragraph 1(g) and subsequent Article 5, of the UNFCCC, all parties are obligated to promote research and systematic observations of climate and other functions. Research and Development (R&D) plays an important role, especially in assessing vulnerability and impacts and developing adaptation and mitigation measures in dealing with climate change.

Accordingly, the Climate Change Secretariat (CCS) has conducted several vulnerability assessments and prepared Vulnerability Profiles to Agriculture and Fisheries, Water, Health, Urban Development, Human Settlement and Economic

Infrastructure, Biodiversity and Ecosystem Services in the country. Researches on climate change related areas have already been conducted by the Centre for Climate Change Studies (CCCS) of the Department of Meteorology, Department of Agriculture, commodity research institutes in the rubber, coconut and tea sectors, and Universities with the assistance of the treasury, National Science Foundation (NSF) Global Environment Facility (GEF) and other national and international donor agencies.

A large number of short-term research studies were undertaken under the senior research program and junior research program of the Climate Change Enabling Activity Programme Phase II Project, funded by the GEF through the Ministry of Environment and Renewable Energy covering climate variability, impacts of climate change on crop yield, adaptation measures in agriculture, emissions from agriculture fields and waste, carbon sequestration in forests, etc. In addition, several research studies were undertaken to determine the impact of temperature, rainfall and sea level rise. Studies were also undertaken to assess the overall climate change impact on agriculture in the wet zone and to develop a district-wise mapping of vulnerability with exposure to flooding, landslides, cyclones and droughts.

Sri Lanka has been making systematic observations in meteorology for over 100 years, and currently with the improved technology to obtain real-time regular data on rainfall from landslide prone areas. In addition to meteorology observations, Sri Lanka makes regular observations on agro-meteorology, hydro-meteorology and ocean-related parameters. Sri Lanka exchanges these data with international data centers on a regular basis.

Systematic observation on atmospheric data such as rainfall, temperature etc. and measure the oceanographic data such as sea water levels, wave heights and other relevant data have been undertaken by many organizations. Further, climate change vulnerability assessments have been conducted for agriculture and fisheries, water, health, urban development, human settlement and economic infrastructure, biodiversity and ecosystem services sectors by the Climate Change Division of the Ministry of Environment and Renewable Energy.

Furthermore, Climate Change Division of the Ministry of Environment and Renewable Energy is organizing a National Level Symposium in order to encourage research and development on climate change adaptation measures and greenhouse gas (GHG) mitigation options to be held in December 2013. This symposium would be instrumental in identifying the research gaps and filling the gap of knowledge in the area of climate change and would assist in mainstreaming the climate change issues into socio-economic development of Sri Lanka.

FUTURE RESEARCH NEEDS

Knowledge of the degree of vulnerability in important sectors such as agriculture, forestry, ecosystems and health sector is needed in order to facilitate the policy makers to make decisions regarding the adaptation and mitigation measures at national level in an efficient and effective manner. The Assessment Reports of the Intergovernmental Panel for Climate Change (IPCC) publish periodically anticipated temperature rise and rainfall variations corresponding to different global circulation models and emission scenarios for given time frames on a regional scale. It is necessary to downscale these projections applicable to Sri Lanka. Further studies need to be conducted to assess the overall impact of climate change on country's agricultural productivity under different scenarios using crop modeling. A large number of areas in agriculture for undertaking further climate change related research have been identified. Seasonal climate forecasting is one such important area of study, which requires attention of researchers in the field of agriculture to support future agricultural development in Sri Lanka aiming at sustainable food security. However, there is a need to build human and physical capacity in carrying out these studies, and modernize the data collection and information dissemination using digital systems for easy

recording and analysis. It is also important to project future scenarios of climate parameters such as temperature and rainfall on a 10 year basis for next 100 years for different climatic and agro-climatic regions. Projections on crop productivity, ecosystem change, impacts on forestry based on crop models are necessary to respond to the future climate change scenarios. The GIS based zoning maps have to be developed to better communicate and take proactive measures to remedy the impacts. The maps should indicate the impact assessments on each vulnerable sector. Awareness creation among the policy makers /implementers, scientists, and investors about the impacts is also necessary.

A major problem faced by researchers in Sri Lanka is the lack of literature regarding climate change research. It is very necessary to have updated reference material regarding weather, climate, climate change and vulnerability for the different sectors. Further research should also be focused on, economics of climate change (costs of adaptation and mitigation options, loss and damage due to sea level rise, floods, droughts), country specific emission factors, appropriate technology for adaptation and mitigation (innovative and traditional), alternative livelihoods for vulnerable communities, tolerant and resistant varieties for floods and droughts, and assessment of the frequency of hazards (floods, droughts, cyclones, etc.).

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