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## ENVIRONMENT

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# Introduction

The constitution of Sri Lanka states that “It is the duty of every person in Sri Lanka to protect nature and conserve its riches”. The national environment policy has been developed acknowledging this duty and provides directions to take steps to conserve and manage Sri Lanka’s environment in all its aspects. Some of the key concepts are biodiversity, cleaner production, climate change, conservation, ecosystems, environment pollution, environment indicators, evolutionary processes, invasive species, living modified organisms, “polluter pays principle”, precautionary principle, sustainable development and caring for the environment. With all these concepts the outcomes to be achieved cover sectors in land, water, atmosphere and biological diversity.

Considering the need of sustainable use of environment for socio-economic benefits, several sub areas such as; climate change, natural disasters, biodiversity, waste management and environment sustainable technologies should be given proper attention.

Today it is a well-known fact that human activities cause climate changes of the globe and leads to environment and climate change related disasters. Research and projections indicate that Sri Lanka is highly vulnerable to effects of climate change and could be affected in different ways. Raised temperatures and unpredictable monsoon rains are already affecting the country’s food production and water resources. More frequent and intense droughts, as well as extreme weather events like flash floods can disrupt public life and damage property and crop harvests. In the longer term, rising sea levels can impact the island’s highly populated coastal areas, threatening human settlements, infrastructure and coastal/marine ecosystems.

In order to adapt to or to mitigate climate change there should be a proper understanding of the future scenarios of climate change in Sri Lanka. As

such, research need to be conducted to suitably downscale the global scale models and include specific features related to Sri Lanka in order to obtain a realistic and reliable climate change forecast for Sri Lanka. Further in order to achieve this task it will be necessary to develop human resources capacity in relevant fields. In order to contribute towards mitigation of climate change the focus should be directed to energy, transportation, industry, waste management, agriculture and livestock.

Sri Lanka has wide variety of biologically rich ecosystems from tropical rain forests to coral reef and is considered to be a biodiversity hotspot. Protecting it and sustainable use is essential as there have been reports that some of the species are threatened due to climate change or due to over exploitation for economic benefits. Removal of spices from the wild, competition between the invasive exotic species and indigenous species, lack of understanding of scientific management, pollution over visitation, under valuation of biodiversity are identified as some of the reasons for biodiversity depletion.

Waste management is an integral component of environment management. Generation of waste has increased due to factors such as population growth, change of life style of people and technological developments. Research is needed to solve the problem of waste management with a long term solutions.

Change of natural environment due to economic development cannot be prevented. However, to minimize environment degradation due to development, energy efficient processes, development of green products etc. has to be encouraged. With these actions it is expected to move towards sustainable development with minimal impact on natural environment.

## Sub Areas, Issues and Relevant Interventions

**Table 1: Sub Areas and Justifications**

Sub Areas	Justifications
<p><b>1) Climate change mitigation and adaptation</b></p> <ul style="list-style-type: none"> <li><i>i) Climate prediction (seasonal and long range) and future projections for Sri Lanka</i></li> <li><i>ii) Adaptations to climate changes</i></li> <li><i>iii) Mitigatory measures for climate changes</i></li> </ul>	<p>Climate prediction is needed for planning and decision making to minimize the vulnerability to climatic change and variability. Need data as input for modeling and further refining of models Already available knowledge (globally) can be used for the adaptation to climate changes by downscaling and incorporating local factors Mitigatory measures are needed to reduce vulnerability to the climate change</p>
<p><b>2) Environment and climate change related disasters - natural and manmade</b></p> <ul style="list-style-type: none"> <li><i>i) Assessment and monitoring of environment related disasters</i></li> <li><i>ii) Development of adaptation measures</i></li> <li><i>iii) Development of appropriate mitigatory measures</i></li> </ul>	<p>It is necessary to assess and monitor environment related disasters for saving life and natural resources and reduce burden on national economy</p>
<p><b>3) Bio diversity</b></p> <ul style="list-style-type: none"> <li><i>i) Threats and issues related to biodiversity</i></li> <li><i>ii) Mitigatory measures to control and minimize development induced impacts</i></li> <li><i>iii) Conservation of bio diversity and sustainable use</i></li> <li><i>iv) Rehabilitation of degraded ecosystem</i></li> </ul>	<p>It is necessary to understand threats and issues related to biodiversity in order to reduce their impacts. Biodiversity can be used in sustainable manner to reap economic benefits.</p>
<p><b>4) Pollution prevention and control</b></p> <ul style="list-style-type: none"> <li><i>i) Waste management</i></li> <li><i>ii) Prevention of air pollution, noise pollution and visual pollution</i></li> <li><i>iii) Prevent oil spills</i></li> </ul>	<p>It is necessary to minimize pollution and conserve the environment to assure healthy lives for the people. Pollution prevention measures are necessary to protect the environment</p>
<p><b>5) Environment sustainable technologies</b></p>	<p>To conserve environment for sustainable development of the country</p>

**Table 2: Issues/Problems, R&D Needs and Relevant Interventions**

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
<p><b>1) Climate change mitigation and adaptation</b></p> <p>i) <i>Climate prediction (seasonal and long range) &amp; future projections for Sri Lanka</i></p> <p>ii) <i>Adaptations to climate changes</i></p> <p>iii) <i>Mitigatory measures for Climate Changes</i></p>	<p>I) Insufficiency of accurate seasonal and long range climate prediction</p> <p>II) Lack of appropriate downscaling tools for local environment</p>	<p>i) Promote accurate seasonal &amp; long term climate predictions.</p> <p>ii) Develop proper downscaling tools for local environment</p> <p>iii) Downscaling GCM Model</p> <p>iv) Establishing permanent monitoring plots in each bio climatic zones</p>	<p><b>Pure and Applied Research</b></p> <p>a) Adaptation of existing methodologies for climate prediction</p> <p><b>Information and Communication Technologies</b></p> <p>a) Development of a database for climate data</p> <p><b>Capacity Building</b></p> <p>a) Train individuals for accurate climate prediction and natural and man-made disaster management</p> <p><b>Pure and Applied Research</b></p> <p>a) Create new models and downscale existing models for climate change predictions</p> <p><b>Information and Communication Technologies</b></p> <p>a) Establish a database of sea level rise, shoreline retreat, salinity, acidity and temperature based on regularly collected data</p>
	<p>III) Inappropriate adaptation methods</p>	<p>i) Carry out R&amp;D to find out appropriate and sustainable adaptation measures</p>	<p><b>Pure and Applied Research</b></p> <p>a) Develop suitable adaptation measures for climate changes</p> <p><b>Popularization</b></p> <p>a) Create awareness among people on adaptation measures</p>
	<p>IV) Lack of mitigatory measures for climate changes</p>	<p>i) Identification of the relevant mitigatory measures to minimize the climate changes and the impacts of climate changes</p>	<p><b>Policy Studies</b></p> <p>a) Develop proper policy for mitigation of adverse effects of climate change</p> <p><b>Popularization</b></p> <p>a) Create awareness among people on mitigation</p>

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
<p><b>2) Environment and climate change related disasters (natural and manmade)</b></p> <p><i>i) Assessment and monitoring of environment related disasters</i></p> <p><i>ii) Development of adaptation measures</i></p> <p><i>iii) Development of appropriate mitigatory measures</i></p>	<p>I) Non-use of available information on disasters</p> <p>II) Lack of appropriate technologies for adaptation measures, trained human resources, equipment, financial resources and awareness of all stakeholders</p>	<p>i) Updating existing information and develop effective communication tools</p> <p>i) Minimize and control disasters such as flood, landslides, drought and other weather related disasters.</p> <p>ii) Develop appropriate technologies to reduce the impacts of natural and manmade disasters</p>	<p><b>Information and Communication Technologies</b></p> <p>a) Development of a database of available information</p> <p><b>Policy Studies</b></p> <p>a) Develop policies for disaster management</p> <p><b>Pure and Applied Research</b></p> <p>a) Identification and development of adaptation technologies for disaster management</p> <p>b) Map disaster-prone areas</p> <p><b>Innovations</b></p> <p>a) Adopt appropriately existing technologies for disaster management (e.g. Rainwater harvesting technology as a preparatory measure for drought)</p> <p><b>Capacity Building</b></p> <p>a) Train individuals for accurate climate prediction and natural and man-made disaster management</p> <p><b>Popularization</b></p> <p>a) Conduct awareness programs on disaster preparedness for all stakeholders including people prone to natural disasters</p> <p>b)</p>
<p><b>3) Biodiversity</b></p> <p><i>i) Threats and issues related to biodiversity</i></p>	<p>I) Threats due to climate change, land degradation, pollution, deforestation, fragmentation, invasive species and urbanization</p>	<p>i) Identify and assess development induced impacts on bio diversity and propose mitigatory measures</p> <p>ii) Asses impact of climate change,</p>	<p><b>Pure and Applied Research</b></p> <p>a) Research on adverse effects on biodiversity due to climate change, pollution etc.</p> <p>b) Develop methods of landscaping to enhance urban bio diversity</p>

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
<p>ii) <i>Mitigatory measures to control and minimize development induced impacts</i></p> <p>iii) <i>Conservation of bio diversity and sustainable use</i></p> <p>iv) <i>Rehabilitation of degraded ecosystems</i></p>		<p>pollution and urban development on biodiversity</p> <p>iii) Mitigate the effects on fragmented natural habitats</p> <p>iv) Carry out R&amp;D on marine, coastal and terrestrial (including inland water) invasive species and develop methodologies to control them</p> <p>v) Identification of impacts of climate change on migratory species</p> <p>v) Carry out research on threatened/vulnerable species leading to development of conservation plans</p>	<p>c) Research on quantification of the exploitation level of bio diversity</p> <p>d) Quantitative research on visitor and ecological carrying capacity of protected areas</p> <p>e) Development of a computerized model to assess impacts of climate change on bio diversity</p> <p><b>Popularization</b></p> <p>a) Create awareness among general public on threats to biodiversity due to pollution, deforestation and invasive species</p>

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
<b>Biodiversity (contd.)</b>	II) Inadequate environmental concerns of development interventions	i) Revisit existing policies and develop required new regulations  ii) Identify and assess development induced impacts on biodiversity  iii) Develop mitigatory measures to reduce impacts of development including, alternative technologies	<b>Policy Studies</b> a) Develop policies and regulations to mitigate impacts of development projects on the environment  b) Carry out survey to identify lapses in implementation of existing regulatory measures  <b>Pure and Applied Research</b> a) Research on environmental impacts of development projects.  b) Carry out research to provide evidence based recommendations to take effective decisions on development projects (e.g. impact of wind power plants on birds etc.)  <b>Innovations</b> a) Innovate mitigatory measures to reduce impact of development on biodiversity
	III) Lack of awareness on social issues related to threats on bio diversity	i) Conduct surveys to assess social issues related to threats on biodiversity and extent of its public awareness  ii) Develop effective communication strategies to create awareness	<b>Pure and Applied Research</b> a) Surveys on social aspects related to threats on biodiversity  <b>Popularization</b> a) Conduct public awareness programs
	IV) Non-compliance and inadequate provisions in regulatory environment	i) Minimize human-wildlife conflict such as elephants, monkeys etc.  ii) Develop monitoring mechanism for effective	<b>Policy Studies</b> a) Develop policies and regulations to minimize human-wild life conflict  b) Investigate the level of compliance by development projects to the regulatory
<b>Biodiversity (contd)</b>			

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
Biodiversity (contd.)		compliances	environment imposed by relevant authorities
	V) Lack of awareness and interest of decision makers and general public on benefits of biodiversity	i) Develop effective communication tools to enhance the awareness	<b>Pure and Applied Research</b> a) Conduct a survey on awareness and attitudes related to biodiversity  <b>Popularization</b> a) Conduct awareness programs among decision makers
	VI) Lack of awareness on potential benefits of bio diversity , scale of usage, sustainability	i) Inventorying of bio diversity of Sri Lanka  ii) Carry out studies on potential benefits of bio diversity for sustainable economic uses  iii) Promote research on eco-system services management  iv) Update national conservation review  v) R&D for ex-situ propagation and cultivation of commercially important flora and fauna  vi) Identify plant species that can be used for value added industry	<b>Policy Studies</b> a) Develop policies for sustainable use of bio diversity  b) Develop benefits sharing mechanisms for sustainable use of bio diversity  c) Develop policy for conservation and sustainable use of medicinal plants  <b>Pure and Applied Research</b> a) Sustainable use of biodiversity and eco-system services  b) Bio indicators of pollution  c) Species that can be used for eco-system restoration  d) Identify, protect and propagate threatened species  e) The level of bio accumulation of toxic matters  f) Agro- biodiversity to exploit and enhance potential benefits



Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
			<p>g) Medicinal plants</p> <p>h) Commercial importance of flora and fauna</p> <p><b>Indigenous knowledge &amp; Intellectual Property Rights</b></p> <p>a) Promote Indigenous knowledge based biodiversity conservation and management</p> <p><b>Popularization</b></p> <p>a) Conduct awareness programs/campaigns for relevant authorities and industries on sustainable use and benefits of biodiversity and medicinal plants</p>
	vii) Degrading Eco-systems due to un-planned development processes and climate change	i) Identify problems associated with degrading eco-systems	<p><b>Policy Studies</b></p> <p>a) Formulate proper policies/regulations to protect eco-systems from the impacts of development processes</p> <p><b>Pure and Applied Research</b></p> <p>a) Causes and magnitude of degrading of eco-systems</p> <p>b) Find out methods of mitigation/restoration</p>
<p><b>4) Pollution prevention and control</b></p> <p><i>i) Waste management</i></p>	l) Unplanned urbanization and industrialization	i) Investigation and revisiting of existing policies	<p><b>Policy Studies</b></p> <p>a) Formulation of new policies to regulate unplanned urbanization and industrialization</p>

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<p><i>ii) Prevention of air pollution, noise pollution and visual pollution</i></p> <p><i>iii) Prevent oil spills</i></p>			<p>b) Develop strategies to implement policies effectively</p> <p><b>Pure and Applied Research</b></p> <p>a) Research on pollution due to urbanization and industrialization</p>
	<p>II) Unavailability of proper disposal methods and sites for solid waste</p>	<p>i) Create awareness on solid waste management</p> <p>ii) Develop resource recovering technologies for non-biodegradable waste</p>	<p><b>Pure and Applied Research</b></p> <p>a) Generating national solid waste management profile</p> <p>b) Research on non-biodegradable waste</p> <p><b>Innovation</b></p> <p>a) Develop technologies for utilization of biodegradable waste</p> <p>b) Technologies for biogas generation</p> <p>c) Technologies for resource recovery from non-bio degradable waste</p> <p><b>Popularization</b></p> <p>a) Create awareness on proper solid waste disposal, compost preparation, utilization of bio degradable waste</p>
	<p>III) Health issues, soil contamination and coastal pollution due to sewage sludge</p>	<p>i) Development of environment friendly sewage/ sludge/seepage management technologies</p>	<p><b>Innovation</b></p> <p>a) Develop environment friendly sewage/sludge management techniques</p>

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
<b>Pollution prevention and control (contd.)</b>	IV) Inadequate capacity and facilities to manage clinical waste	i) Find out clinical waste management practices used by hospitals and diagnostic laboratories  ii) Identify different cost effective technologies for specific clinical waste  iii) Monitoring of laboratory chemical and clinical waste disposal	<b>Policy Studies</b> a) Develop policies for clinical waste management  <b>Pure and Applied Research</b> a) Island wide survey to identify clinical waste management practices used by hospitals and diagnostic laboratories  <b>Innovations</b> a) Development of cost effective technologies for clinical waste management  <b>Testing, Standardization &amp; Accreditation</b> a) Pay special attention to clinical waste management when accrediting diagnostic laboratories  <b>Popularization</b> a) Awareness campaigns for relevant stakeholders on clinical waste management
<b>Pollution prevention and</b>	V) Sedimentation and eutrophication in inland tanks/ water bodies due to soil erosion, heavy rain and flash floods	i) Develop innovative technologies to prevent soil erosion and to minimize sedimentation and eutrophication in water tanks	<b>Pure and Applied Research</b> a) Research to identify and promote plant species with special reference to economic values that can be used to minimize sedimentation (e.g. <i>Pandanus</i> )  <b>Innovation</b> a) Develop technologies to prevent sedimentation and eutrophication

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
<b>control (contd.)</b>	VI) Lack of effective and efficient methodologies for effluent/emission/industry and domestic waste management	<ul style="list-style-type: none"> <li>i) Investigate the feasibility of developing central waste treatment facilities</li> <li>ii) Develop models to predict water pollution qualitatively and quantitatively that occur from new industrial plants</li> </ul>	<p><b>Pure and Applied Research</b></p> <ul style="list-style-type: none"> <li>a) Assess assimilation capacity of waste in the environment</li> <li>b) Assess industrial waste load in water bodies</li> <li>c) Develop models to predict pollution levels</li> </ul> <p><b>Innovations</b></p> <ul style="list-style-type: none"> <li>a) Develop low cost waste treatment methods for industries</li> <li>b) Develop affordable central waste treatment facilities</li> <li>c) Develop low cost ground water treatment methods</li> </ul> <p><b>Information and Communication Technologies</b></p> <p><b>Capacity Building</b></p> <ul style="list-style-type: none"> <li>a) Train individuals for treatment of industrial &amp; domestic waste and hazardous waste management</li> </ul>
<b>Pollution prevention and control (contd.)</b>	VII) Inadequate technologies, facilities, trained HR to manage e-waste and nuclear waste	<ul style="list-style-type: none"> <li>i) Low cost waste management methods for e-waste and nuclear waste</li> </ul>	<p><b>Policy Studies</b></p> <ul style="list-style-type: none"> <li>a) Review and upgrade Policies to manage hazardous waste</li> </ul> <p><b>Innovations</b></p> <ul style="list-style-type: none"> <li>a) Low cost waste treatment methods</li> <li>b) Development and implementation of recycling methodologies</li> <li>c) Technologies for hazardous waste management</li> </ul>

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
<p><b>Pollution prevention and control (contd.)</b></p>			<p><b>Capacity Building</b></p> <p>a) Train individuals for treatment of industrial and domestic waste and hazardous waste management</p>
	<p>VIII) Lack of awareness and attitudinal constraints on e-waste and nuclear waste</p>	<p>i) Create awareness</p> <p>ii) Identify international conventions on nuclear waste management and policies that need to be implemented in Sri Lanka</p>	<p><b>Capacity Building</b></p> <p>a) Conducting awareness programs for e-waste collectors on hazardous effects of e-waste</p> <p><b>Popularization</b></p> <p>a) Create awareness on hazardous waste</p>

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
<p>Pollution prevention and control (contd.)</p>	<p>IX) Air pollution due to urbanization and industrialization</p>	<p>i) Monitoring of air pollution levels in large cities and areas near industrial zones</p> <p>ii) Assess and find methods to mitigate transboundary pollutant issues</p> <p>iii) Prevention of possible adverse air pollution situations such as formation of smog</p>	<p><b>Policy Studies</b></p> <p>a) Develop policies to control air and noise pollution and to mitigate transboundary pollution, paying due attention to international treaties</p> <p>b) Develop policies to prevent adverse air pollution leading to formation of smog</p> <p>c) Develop regulations on air and noise pollution for industrial zones</p> <p><b>Pure and Applied Research</b></p> <p>a) Research on effects of air pollution and noise pollution on human health</p> <p>b) Survey on pollution levels</p> <p>c) Assess the levels of transboundary pollution and identify methods to mitigate</p> <p>d) Research on low cost emission treatment methods</p> <p>e) Review studies on available knowledge on formation of smog and its hazardous effects</p> <p>f) Develop models to predict &amp; illustrate air pollution and noise pollution</p> <p><b>Testing, Standardization &amp; Accreditation</b></p> <p>a) Accredite emission treatment processes</p> <p><b>Popularization</b></p> <p>a) Create awareness on air pollution and noise pollution (origin, impacts, mitigation, regulations etc.)</p>

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
	X) Sound and noise pollution due to urbanization and industrialization	i) Conducting R&D on sound & noise pollution, and related health problems	<p><b>Pure and Applied Research</b></p> <p>a) Research on effects of sound and noise on human health</p> <p><b>Popularization</b></p> <p>a) Create awareness on effects of sound &amp; noise pollution and safety measures</p>
	XI) Visual pollution that occurs due to unplanned urbanization and inadequate regulations	i) Reduce the visual pollution induced by urbanization	<p><b>Policy Studies</b></p> <p>a) Develop appropriate policies and regulations to minimize visual pollution in urban areas</p> <p><b>Pure and Applied Research</b></p> <p>a) Research on health issues related to visual pollution</p> <p>b) Behavioral changes of human beings due to visual pollution</p> <p><b>Popularization</b></p> <p>a) Create awareness on visual pollution</p>
	XII) Lack of technologies and capacity to deal with large scale oil spills	i) Efficient removal of oil spills and develop scientific models for assessing damages	<p><b>Policy Studies</b></p> <p>a) Formulate policies that promote adoption of international regulations related to oil spills</p> <p><b>Pure and Applied Research</b></p> <p>a) Develop technologies to remove oil spills</p> <p>b) Develop models to illustrate and assess damages of oil spills</p> <p><b>Capacity Building</b></p> <p>a) Train people to remove oil spills</p>

Sub Areas	Issues/Problems	Research and Development Needs	Relevant Interventions
<b>5) Environment sustainable technologies</b>	l) Lack of awareness, resources, attitudes and regulations	i) Development of green technologies	<p><b>Innovations</b></p> <p>a) Develop environment sustainable technologies/products</p> <p><b>Testing, Standardization &amp; Accreditation</b></p> <p>a) Accredit the processes of development of environmental sustainable products</p> <p><b>Popularization</b></p> <p>a) Create awareness on environment sustainable technologies</p>