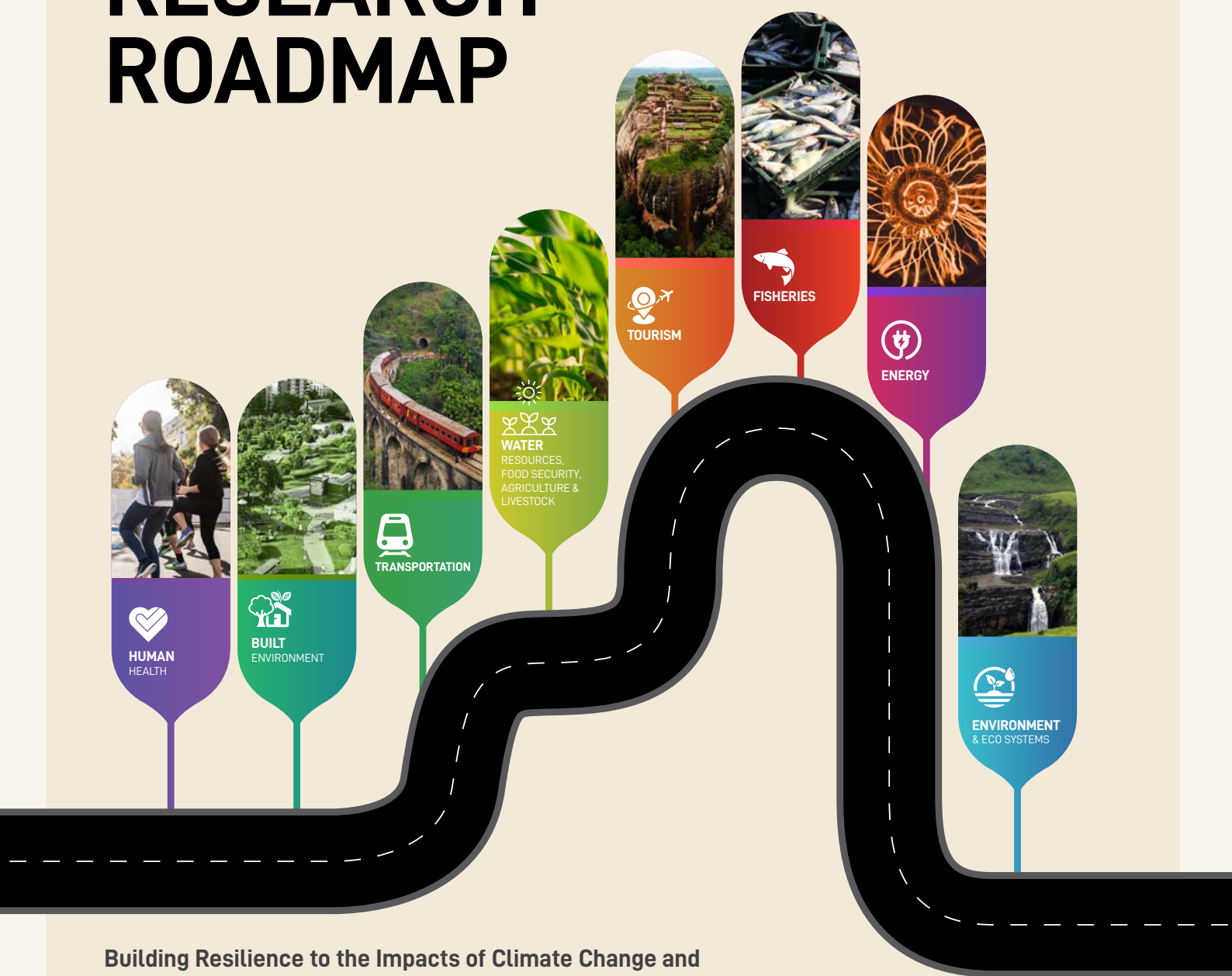




CCADRR

Research Training Network on Tackling Climate Change as an Underlying Disaster Risk Driver (CCA-DRR)

RESEARCH ROADMAP



Building Resilience to the Impacts of Climate Change and Other Disaster Risks in Sri Lanka

Edited by

Prof. Nishara Fernando
Prof. Lalith Rajapakse

University of
HUDDERSFIELD
Inspiring global professionals

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Research Roadmap on Building Resilience to the Impacts of Climate Change and Other Disaster Risks in Sri Lanka



Research Training Network on
Tackling Climate Change as an Underlying Disaster Risk Driver (CCA-DRR)

July 2023

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RESEARCH ROADMAP

SCHEMATIC REPRESENTATION



Research Training Network
on Tackling Climate Change
as an Underlying Disaster
Risk Driver (CCA-DRR)



**HUMAN
HEALTH**



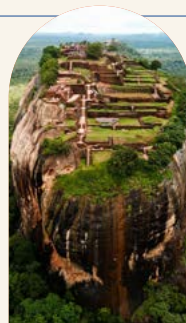
**BUILT
ENVIRONMENT**



TRANSPORTATION



**WATER
RESOURCES,
FOOD SECURITY,
AGRICULTURE &
LIVESTOCK**



TOURISM



FISHERIES



ENERGY



**ENVIRONMENT
& ECO SYSTEMS**

1. INTRODUCTION

1.1. Research Training Network on Tackling Climate Change as an Underlying Disaster Risk Driver (CCA-DRR)

Climate change increases disaster risk by altering the frequency and intensity of hazard events, affecting vulnerability to hazards, and changing exposure patterns. Countries such as Sri Lanka have experienced these impacts of climate change, including an increase in extreme weather related events such as cyclones, droughts, monsoonal rain, and subsequent flooding and landslides. Despite increasing recognition of their links, Disaster Risk Reduction (DRR) and climate change adaptation (CCA) have largely remained distinct and independent in research and policy communities. In order to rectify this, the UN Sendai Framework for DRR 2015–2030 laid out a pathway for DRR that has been adopted by 187 countries, and emphasises that "more dedicated action needs to be focused on tackling underlying disaster risk drivers, such as the consequences of climate change".

This Network on CCA-DRR convened and led by the University of Huddersfield's award-winning Global Disaster Resilience Centre (GDRC), which brought together a bi-lateral cohort of UK and Sri Lankan scientists to build capacities that can help to better integrate CCA and DRR. The Network aimed to advance the dialogue between the CCA and DRR communities by investigating differences, overlaps and potential synergies between the two realms. It aimed to achieve this through a structured training programme that drew together international expertise and diverse disciplinary perspectives. Through a series of seminars, workshops, symposiums, and field trips, participants were equipped with comprehensive knowledge, practical skills, and interdisciplinary insights to effectively address and mitigate the impacts of climate-related disasters while bridging the identified gaps. The aim of this Roadmap is to provide a clear and strategic plan to advance climate change adaptation and disaster risk reduction efforts by addressing the current status quo and thereby identifying existing gaps.

1.2. DRR and Climate Change Nexus

Climate Change is one of the key challenges that human beings experience at present, affecting every dimension of human life, irrespective of geographical orientation. Human Health, Built Environment, Transportation, Water resources-Food security-Agriculture and Livestock, Tourism, Fisheries, Energy, and Environment/Ecosystems sectors significantly impact climate change through their contribution to greenhouse gas emissions, accounting for a major fraction of global energy-related CO₂ emissions relating to fossil fuel burning, material extraction and construction, and infrastructure operations including heating, cooling, lighting, etc. These changes in turn are impacting the habitability of places and the ability to sustain livelihoods, consequently resulting in people becoming more likely to move (migrate, relocate) to improve their circumstances and sustain and protect their livelihoods [1],[2].

The impact of climate change further complicates the lives of vulnerable communities. Governments around the world adopt various disaster risk reduction measures to counter the effects of climate change, especially the cascading impacts of global sea level rise (SLR). These Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) measures include building adaptation structures and relocating affected communities, etc.[3].

-
- 1 Tacoli, C. (2009). Crisis or adaptation? Migration and climate change in a context of high mobility. *Environment and Urbanization*, 21(2), 513-525.
 - 2 Warner, K. & Afifi, T. (2014). Where the rain falls: Evidence from 8 countries on how vulnerable households use migration to manage the risk of rainfall variability and food insecurity, *Climate and Development*, 6:1, 1-17, DOI: 10.1080/17565529.2013.835707
 - 3 Kwadijk, J. C., Haasnoot, M., Mulder, J. P., Hoogvliet, M. M., Jeuken, A. B., van der Krogt, R. A., & de Wit, M. J. (2010). Using adaptation tipping points to prepare for climate change and sea level rise: a case study in the Netherlands. *Wiley interdisciplinary reviews: Climate Change*, 1(5), 729-740.

1.3. International Frameworks for DRR and Climate Change

Disaster risk reduction is a critical global concern as climate change and natural hazards increasingly threaten human societies and the environment. In response to these challenges, the international community has established several key frameworks to address disaster risk reduction comprehensively. This section briefly discusses and compares three significant international frameworks: the Sendai Framework for Disaster Risk Reduction, the Paris Agreement, and the Sustainable Development Goals (SDGs). By examining their key elements and significance, one can understand how these frameworks contribute to building resilience and promoting sustainable development in the face of escalating disaster risks.

The Sendai Framework for Disaster Risk Reduction

The Sendai Framework, adopted at the Third UN World Conference on Disaster Risk Reduction in 2015^[4], outlines a comprehensive strategy to reduce disaster risk and enhance resilience at global, regional, national, and local levels.

The key elements of the Sendai Framework for Disaster Risk Reduction encompass prioritization of disaster risk reduction through integration into policies, plans, and development initiatives at all levels, aiming to achieve sustainable outcomes.

It further revolves around four essential priority areas, namely, (a) understanding disaster risk, (b) strengthening disaster risk governance, (c) investing in disaster risk reduction for resilience, and (d) enhancing disaster preparedness for effective response and recovery. These components underscore the framework's comprehensive approach to fostering proactive disaster risk management and building resilience against the adverse impacts of natural hazards.

The Sendai Framework marks a paradigm shift from response-centric approaches to a proactive focus on prevention and preparedness. By prioritizing disaster risk reduction and integrating it into development plans, the framework seeks to save lives, protect livelihoods, and reduce economic losses caused by disasters. Its emphasis on evidence-based decision-making and the involvement of multiple stakeholders ensures a holistic approach to disaster risk reduction.

4 UNDRR (2015). Sendai Framework for Disaster Risk Reduction 2015-2030. Retrieved from <https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030>

The Paris Agreement

The Paris Agreement, adopted in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC), aims to limit global warming to well below 2 degrees Celsius above pre-industrial levels, with efforts to limit it to 1.5 degrees Celsius [5].

Under the Paris Agreement, each country is mandated to submit Nationally Determined Contributions (NDCs) outlining their specific climate action plans, which encompass emission reduction targets and adaptation measures. Additionally, the agreement sets up a mechanism for conducting periodic global stocktakes to assess the collective progress made towards achieving the long-term goals and to enhance climate action on a global scale. Moreover, the agreement places a strong emphasis on the responsibility of developed countries to extend financial support to assist developing nations in adapting to climate change and facilitating their transition towards low-carbon, climate-resilient economies.

The agreement represents a landmark effort to address climate change on a global scale. By fostering international cooperation and commitment, the agreement aims to mitigate climate-related disasters, such as extreme weather events, sea-level rise, and disruptions to ecosystems. Its emphasis on financial assistance to developing countries acknowledges the disproportionate impact of climate change on vulnerable nations and promotes equitable resilience-building efforts.

The Sustainable Development Goals (SDGs)

The Sustainable Development Goals, adopted by all United Nations Member States in 2015, constitute a universal call of action to end poverty, protect the planet, and ensure prosperity for all [6]. Out of the 17 goals, several are directly related to climate change and disaster risk reduction:

- **Goal 1: No Poverty** - By eradicating poverty, vulnerable communities become more resilient to disasters.
- **Goal 11: Sustainable Cities and Communities** - This goal promotes inclusive, safe, and resilient cities, fostering disaster resilience at the local level.
- **Goal 13: Climate Action** - Addressing climate change is central to reducing disaster risks and promoting sustainable development.

The SDGs provide a comprehensive framework that integrates disaster risk reduction with broader development objectives. By addressing root causes of vulnerabilities such as poverty and inadequate infrastructure, the SDGs help build long-term resilience to disasters⁶. The interconnected nature of the goals encourages collaboration among stakeholders, fostering a holistic approach to disaster risk reduction and sustainable development.

The Sendai Framework, the Paris Agreement, and the Sustainable Development Goals bring unique elements and approaches to the table, yet they share a common objective: to build resilience, protect communities, and promote sustainable development in the face of escalating disaster risks.

1.4. Climate Change and DRR in Sri Lanka

Sri Lanka experiences impacts of climate change, including slow onset climate hazards such as sea level rise, extreme weather conditions such as droughts as well as the rapid onset climate events such as floods and landslides. Data from the Household & Income Expenditure Survey reveals that, in 2016, one in every 11 households (HHs) were affected by natural hazards in Sri Lanka. In 2016, HHs were mainly affected by heavy rain and related flash floods, wild animal attacks and extended dry periods without rainfall. Similarly, landslides,

5 UNFCCC (2015). The Paris Agreement. Retrieved from <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

6 United Nations (n.d.). Sustainable Development Goals. Retrieved from <https://sdgs.un.org/goals>

heavy winds, as well as changed monsoon patterns, wind speed and directions have caused most climate and environment-related human mobility in Sri Lanka^[7].

As for economic losses due to disasters, Sri Lanka was among the three (3) most affected countries in the 2017 estimates in terms of weather-related loss events, ranking second (2) highest on the Climate Risk Index which measures fatalities and economic losses occurring because of extreme weather^[8]. Economic losses following the 2017 flooding increased by 50% when compared to the previous decade between 2007 and 2016.

1.5. Research Roadmap

Against this backdrop, this report presents a Research Roadmap for building resilience to climate change by targeting disaster risk reduction in Sri Lanka. The report was developed by twenty-four academics representing different disciplines from eight national universities in Sri Lanka under the CCA-DRR research training network.

The main objective of the roadmap is to outline a research agenda which will guide the development of specific research projects to be conducted by academics, applied researchers and others both within and across disciplines, to provide answers to vital scientific questions, reduce scientific uncertainties, and provide a sound scientific foundation for future policy development to increase societal resilience while minimizing community vulnerabilities. In this context, the Road Map is structured around 8 sectors: Human Health; Built Environment; Transportation; Water Resources; Food Security, Agriculture and Livestock; Tourism; Fisheries; Energy, and Environment/Ecosystems.

This roadmap will also help to properly coordinate with various institutions, agencies, departments, the private sector, and civil society, in disaster risk management and climate change adaptation in the short and long-term perspectives.

7 IOM,WFP,FAO (2018). Rapid Assessment Report: Understanding Migration Trends from Climate Change Affected Districts in Sri Lanka. Colombo: WFP, IOM, FAO.

8 Eckstein, D., Hutfils, M.-L. & Winges, M. (2019). GLOBAL CLIMATE RISK INDEX 2019 Who Suffers Most From Extreme Weather Events? Weather-related Loss Events in 2017 and 1998 to 2017, Berlin: Germanwatch.



HUMAN
HEALTH

1

2. POLICY DRIVERS, SECTOR SNAPSHOT AND KEY RESEARCH DRIVERS

The development of the CCA-DRR Roadmap involved a meticulous and comprehensive approach by focusing on identifying essential elements for effective policy formulation and strategic implementation. Through a systematic analysis of policy drivers, a thorough sector snapshot, and the identification of key research drivers, the roadmap provides a holistic framework to address the intricate interplay between climate change adaptation and disaster risk reduction in Sri Lanka. This approach ensures a well-informed and well-rounded strategy to enhance resilience and sustainability in the face of evolving climate challenges.

These aspects are discussed by focusing on selected major contributory sectors as follows.

SECTOR 1: HUMAN HEALTH

The Human Health sector plays a crucial role in the comprehensive CCA-DRR roadmap by contributing to the overall resilience of Sri Lanka. By integrating health-focused strategies and leveraging medical expertise, the sector enhances disaster preparedness, response, and recovery, ensuring the well-being of communities in the face of climate-related challenges.

Introduction/Guiding Principles/Objectives

Climate change associated extreme weather events and biological hazards impose a serious threat to the physical and mental health of people and the public health system of the country.

Hazards	Problems	Gaps
Climate change associated extreme weather events and biological hazards	<ul style="list-style-type: none"> Increasing heat-related illnesses (increasing non-communicable diseases, strokes, cardiovascular diseases, diabetes, respiratory illnesses) Disease outbreaks - Vector-borne diseases, Water borne diseases. Malnutrition among vulnerable communities Mental health-related illnesses among vulnerable communities Health infrastructure vulnerability 	<ul style="list-style-type: none"> Systemic limitations when integrating climate-change-induced illnesses into the public health system. Lack of effective mechanisms and cohesive programs to control and monitor vector-borne diseases. Lack of knowledge and awareness among communities, healthcare providers and policymakers on climate change-related health impacts Lack of access to water and sanitation infrastructure among vulnerable communities.

Salient Research Questions

1. Is the public health system capable of handling extreme weather events and what mechanisms are used when integrating vulnerable communities?
2. Are vulnerable communities knowledgeable about the impacts of extreme weather events and what are their adaptations measures?
3. Are cities provided with optimum urban amenities to reduce disease outbreaks among vulnerable communities?

Mapping to SENDAI Framework

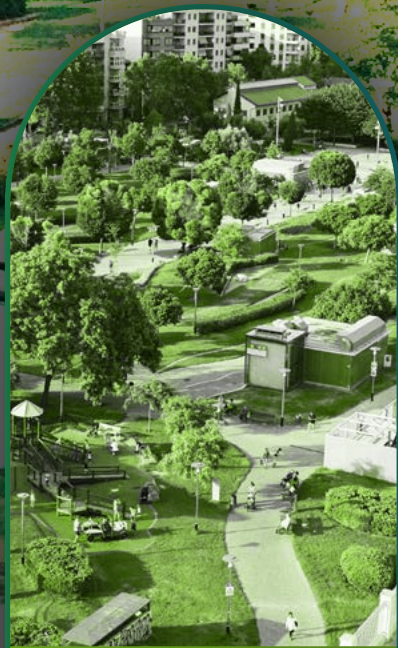
Priorities one and two are focussed.

Major Policy Drivers

Streamlining/improving policies, rules & regulations on public health by incorporating DRR and CCA related policies/guidelines.

Cross-cutting Themes

Vulnerable populations, community resilience, gender and social inclusion, preparedness and response training, and research and data collection.



2

**BUILT
ENVIRONMENT**

SECTOR 2: BUILT ENVIRONMENT

The Built Environment sector stands as a cornerstone in the holistic CCA-DRR roadmap, shaping Sri Lanka's resilience by fostering sustainable urban planning, resilient infrastructure, and disaster-resistant construction practices. Through innovative design and strategic development, this sector fortifies communities, mitigating vulnerabilities and enhancing adaptability in the face of climate-induced threats.

Introduction/Guiding Principles/Objectives

The Built Environment plays a critical role in climate change adaptation and disaster risk reduction. Sustainable construction, resilient infrastructure, and effective risk management are vital to create resilient communities in the face of a changing climate.

Hazard	Problems	Gaps
Floods/ Landslides	<ul style="list-style-type: none"> Traditional construction practices and operations intensify emissions, floods, and landslides while lacking resilience in vulnerable areas. 	<ul style="list-style-type: none"> Design and construction practices lack material optimization, circularity, and digitization for sustainability. Socially acceptable sourcing, labour considerations, and reliable data are overlooked.
Droughts	<ul style="list-style-type: none"> Unsustainable building practices intensify droughts, heat stress, and energy consumption, while also depleting water resources. 	<ul style="list-style-type: none"> Inadequate socio-cultural integration, community participation, and capacity building. Outdated policies and guidelines impede sustainable and resilient practices. Insufficient financing and data management policies.
Biological hazards	<ul style="list-style-type: none"> The built environment lacks pandemic adaptation and user-centric design. It is crucial to create healthy living spaces for human well-being, with over 90% of people spending their time indoors. 	<ul style="list-style-type: none"> Adaptive reuse of buildings is overlooked, and well-being in the built environment is not sufficiently established. Concerns about labourer health in unregulated construction sites. The built environment lacks optimized human health adaptation.
Coastal Hazards	<ul style="list-style-type: none"> Building regulations overlook the environmental and socio-cultural sensitivities of coastal environments, neglecting their biological and aesthetic significance. This applies to various contexts, including coastal and hill-country regions, where form and materiality should be considered. 	<ul style="list-style-type: none"> Outdated policies lack architectural recommendations for environmental and sociological concerns. Limited stakeholder participation leads to communication gaps. Integration between the built and natural environment is inadequate.

Salient Research Questions

1. Understanding disaster risk posed by the built environment: The role of the built environment in aggravating climate change and associated disaster risks (Prevention of built-environment induced disasters). SENDAI 1 & 3 [Timeline (2023-2026) – 3 years]
2. Governance and policy: Identifying and evaluating gaps in existing governance practices, policies and guidelines and recommending updates/ upgrades. SENDAI 2 [Timeline (2023-2028) – 3 to 5 years]
3. "Build back better": Adaptive reuse through smart and connected building products and socio-cultural integration. SENDAI 4 [Timeline (2023-2030) – 7 years]

Mapping to SENDAI Framework

Priorities 1 and 3, 2, and 4 are focussed, respectively.

Major Policy Drivers

Streamlining/improving policies, rules and regulations on Built Environment, Land Use Planning, Construction Practices, etc., by incorporating DRR-CCA related policies/ guidelines

Cross-cutting Themes

Sustainable construction practices, local community engagement, ecosystem-based solutions, accessible and inclusive design, public-private partnerships, capacity building and education



3

TRANSPORTATION

SECTOR 3: TRANSPORTATION

The Transportation sector assumes a pivotal role in the comprehensive CCA-DRR roadmap, bolstering Sri Lanka's resilience through efficient mobility solutions and robust infrastructure. By integrating climate-responsive transportation planning, the sector ensures swift disaster response, enhances accessibility to critical services, and strengthens the nation's ability to adapt and withstand changing environmental conditions.

Introduction/Guiding Principles/Objectives

Floods/landslides, biological hazards and air pollution are directly connected to the transportation sector and worsen the disaster effects on the public.

Hazards	Problems	Gaps
Flood/ Landslides	<ul style="list-style-type: none"> Disruption to connectivity: Disruption of connectivity of road and railway networks (short term) affecting the transportation of essential goods, food security, ability to reach healthcare facilities and essential services; Damages to road and railway networks that cause disruptions to transportation immediately after the damage and during repair/reconstruction (mid and long term). 	<ul style="list-style-type: none"> Dearth of knowledge on available alternative transport mechanisms to ensure continuity of services. Potential risk to human health and livelihood (prioritizing DRR actions) and estimation/ prediction of loss (human/ financial).
Biological hazards	<ul style="list-style-type: none"> Epidemic-related problems and social injustice: Difficulties faced by transportation providers complying with health guidelines and restrictions, financial losses when adhering to health guidelines; Limited affordable transportation options during an epidemic that create social injustice, especially for those with limited mobility options. 	<ul style="list-style-type: none"> Government policies/ rules and regulations on transportation under epidemics. Spreading of diseases due to the use of public transport modes and the ineffectiveness of health guidelines.
Air pollution	<ul style="list-style-type: none"> Emission of hazardous gases from vehicles: Fuel inefficient vehicles; Traffic congestion; Road construction, repair & maintenance. 	<ul style="list-style-type: none"> Inadequacy of policies and implementation of them on emissions from the transport sector, leading to environmental pollution.

Salient Research Questions

1. How vulnerable is our transportation network to floods/landslides, and what is the estimation of vulnerability in terms of cost, time, health and safety, and human life?
2. How do communities respond during disasters in relation to their transportation decisions, considering factors such as individual decision-making processes, rationality, vulnerability, and the consideration of potential losses or gains?
3. To what extent do local governments and authorities maintain and enforce rules, regulations, and policies related to maintaining the quality and resilience of the transportation network?

Mapping to SENDAI Framework

Priorities 1 & 3 are focused. Understanding disaster vulnerability of Sri Lankan transportation network; Investing in disaster risk reduction for the resilience of the Sri Lankan transportation network.

Major Policy Drivers

Streamlining/improving policies, rules & regulations on infrastructure planning and development by incorporating DRR and CCA related policies/guidelines.

Cross-cutting Themes

Accessibility and inclusivity, efficient evacuation plans and emergency response, community engagement and stakeholder participation, data-driven decision-making and real-time monitoring.



WATER
RESOURCES,
FOOD SECURITY,
AGRICULTURE &
LIVESTOCK

4

SECTOR 4: WATER RESOURCES, FOOD SECURITY, AGRICULTURE AND LIVESTOCK

Water Resources, Food Security, Agriculture, and Livestock sectors form a vital cornerstone of the all-encompassing CCA-DRR roadmap, safeguarding Sri Lanka's sustenance amid climate challenges. By implementing resilient water management, sustainable farming practices, and ensuring food security, this sector bolsters communities, ensuring their well-being and stability against climate-induced adversities.

Introduction/Guiding Principles/Objectives

Climate shocks and changes in weather patterns appeared to be the decisive factor affecting agriculture and allied fields to a greater extent in Sri Lanka. Food security should ensure the rights to use and manage our lands, territories, waters, seeds, livestock and biodiversity while ensuring food sovereignty which has six pillars^[9], ^[10]; Works with nature, Focuses on food for people, Values food providers, Localizes food systems, Puts control locally, and Builds knowledge and skills. Therefore, the purpose of the road map is to: (1) Map the interrelation between climate change, food security and food systems; (2) Elaborate the ways that food sovereignty contributes to securing the rights of people and nature while also exploring agrifood activism and discourses on food security and food sovereignty; (3) Understand the extent to which these concepts are established in Sri Lankan development while determining the way forward to deal with them. Thus the concerns of major hazards linked to floods/landslides, drought, biological hazards and coastal hazards are incorporated into the present document.

Hazards	Problems	Gaps
Flood/ Landslides/ Drought/ Coastal hazards	<ul style="list-style-type: none"> Declining yield of major field and plantation crops Declining resilience to withstand stresses and diminishing lifespan of plants Accelerated soil erosion Declining quality of major crop plantations Increasing pest attacks and diseases to crops Onjuries to farm animals 	<ul style="list-style-type: none"> Potential risks to livelihood (prioritizing DRR actions) and lack of estimation of associated losses The current resilience assessment has failed to consistently comply with global research communication Inadequate resilient assessment studies and technology application in Sri Lanka Inadequate accessibility to reliable data and the dearth of research
Biological hazards	<ul style="list-style-type: none"> Pandemic situations pose a serious threat to food security and livelihoods of the people May also affect the availability of key intermediate inputs for farmers 	<ul style="list-style-type: none"> No market transparency in agriculture and food products via the provision of timely market information. Absence of clear and transparent communication Absence of reliable food supply chains Lack of preparedness for future shocks Potential risk to human health and livelihood (prioritizing DRR actions) and estimation of loss:

9 Nyeleni (2007). Nyeleni synthesis report. Selingue, Mali.

10 La Via Campesina (2018) Food sovereignty now: a guide to food sovereignty. European Coordination Via Campesina, Bruxelles, Belgium.

Salient Research Questions

1. Lack of adequate policy implementation, inadequate reliable databases, farmer education and capacity building.

Mapping to SENDAI Framework

The research questions are mapped with the SENDAI framework, CCA-DRR, Paris Agreement and SDGs. They agree with all the priorities (excluding 5) in the SENDAI framework, the objectives of CCA-DRR, all priorities in the Paris Agreement, and all goals of SDGs.

Major Policy Drivers

Streamlining and implementing existing policies to cope with issues related to climate change, improving existing databases to obtain reliable information and, upgrading education and capacity building through research and training.

Cross-cutting Themes

Sustainable water management practices, agricultural resilience, access to clean water, diversification of crops and livestock breeds, knowledge sharing and capacity building and lack of clear policies for water sharing among different stakeholders (Community, Energy, Agriculture, Forestry, Industry, etc.) during droughts and water scarce periods.



TOURISM

5

SECTOR 5: TOURISM

The country heavily depends on the Tourism sector for its economic recovery and it assumes a pivotal role in the comprehensive CCA-DRR roadmap, fostering Sri Lanka's resilience by promoting sustainable tourism practices and minimizing environmental impacts. Through responsible tourism development, this sector enhances community livelihoods, preserves natural resources, and contributes to the nation's overall adaptability and disaster resilience in a changing climate.

Introduction/Guiding Principles/Objectives:

The major sectorial problems identified under the tourism sector include vulnerability to natural disasters, inadequate preparedness and response, damage to tourism infrastructure, negative perception and reputation, climate change, coastal vulnerability and limited integration of disaster risk reduction into tourism planning.

Hazards	Problems	Gaps
Natural Disasters	<ul style="list-style-type: none"> Vulnerability to Natural Disasters: Sri Lanka is prone to natural disasters such as floods, landslides, cyclones, and Tsunamis. These events can disrupt tourism activities, damage infrastructure and attractions, and pose risks to the safety of tourists and local communities. Inadequate Preparedness and Response: Limited early warning systems, inadequate emergency preparedness plans specifically tailored for the tourism sector, and a need for enhanced coordination among tourism stakeholders, local authorities, and disaster management agencies. Damage to Tourism Infrastructure: The recovery and reconstruction of these assets may take time, resulting in disruptions to tourism operations and visitor flows. Negative Perception and Reputation: Rebuilding trust and restoring the image of Sri Lanka as a safe and attractive destination after a disaster is crucial. Climate Change and Coastal Vulnerability: Coastal areas, which are popular tourist destinations face risks such as erosion, saltwater intrusion, and increased vulnerability to cyclones and Tsunamis. Limited Integration of Disaster Risk Reduction into Tourism Planning: However, challenges may exist in terms of limited awareness, capacity, and coordination among tourism stakeholders regarding DRR strategies and practices. 	<ul style="list-style-type: none"> What are the specific vulnerabilities of the tourism sector in Sri Lanka to different types of disasters? What are the best practices for early warning systems, emergency protocols, evacuation plans, and coordination among tourism stakeholders and disaster management agencies? Quantification and evaluation of economic losses How to understand the long-term effects of negative perception Integrated assessment of climate change impacts on coastal tourism How can disaster risk reduction principles be integrated into sustainable tourism practices in Sri Lanka?

Salient Research Questions & Mapping with SENDAI Framework

1. What are the specific vulnerabilities of the tourism sector in Sri Lanka to different types of disasters? [Understanding Disaster Risk (Priority 1)].
2. How can preparedness and response mechanisms be strengthened specifically for the tourism sector in Sri Lanka? [Strengthening Disaster Risk Governance (Priority 2)].
3. How can disaster risk reduction principles be integrated into sustainable tourism practices in Sri Lanka? [Investing in Disaster Risk Reduction for Resilience (Priority 3)].
4. What are the best practices for early warning systems, emergency protocols, evacuation plans, and coordination among tourism stakeholders and disaster management agencies? [Enhancing Disaster Preparedness for Effective Response and to "Build Back Better" in Recovery, Rehabilitation, and Reconstruction (Priority 4)].

Major Policy Drivers

Policy Integration and Mainstreaming, rules and regulations on tourism, Climate Change Awareness and Education, Data Collection and Analysis, Risk Assessment and Vulnerability Mapping, Infrastructure Resilience, Diversification of Tourism Offerings, Community Engagement and Empowerment, Public-Private Partnerships, Insurance and Financial Mechanisms, Research and Innovation, International Collaboration.

Cross-cutting Themes

Community-based tourism for socio-economic resilience, sustainable and responsible tourism practices, risk communication and preparedness, data collection and analysis, private sector stakeholders, capacity building and training.



6

FISHERIES

SECTOR 6: FISHERIES

The Fisheries sector plays a vital role in the holistic CCA-DRR roadmap, enhancing Sri Lanka's resilience by ensuring sustainable marine resource management, food security and livelihood protection. By implementing climate-responsive fishing practices, safeguarding marine ecosystems, and supporting fishing communities, this sector contributes significantly to the nation's ability to withstand climate-related challenges.

Introduction/Guiding Principles/Objectives:

The theme considered in this section is the climate change impact on fisheries and building a resilient fisheries supply chain (sustainable and smart resilient fisheries). The purpose of this section is to identify the gaps, opportunities and vulnerabilities and develop resilient mechanisms for both marine and inland fisheries.

Hazards	Problems	Gaps
Climate change impact on fisheries	<ul style="list-style-type: none"> • Effects of climate change on stocks that sustain the main fisheries • Poor safety and quality concerns and awareness in fish production (around 10% is A grade for exports) • Governance and management issue (the government had given permission to Indian fishermen) • Energy issue: need to use sustainable and energy efficient fishing vessels 	<ul style="list-style-type: none"> • Lack of quantifiable data for economic analysis • The issue with fisheries governance, management and policy implementation. • The gap of not being energy efficient in fisheries • High vulnerability of the fisheries community. Hence there is a gap in responses and adaptation to climate related hazards in the fisheries community.

Salient Research Questions

1. Implications for food security, livelihoods, and the economy (Economic analysis)?
2. Consequences on fisheries governance and management (property rights- government policies)
3. Energy efficient (use of electric fishing vessels)?
4. Responses and adaptation in fisheries

Mapping to SENDAI Framework

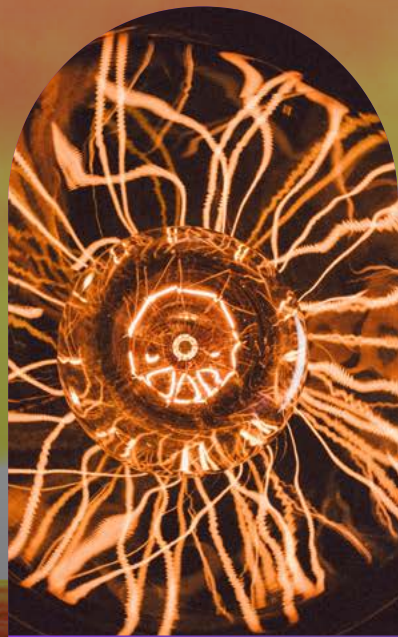
All four priorities are relevant

Major Policy Drivers

Policy enabling environment for climate induced disaster risk resilient fish value chain.

Cross-cutting Themes

Early warning systems and communication, alternative livelihood options, disaster-resilient infrastructure, social and economic vulnerabilities, cross-sectoral partnerships for coordinated response and recovery efforts.



ENERGY

7

SECTOR 7: ENERGY

The Energy sector assumes a pivotal role in the comprehensive CCA-DRR roadmap, bolstering Sri Lanka's resilience by promoting renewable energy adoption and enhancing energy efficiency. By reducing carbon emissions and ensuring reliable power supply, this sector strengthens disaster preparedness, mitigates climate impacts, and fosters a sustainable energy future for the country.

Introduction/Guiding Principles/Objectives

The energy sector is connected to other sectors such as industry, waste, agriculture and forestry. The energy sector is the key contributor to development, and it is also highly vulnerable to climate change.

Hazards	Problems	Gaps
Heatwaves	<ul style="list-style-type: none"> How energy consumption (demand) can change (increase) during periods of heatwave due to excessive use of cooling devices is unknown. 	<ul style="list-style-type: none"> Understanding the correlation between heatwave scenarios and energy demand.
Drought	<ul style="list-style-type: none"> Hydropower, agriculture, and drinking water are three key sectors that depend on water. When there is a prolonged drought period due to climate change, how it can impact the three sectors and how that will affect integrated water management has not been studied. 	<ul style="list-style-type: none"> Understanding the optimized trade-offs for water sharing in the event of prolonged drought periods. What are the contingency measures available for better water resource allocation among different priorities – (For example, decision making models).
Coastal hazards/ Landslides/ Floods	<ul style="list-style-type: none"> Disaster preparedness levels of electricity power generation plants, transmission lines/ other system components in the coastal other disaster-prone areas (exposed to coastal hazards, landslides). Data on the availability of emergency/backup power supply for critical infrastructure facilities in case of disasters (hospitals, police stations, fire stations etc.) 	<ul style="list-style-type: none"> There are no maps overlayed with disaster risks with the power stations – which are critical in the event of disasters. Are the power plants resilient to disaster risks? There is no mapping of critical infrastructure facilities that depend on the power system and resilience (infrastructure interdependency)
Climate change impacts	<ul style="list-style-type: none"> There is a lack of information/data on the disaster preparedness plans in Sri Lanka about DRR-CCA and Energy nexus and intersectoral approaches and the policy coherence between the energy and climate change sector. Impact of energy generation from renewable energy sources due to changes in climatic parameters. How does this impact renewable energy investment? Policy level gaps and institutional mechanisms/ coordination with state institutions on renewable energy regulations that promote investment. 	<ul style="list-style-type: none"> The policy (in)coherence needs between the energy and climate change sector commitments needs to be studied. How the renewable energy generation plan is impacted by climate change parameters. What is the trade-off between waste management and waste-energy projects?

Hazards	Problems	Gaps
Cross sectoral issues	<ul style="list-style-type: none"> How energy consumption (demand) in the transportation sector is impacted by climate change or due to disaster events. 	<ul style="list-style-type: none"> There is a lack of understanding of energy demand in the transportation sector due to climate change impacts as well as disaster disruptions.

Salient Research Questions

1. How far the energy sector is resilient to disaster and climate change risks (an analysis from a multi-hazard perspective – a key focus can be given to the impact due to heatwaves).
2. To what extent are the existing policies in the energy sector and climate change domain coherent and compatible – that will achieve climate risk-sensitive energy demand forecasting?
3. To what extent are the energy system components (mainly in the power and transportation sectors) resilient to frequent disasters such as floods/landslides and less frequent disasters such as cyclones/tsunamis.

Mapping to SENDAI Framework

All four priorities are relevant

Major Policy Drivers

Strengthening the coherence of the policies and regulations in the power and energy sector to develop an enabling policy framework to support renewable energy and energy efficiency targets aligning with climate change scenarios and in line with the climate change mitigation and adaption strategies along with promoting measures to achieve SDG 7 affordable and clean energy with implementation mechanisms.

Cross-cutting Themes

Climate change adaptation measures, early warning systems, innovative technologies, capacity building and training.



8

ENVIRONMENT
& ECO SYSTEMS

SECTOR 8: ENVIRONMENT/ECOSYSTEMS

The Environment/Ecosystems sector is a cornerstone of the holistic CCA-DRR roadmap, safeguarding Sri Lanka's resilience by preserving and restoring natural ecosystems. By integrating ecosystem-based approaches, this sector enhances disaster resilience, mitigates climate impacts, and sustains vital services, ensuring the well-being of communities and fostering harmonious coexistence with nature.

Introduction/Guiding Principles/Objectives

Environment/ecosystems are directly connected to floods/landslides, coastal hazards, soil erosion and drought and worsen the disaster effects on the public.

Hazards	Problems	Gaps
Flood, landslides, soil erosion, drought, human intervention, coastal hazards	<ul style="list-style-type: none"> • Terrestrial problems: There will be leaching or accumulation of pollutants in the soil EG: Microplastics, heavy metals, Salinity, Organic Matter etc.; Mismanagement of lands and wastes, deforestation, loss of biodiversity, Extinction of species, and Urban heat island effect are observed. • Atmospheric problems: Depletion of the ozone layer, CO₂ emissions, NOx increase and other GHG gases emissions, microplastic and health concern PM loading. • Aquatic problems: Loss of biodiversity; Encroachment of riverbanks, flood plains, and wetlands; Adding pollutants/ nutrients to imbalance the processes in the aquatic ecosystems and causing problems to aquatic flora and fauna EG: Microplastics, Oil and grease. • Marine problems: Sea level rise, seawater intrusion; Loss of biodiversity; Changing effect of L-Nino & La Nino; Destruction of coral reefs, and Coastal erosion; Oil spills. 	<ul style="list-style-type: none"> • Information gaps: Historical and updated data shortage (Geological, geospatial-temporal data, soil data, meteorological data); Lack of data sharing – lack of mechanism and sharing platform; Lack of proactive measures (flood risk map, lack of updating landslide risk map (EG: high risk- relocating, medium risk – no plan to ensure the safety of people). • Technology gaps: Lack of resilient house construction technology for disasters; Lack of state-of-the-art facilities for environmental monitoring; Lack of facilitating innovations. • Policy and governance gaps: Rules and regulations – implementation issues: awareness, human resources, negligence by the public, EG: environmental legislations available- but there is no proper or unique implementation for everyone. • Institutional and coordination gaps: No proactive measures (disaster Early warning/ Disaster alarming system), lack of coordination among stakeholder institutions.

Salient Research Questions

1. To fill the information gaps in identified ecosystems: What strategies can be used to ensure data availability, management and sharing to ensure the conservation, restoration and sustainable use of forests and wetland ecosystems and services for Sri Lanka?
 - Develop a national database to ensure the conservation, restoration and sustainable use of forests and wetland ecosystems and services for Sri Lanka.
2. To mitigate the impact of human intervention on climate change: What is the minimum extent of forest cover required in Sri Lanka to mitigate the impact of human intervention on climate change?
 - Quantification of required minimum forest cover for Sri Lanka by restoring degraded forests and substantially increasing afforestation and reforestation.
3. To empower stakeholders: What measures can be used to strengthen the resilience and adaptive capacity of stakeholder institutions to floods and landslides in Sri Lanka?
4. And what are the early warning systems available for floods and landslides globally and how to adopt such available technologies in Sri Lanka?
 - Strengthen resilience and adaptive capacity to floods and landslides in Sri Lanka by education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

Mapping to SENDAI Framework

All four priorities are relevant.

Major Policy Drivers

Streamlining/improving policies, rules and regulations on data sharing and activities related to climate change and disaster risk reduction, strong Policy implementation mechanism for available policies and legislations.

Cross-cutting Themes

Data-driven decision-making, cross-sectoral coordination, integrated disaster management planning, capacity building and awareness-raising.

3. RELATED ACTIVITIES

A framework encompassing interactive group discussions, scenario-based simulations, collaborative case studies, and expert-led knowledge sharing, a series of Related Activities have been meticulously planned Within the CCA-DRR Networking workshop as described below to synergistically contribute to the overarching goals of the CCA-DRR Roadmap.

Through their hands-on engagements, participants gained practical insights, fostering cross-sectoral collaboration, and developed actionable strategies to effectively implement the roadmap's principles across various sectors, to enable target achievement by informing findings to relevant stakeholders and ensuring effective implementation, while strengthening and bolstering Sri Lanka's resilience to climate challenges.

Planned Workshops and Other Interim Targets

No.	Event/Activity
1	CCA-DRR Staff Exchange Programme - Global Disaster Resilience Centre University of Huddersfield, United Kingdom.
2	Panel Discussion - "Disaster Risk Education, Research and Policy in Sri Lanka; Challenges and Recommendations for Scaling up" at the National Conference on Disaster Risk Reduction and Management in Sri Lanka organized by General Sir John Kotelawala Defence University (KDU), Sri Lanka.
3	Writing academic papers (Draft outline is to be prepared during the workshop and draft paper to be developed in 3 months)
4	14 th International Conference on Sustainable Built Environment 2023 (ICSBE) or The Kandy Conference.
5	Submitting a research proposal for rhe REED funding "Strengthening nature-based climate-induced disaster resilience of coastal ecosystems and communities residing in the vulnerable coastal belt of Sri Lanka" (Tentative title).
6	Dissemination of findings at the Committee of Vice-Chancellors and Directors (CVCD) meetings.
7	Dissemination of findings at Meetings with UNDP representatives.

4. TIME SCALES

Details of the Time Scales Considered and Adopted

No.	Workshops and Interim Targets	Time Scales
1	CCA-DRR Staff Exchange Programme - Global Disaster Resilience Centre University of Huddersfield, United Kingdom	July 2023
2	Panel Discussion - "Disaster risk reduction, research and policy in Sri Lanka; Challenges and recommendations for scaling up" at the National Conference on Disaster Risk Reduction and Management in Sri Lanka organized by the General Sir John Kotelawala Defence University (KDU), Sri Lanka.	July 2023
3	Writing academic papers	End of August 2023
4	14 th International Conference on Sustainable Built Environment 2023 (ICSBE) or The Kandy Conference	December 2023
5	Submitting a research proposal for the REED funding "Strengthening nature-based climate-induced disaster resilience of coastal ecosystems and communities residing in the vulnerable coastal belt of Sri Lanka" (Tentative title)	End of August 2023
6	Dissemination of findings at CVCD meetings	To be decided
7	Dissemination of findings at Meetings with UNDP representatives	To be decided

5. MONITORING AND EVALUATION MECHANISMS

Progress of Workshops and Other Outputs will be monitored based on the following milestones including Interim submissions/Reporting/Evaluations/Feedback.

Interim submissions/ reporting Evaluations/Feedback	Monitoring and Evaluation Mechanisms
Publication of academic papers	<ul style="list-style-type: none"> • Number of reads and downloads • Number of citations
Publication of CCA - DRR report	<ul style="list-style-type: none"> • Number of reads and downloads • Number of citations
Publicity in University and other News media	<ul style="list-style-type: none"> • Number of likes • Number of views
Produce a YouTube video - Awareness	<ul style="list-style-type: none"> • Number of likes • Number of views
Islandwide Quizz competition – Online platform for different age groups -provide a certificate if they reach the qualified mark. (E certificate) This can go through Facebook.	<ul style="list-style-type: none"> • Number of Participants • Number of applications received
Citation of the document in government policy documents, scientific publications etc.	<ul style="list-style-type: none"> • Number of citations

Annex

List of academics who are part of the workshop and contributed to the workshop, are listed below. All their efforts are greatly appreciated.

Sector	Group Members	
Sector 1: Human Health	Professor Indrika Rajapaksha Department of Architecture, University of Moratuwa	Professor Nishara Fernando Department of Sociology , University of Colombo
Sector 2: Built Environment	Professor Lalith Rajapakse Dept. of Civil Engineering, University of Moratuwa	Ms. Kalpanee Jayatilake Department of Architecture, University of Moratuwa
Sector 3: Transportation	Dr. Chaminda Bandara Dept. of Civil Engineering, University of Peradeniya	Dr. Pradeep Peiris Department of Political Science and Public Policy, University of Colombo
	Mr. Lahiru Dissanayake Dept. of Civil Engineering, University of Peradeniya	
Sector 4: Water resources, Food security, Agriculture and Livestock	Professor K.D.N Weerasinghe Dept. of Agricultural Eng., University of Ruhuna	Professor S.B. Nawaratne Department of Food Science and Technology, University of Sri Jayawardenapura
	Professor Champa Nawaratne Dept. of Agricultural Eng.,University of Ruhuna	Dr. Chathuri Senanayake Dept. of Biosystems Technology, University of Sri Jayewardenepura
Sector 5: Tourism	Professor Guttilla Yugantha Jayasinghe Dept. of Agricultural Engineering, University of Ruhuna	Professor H.D. Karunaratne Vice Chancellor, University of Colombo
Sector 6: Fisheries	Professor Achini De Silva Department of Agribusiness Management, Sabaragamuwa University of Sri Lanka	Dr. U.L. Abdul Majeed Department of Biosystems Technology, Faculty of Technology, South Eastern University of Sri Lanka
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Sector 7: Energy	Professor Ranjith Dissanayake Dept. of Civil Engineering, University of Peradeniya	Dr. A.M.A. Saja Department of Interdisciplinary Studies, South Eastern University of Sri Lanka
	Professor M. Esham Department of Agribusiness Management, Sabaragamuwa University of Sri Lanka	
Sector 8: Environment/ Ecosystems	Professor V.P.A. Weerasinghe Dept. of Zoology and Environmental Management, Faculty of Science, University of Kelaniya	Professor L. Manawadu Dean/ Faculty of Arts,Chair/Department of GeographyUniversity of Colombo.
	Dr. B.G.N. Sewwandi Dept. of Zoology and Environmental Management, Faculty of Science, University of Kelaniya	Dr. M.H. Haroon Dept. of Chemical Sciences, Faculty of Applied Sciences, South Eastern University of Sri Lanka

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Research Training Network on Tackling Climate Change as an Underlying Disaster Risk Driver (CCA-DRR)

RESEARCH ROADMAP

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University of
HUDDERSFIELD
Inspiring global professionals

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