MAINSTREAMING CLIMATE CHANGE ADAPTATION AND DISASTER RISK REDUCTION INTO FOOD SECURITY SECTOR

Madurapperuma Arachchilage Sisira Jayantha Kumara

U1650835

School of Applied Sciences

University of Huddersfield

United Kingdom

Submitted in Partial Fulfilment of the Requirements of the Degree of Doctor of Philosophy,

October 2023

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ACKNOWLEDGEMENTS

This research would not be possible without the generous assistance of many people and organisations, both in the UK and Sri Lanka. First and foremost, I sincerely thank my supervisor, Prof. Dilanthi Amaratunga. I am grateful and indebted to her for encouraging me to pursue this research and for her continued support and guidance throughout my PhD journey. I feel privileged to have her as my supervisor, and I would not have finished this study without her encouragement, technical guidance, and advice. I would also like to thank my co-supervisor, Prof. Richard Haigh, for his continued support and mentorship throughout the journey.

My thanks also go to the academics, support staff, and other researchers at the School of Applied Sciences. My former and current colleagues in the Global Disaster Resilience Center have provided me with invaluable feedback and moral support. I am also grateful to Dr Kinkini Hemachandra and Dr Chathu Jayakodi at GDRC for their friendship and encouragement throughout my PhD journey.

I am also thankful to all of the respondents who took part in the interviews and gave me the information I needed by giving me many hours of their time. I would also like to thank all of the academics and professionals who read and gave feedback on my journal articles, papers, conference talks, and workshops and who helped shape this research. I also would like to thank every individual and organisation that helped make this research study a reality in any way.

Finally, I would like to thank my entire family, especially my mother, for her unwavering understanding, support, and encouragement throughout my life, my education, and this study. Finally, my heartfelt gratitude goes to Lasangi, my loving wife, for being the strength in my life, and to Savidya and Rashini, my lovely daughters, for their understanding and helping in whatever ways they could while I was doing the research and thesis writing process.

DECLARATION

This thesis is submitted in accordance with the rules and regulations of the University of Huddersfield for the award of a PhD by research. Before this submission, some of the research results had already been published in refereed journals, book chapters, and conference papers (see Appendix A) while the study was still going on.

The researcher declares that no part of the work referred to in this thesis was submitted in support of an application for another degree or qualification at this or any other university or learning institution.

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Madurapperuma Arachchilage Sisira Jayantha Kumara (U1650838)
October 2023

ABBREVIATIONS

ABC	National (A), district (B) and community (C) level commitees apointed by the President
ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
AIT	Asian Institute of Technology
CAQDAS	computer-aided qualitative data analysis software
CARP	Council for Agricultural Research Policy
CBA	Community Based Adaptation
CBO	Communnity Based Organization
CCA	Climate Change Adaptation
CHA	Consortium of Humanitarian Affairs
COP	Cobference of Parties
CRIWM	Climate Resilient Integrated Water Management Project
CZMP	Coastal Zone Management Plan
DAC	Divisional Agriculture Committee
DCC	District Coordinating Committee
DM	Disaster Management
DMC	Disaster Management Center
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DRSD	Disaster Resilience and Sustainable Development Conference
DSS	Decision Support System
FAO	Food and Agriculture Organization
FS	Food Security
GA	Government Agent / District Secretary
GADRI	Global Allience of Disaster Research Institutes
GCE	General Certificate of Education
GDP	Gross Domestic Product
GDRC	Global Disaster Resilience Center
GPDRR	Global Platform on Disaster Risk Reduction

ICBRITAE	International Conference on Building Resilience in Tropical Agroecosystem
ICSECM	International Conference on Structural Engineering and Construction Management
IDNDR	International Decade for Natural Disaster Reduction
IFAD	International Fund for Agriculture Development
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
IUCN	International Union for Conservation of Nature
KUPANISA	Agriculture Research Assitant Officers
MAXQDA	Qualitative Data Analysis Software
MHEW	Multi-hazards Early Warning
NAPCLD	National Action Program for Combatting Land Degradation
NCCAS	National Climate Change Adaptation Strategy
NCCP	National Climate Change Policy
NCDM	National Committee for Disaster Management
NDMP	National Disaster Management Plan
NGO	Non-Governmental Organization
NPD	National Planning Department
OFC	Other Field Crops
PMB	Paddy Marketting Board
PRA	Participatory Rural Appraisal
SDG	Sustainable Development Goals
SFDRR	Sendai Framework for Disaster Risk Reduction
SME	Small and Medium Enterprises
SWOT	Strengths, Weakness, Opportunities and Threat
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Program
UNDRR	United Nations Disaster Risk Reduction
UNFCCC	United National Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
US	United States

USA	United States of America
WFP	World Food Program
WHO	World Health Organization
WMO	World Meteriological Organization

ABSTRACT

Disasters and their effects are rising worldwide, particularly in developing nations. Climate change is causing more frequent, intense, and recurrent disasters than ever. Developing countries are disproportionately affected due to low coping capacities. The Sustainable Development Goals (SDGs), Sendai Framework for Disaster Risk Reduction (SFDRR), and the Paris Agreement on Climate Change were adopted in 2015 to prioritise resilience-based sustainable development outcomes. "Zero Hunger," the second SDG, highlights the precarious state of food security and the need for investments to achieve it. The food security sector has been disproportionately affected by disasters and climate change due to its inherent and systemic vulnerability. This study has recognised that district governments and other sub-national key stakeholders are crucial to achieving food security. Despite growing recognition of the role of subnational actors, several issues related to insufficient contributions and efforts in mainstreaming climate change adaptation (CCA) and disaster risk reduction (DRR) into development work have been reported. Therefore, this research aims to develop a framework for mainstreaming CCA and DRR into food security sector planning at the sub-national level.

The research adopts the multiple case studies strategy and investigates three districts in Sri Lanka. Documents, archival records, and key informant interviews in the case districts were used to collect data. Semi-structured interviews with national experts supplemented case study findings. According to the study findings, district administrations and their local stakeholders face many challenges, limitations, and issues in mainstreaming CCA and DRR into the food security sector. Therefore, the study proposes a comprehensive framework to mainstream CCA and DRR into food security sector planning at the sub-national level. The study also makes several recommendations for reforming and restructuring existing planning processes to make them climate and disaster inclusive. The study shows the importance of identifying specific roles, mandates, and enabling environments for each stakeholder at different levels, including end users like community groups and farmer organisations. Governance issues, multi-stakeholder coordination issues, technical knowledge and know-how, fragmented approach to integration, lack of communications and awareness, data and evidence, financial solutions and resource efficiency, institutional mechanisms and mandated institutions, policy and legal provisions and related tools and methodologies should be addressed as a priority to advance CCA and DRR mainstreaming agendas.

CHAPTER 1 : INTRODUCTION

1.1 Background to the Study

1.1.1 Disaster Trends and Impacts

The magnitudes of hazards and their frequencies are on the rise. Based on the latest report by the World Meteorological Organisation (WMO), which analysed the past 50 years' data, it is evident that most disasters are triggered by climate, weather, and water-related hazards (World Meteorological Organization, 2022). Disasters do not affect all countries and communities on the same scale. Their impact on poor and vulnerable countries is much higher than that of their developed counterparts (UNDRR, 2020; United Nations, 2019). Disasters affect not only lives but also other infrastructure and properties such as roads, schools, public amenities, livelihoods, etc. According to the World Bank, more than 350 million people are impacted annually by disasters and protracted crises (United Nations, 2019). Based on the latest statistics, more than 2 million people have been killed by disasters, affecting more than 6.9 billion people in the Asia-Pacific region alone. Asia has reported the highest number of fatalities and affected people from 1970-2020 (United Nations, 2021). Some of the most common hazards in the region include floods, droughts, cyclones, landslides, and earthquakes. The most common impacts include fatalities, injuries, house and property damages, and loss of livelihoods.

On the other hand, studies suggest that the climate is changing. The sea-level rise and global mean temperature changes have been projected to impact food security, biodiversity, and ecosystem services (Javeline et al., 2019). The link between climate change and climate-induced hazards is much more evident than ever before. Climate change has been directly and indirectly attributed to increased or decreased precipitation, and temperature changes, leading to more frequent and intense hazards such as floods, droughts, cyclones, heatwaves, and cold waves (Christopher B Field et al., 2012). The impact of climate change is a global phenomenon, and no country will escape its effects. However, poor and developing countries, specifically those in lower latitudes, will face severe consequences of climate change and climate-induced hazards compared to their richer counterparts (Mendelsohn et al., 2006). Some critically affected sectors due to climate change include agriculture, food security, and water resource management.

Against the backdrop of climate change and climate-induced hazards, countries have agreed to post-2015 development frameworks, especially the Sustainable Development Goals (SDGs),

the Paris Agreement on Climate Change (the Paris Agreement), and the Sendai Framework for Disaster Risk Reduction (SFDRR). The COVID-19 pandemic has posed unprecedented development challenges to all regions, irrespective of their socio-economic development status. It has tested the resilience of the economies and derailed decades of development outcomes. While climate change, climate-induced hazards, and COVID-19 have impacted the progress of all SDGs, specific goals such as eradicating extreme poverty (Goal 1) and zero hunger (Goal 2) have been significantly derailed. The latest study findings suggest that COVID-19 has caused significant stress to the national economies, which has delayed the implementation of the SDGs and their priority actions (Leal Filho et al., 2020).

1.1.2 The Concept of Mainstreaming

The concept of mainstreaming refers to the process of elevating something to the level of acceptance that it is considered to be the norm (Cambridge University, 2023). In the context of development planning, the term mainstreaming can be defined as a systematic process of integration various interventions such as disaster risk reduction and climate change adaptation to mitigate negative impacts disasters and climate change on the overall development processes. It would help address risks within the context of development, ensuring that development policies, programmes, and projects do not create any forms of vulnerability in the process (Seddiky et al., 2020). With the rise in disaster-related risk, experts are increasingly agreeing that the key to risk reduction lies in the 'mainstreaming' of disaster risk reduction into development planning and policy. Through this process, the fundamental DRR principles are merged with development goals, governance arrangements, and the policies and practises of institutional bodies (Tiepolo et al., 2017).

1.1.3 The Concepts of Food Security and Food Insecurity

A state of food security is said to exist when all people, at all times, have access to sufficient, safe, and nutritious food that satisfies their dietary needs and food preferences for an active and healthy life. Food security has four dimensions that correspond to different levels. 1 Availability (at national level), 2) Accessibility (at household level), 3) Utilization (at individual levels) and 4) Stability - that can be thought of as a time dimension that affects all levels (Peng & Berry, 2019). Authors further argue that rather than being broken down into four "pillars," food security is best understood as a causal, connected pathway from production to consumption, through distribution to processing, and recognised in many domains. The

relationship between food security and food insecurity is dynamic, reciprocal, and time-dependent, and the outcome depends on how the stresses of food insecurity interact with coping mechanisms.

Food security is an integral part of sustainable development, as stated in the second goal of the SDGs. In some countries, it is considered a fundamental human right (Hertel, 2015). From the planning perspective, food security is seen as an integrated sector that depends on many other sectors, such as agriculture, fisheries, livestock, irrigation, and health. The COVID-19 pandemic has impacted all dimensions of food security, restricting availability, disturbing access, reducing utilization, and fluctuating stability (Laborde et al., 2020). Sound development planning is needed to mitigate the impact of disasters and climate change on food security. If not, disasters and climate change can derail development outcomes, leading to widespread food insecurity. Food insecurity can be defined as a condition where a person lacks regular access to both safe and nutritious food for normal growth and development leading less active and healthier life. Food insecurity can manifest itself in varying degrees of severity. The Food Insecurity Experience Scale (FIES) is used by FAO to assess food insecurity, which categorises it into three main groups, namely mild food insecurity, moderate food insecurity and severe food insecurity (FAO, 2023).

Concerted efforts are required by various stakeholders at national, subnational, and local levels to achieve food security. Mainstreaming climate change adaptation (CCA) and disaster risk reduction (DRR) into food security sector planning is one of the key interventions to ensure food security for all. There are ongoing and past research efforts on how to mainstream CCA and DRR into sectors and governance (Carolina Bonifacio et al., 2010; Dash & Akhter, 2023; Gabriel et al., 2021; Heazle et al., 2013; Jacqueline Pereira et al., 2010; Khailani & Perera, 2013; Madurapperuma et al., 2021b). However, sub-national and local governments face multiple mainstreaming challenges and bottlenecks that require a wholistic approach to address them. In this context, the aim of the research is to develop a comprehensive framework for mainstreaming CCA and DRR into food security sector planning at the district level (sub-national level).

1.2 Justification for the Research

The importance of CCA and DRR has been widely recognised among researchers, policymakers, and practitioners worldwide. One of the key interventions is to mainstream them into the development planning processes. However, there are numerous challenges in

mainstreaming; therefore, the development of strategies, training, and frameworks is a priority (Gabriel et al., 2021). Currently, most countries have independent institutional systems for DRR, CCA, and food security. Therefore, maintaining policy coherence is a major challenge (Booth et al., 2020). SFDRR has identified the importance of mainstreaming DRR into priority sectors and investing at sub-national and local levels (UNISDR, 2015). Leadership and convening roles are critical for mainstreaming CCA and DRR into local development plans (Baba et al., 2015). There is a lack of attention at the sub-national level for mainstreaming DRR and CCA measures (Dash & Akhter, 2023). The current domain gap between CCA and DRR can be attributed to varying political priorities, misperceptions, miscommunications, uneven funding, and varying operational time frames (Booth et al., 2020). CCA and DRR can effectively be mainstreamed into national development through appropriate policies, institutional arrangements, planning processes, research bridging the science-governance interface, and sustained efforts to raise education and awareness (Jacqueline Pereira et al., 2010). Despite the existence of DRR-CCA laws and policies, their implementation is still in its early stages at most local government or sub-national levels (Gabriel et al., 2021).

Mainstreaming CCA and DRR is a multistakeholder effort that should be led by the government in partnership with the private sector, civil society organisations, nongovernmental organisations (NGOs), and community members. The scale and quality of stakeholder involvement in developing a climate-resilient development strategy will determine its legitimacy, the feasibility of financing it and the effectiveness of its implementation (Widiati & Irianto, 2019). Empowering the local governments in participatory planning and development is crucial for a more diligent mainstreaming of DRR into local development planning (Khailani & Perera, 2013). There are numerous challenges for mainstreaming CCA and DRR, which include a lack of technology and data, capacity issues, a lack of political will and champions, and a lack of awareness and understanding of the need for synergy between CCA and DRR (Pulhin et al., 2010).

The effects of climate change and natural disasters are among the leading causes of hunger, affecting all aspects of food security (Malau et al., 2021). Climate change-induced extreme events imperil food security and the eradication of poverty. Advancing food security will require adapting to the effects of climate change and reducing disaster risks. Nevertheless, the coherence between food security, DRR and CCA is not always reflected in policies, resulting in fragmented approaches to planning and implementation (Zembe et al., 2022c). As part of the ongoing climate change negotiations, the need for systematic linkages between DRR and CCA is being discussed. In practice, however, crucial differences exist between DRR and CCA,

significantly hindering their integration (Birkmann & von Teichman, 2010c). According to them, key challenges include spatial scale, temporal scale, functional scale, norms mismatches, and knowledge mismatches. Other significant obstacles to the mainstreaming of CCA and DRR include inappropriate funding mechanisms, a lack of coordination and collaboration between key actors, a lack of implementation and mainstreaming measures, poor governance systems, social, political, and cultural issues, competing institutions, a lack of data, communication, information exchange, community participation, and policy gaps (Islam et al., 2020).

As discussed in Sections 2.7 and 2.10 , Sri Lanka is exposed to climate change and recurrent disaster events. Furthermore, the country is going through an economic downturn, leading to widespread food insecurity. It is projected that average rainfall will reduce by 17% (A2 scenario) and 9% (B2 scenario), impacting paddy production, which is the staple food of the island nation, but adaptation options vary on the agro-ecological zone (De Silva et al., 2007). Both rainfall and temperature variations due to climate change will negatively impact paddy production in the Wet and Dry Zone of Sri Lanka, impacting food production and security (Chandrasiri et al., 2022). Therefore, the authors argue that climate-smart agriculture projects should be institutionalized to face future climate risks in the country. With the establishment of the climate change secretariat, Sri Lanka has taken some positive steps in adaptation to climate change. However, it is at an early stage of development (Hewawasam & Matsui, 2019). The country faces unprecedented food security challenges due to climate change and recurrent disasters. Therefore, comprehensive mainstreaming options and policy coherence should be established at national and sub-national levels (Madurapperuma et al., 2021a).

As outlined by previous researchers, there are several key challenges and bottlenecks in mainstreaming CCA and DRR into food security sector planning processes. It is evident that mainstreaming CCA and DRR into the food security sector is still an emerging research area, and there are substantial research gaps on the nexus between CCA, DRR, and the food security sector. As discussed above, several authors have highlighted the need to mainstream CCA and DRR into the food security sector, but how such an approach should be addressed in the planning processes through academic research is not adequately covered. Hence, there is a need to undertake research on how CCA and DRR can be mainstreamed into food security sector planning, specifically at sub-national and local levels.

1.3 Research Aim and objectives.

1.3.1 Research Aim

The aim of this research is to develop a comprehensive planning framework to mainstream climate change adaptation and disaster risk reduction into food security sector planning processes at sub-national levels in Sri Lanka.

1.3.2 Research Objectives

- To investigate the need for and importance of mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.
- To explore effective methods and approaches for mainstreaming climate change adaptation and disaster risk management into food security sector planning processes in Sri Lanka.
- To design a comprehensive planning framework for mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.
- To make recommendations as to how planning structures and processes can be reformed to ensure effective mainstreaming of climate change adaptation and disaster risk reduction into the food security sector in Sri Lanka.

The research methodology used to achieve the aforementioned aims and objectives is discussed in the following section.

1.4 Research Methodology

Chapter 4 discusses the research methodology in detail. It is organised into three major sections. The first section describes the justification and procedure for determining the research problem (Section 4.3), while the second section presents the research aim, objectives, and research questions (Sections4.3.4). The next section presents the methodological research design, research philosophy, and approach (Sections 4.4, 4.5, 4.6). The fourth section presents a methodological choice, research strategy, and time horizon (Sections 4.7, 4.8, 4.9). The fifth section presents the research techniques, data collection, and analysis (Section 4.10), following

the M. Saunders et al. (2019) research onion as a guide. The chapter concludes with a discussion of the procedures used to enhance the quality of research (Section 4.12).

As discussed in Section 1.3.1, the aim of this research is to develop a comprehensive planning framework to mainstream CCA and DRR into food security sector planning at the sub-national level. Mainstreaming CCA and DRR into the food security sector is a complex issue involving multiple sectors, actors, and governance levels. Therefore, it cannot be theorised in accordance with specific laws, as in the natural sciences. Thus, the researcher follows interpretivism as its philosophy. Case studies have been chosen as the most suitable research strategy, and the rationale for this choice has been presented in Section 4.8. The study employs a holistic multiple case design with the unit of analysis 'mainstreaming CCA and DRR into food security sector planning'. Accordingly, three case studies were conducted by selecting three districts in Sri Lanka which were vulnerable and exposed to climate change and disasters. The island nation has a unitary government known as the "Democratic Socialist Republic of Sri Lanka." The country is predominately governed by the central government, which has an administrative system down to the village level, while the provincial and local governments also exist with elected representatives and associated governance structures. There are 25 districts in the country. As discussed in Section 4.8.1.3, all 25 districts are relevant for this research study as they qualified based on the first selection criteria stated in Section 4.8.1.3. Therefore, a two-phased screening process was applied to select the most suitable cases for the study as explained in Section 4.8.1.3, and subsequently, Trincomalee, Anuradhapura, and Polonnaruwa districts were selected for the case studies. Multiple key informant interviews were conducted within the case studies to collect valid and reliable data pertinent to the study area. Interviews were designed to capture evidence and data relevant to mainstreaming CCA and DRR into food security sector planning and its associated challenges at district and local levels. Accordingly, data were gathered using semi-structured interviews with key informants representing policymakers, government officials, experts, and practitioners at national, provincial, district, and local levels.

Furthermore, a validation round-table discussion with senior academics from leading universities in Sri Lanka, the UK, and Europe was organised towards the later part of the research to validate the framework for mainstreaming CCA and DRR into the food security sector planning. Government publications, policies, strategies, and other archival records and literature were reviewed to gain an in-depth understanding and knowledge about the cases being studied.

The qualitative data were analysed by summarising the data, categorising and structuring the data to recognise relationships, developing and testing hypotheses, and producing well-grounded conclusions (M. N. K. Saunders et al., 2019). Nvivo20 (Mac version) computer-aided software was used to manage, organise, and analyse qualitative data collected through key informants' interviews.

1.5 Knowledge Gaps

The researcher is addressing the specific knowledge gap in mainstreaming climate change adaptation and disaster risk reduction into food security sector planning at sub-national levels. The specific knowledge gap includes the identification of appropriate tools, approaches, and frameworks for mainstreaming CCA and DRR into food security sector planning coherently. While there are isolated efforts, publications and prior research related to mainstreaming CCA or DRR into various development practices, there is a lack of theories, practices and knowledge related to integrated planning, addressing such inter-related issues more coherently, keeping the sustainable development and its goals such as zero hunger in the core of development planning processes, specifically at sub-national and local levels.

1.6 Contribution to Knowledge

The study contributes to the growing body of knowledge by developing a comprehensive framework to mainstream CCA and DRR into food security sector planning at the sub-national level, thereby advancing the progress of SDG-2. Thus, the research contributes to both theory and practice. With regard to theoretical contributions, the study demonstrates how CCA and DRR can be mainstreamed into food security sector planning at subnational and local levels. It contributes to the existing body of knowledge by identifying CCA and DRR mainstreaming measures, tools, entry points, and enabling environments required at the district and local levels to address the inherent and systemic vulnerabilities of the food security sector. The area of research has become very popular after the launch of the post-2015 development agenda, the SDGs, the SFDRR, and the Paris Agreement and renewed calls for policy coherence at global, regional, national, and subnational levels. Therefore, researchers have started investigating interdisciplinary research themes related to policy coherence, integrated planning, and mainstreaming CCA and DRR into SDG goals and related sectors, leading to many publications and policy documents. However, most of them are contained in reports and policy documents and lack rigorous scientific approach. Thus, this research contributes significantly

to theory and knowledge through a rigorous empirical investigation of the mainstreaming of CCA and DRR into food security sector planning.

In terms of its contribution to practice, the research findings will help relevant policymakers, stakeholders, planners, and practitioners to understand the challenges of mainstreaming CCA and DRR into food security sector planning at sub-national levels. It will further help to understand how those challenges can be overcome or mitigated by reforming and restructuring existing planning processes and instruments. The findings will also help clarify the roles of various stakeholders, including the district and divisional governments, so mainstreaming CCA and DRR into the food security sector can be progressive. The findings of the study significantly contribute to advocating local actions in implementing global frameworks at sub-national and local levels. 'Localisation' is an emerging practise area in post-2015 development frameworks; therefore, the mainstreaming framework, findings, and recommendations significantly contribute to such emerging practise areas.

1.7 Organisation and Structure of the Thesis

1.7.1 Chapter 1: Introduction

The first chapter introduces the research for the thesis. It gives a brief overview of the study, research justification, research aim and objectives, research methodology, contribution to knowledge, and structure of the thesis.

1.7.2 Chapter 2: Literature Review

Chapter 2 provides a comprehensive review of the literature, covering key concepts of the study. It provides a literature review of the issues associated with climate change, disasters, and food security, as well as the need for mainstreaming CCA and DRR into food security sector planning. The chapter also presents a thorough review of the literature that addresses issues pertinent to the Sri Lankan context, given that the focus of the research is limited to Sri Lanka. In addition, Chapter 2 summarises the strategies, policies, and plans that govern Sri Lanka's DRR, SDG, and CCA institutional ecosystems and interventions.

1.7.3 Chapter 3: Conceptual Framework

The third chapter presents the conceptual framework of the research, highlighting the key concepts identified from the literature and international expert opinions as well as their relationships and boundaries.

1.7.4 Chapter 4: Research Methodology

Chapter 4 provides the methodological research design and the process adopted for conducting the research. The chapter first discusses the process of establishing the research problem. Then it presents, in detail, the research philosophy, research approaches, research strategies, choices of methods, time horizons, and techniques, and procedures adopted for data collection and analysis, the thesis writing up, and tests for validity and reliability of the research design.

1.7.5 Chapter 5: Data Analysis

The fifth chapter presents analytics of the empirical evidence gathered through national expert interviews and key informant interviews for the three selected case studies. The chapter provides background information, describes the interviewing procedure, and concludes with a thorough analysis of data and evidence. The analysis of the case studies is presented in two major sections: within-case analysis and cross-case analysis.

1.7.6 Chapter 6: Findings

Chapter 6 provides an overview of the principal research findings and compares and contrasts the findings from the national expert interviews and case studies with the findings from the literature.

1.7.7 Chapter 7: Conclusions

The final chapter of the thesis establishes the conclusions of the research study based on empirical investigations. Finally, the implications of the study on advancing theory and practice are also discussed through the findings. It also discusses the limitations of the study and potential future research directions in this research discipline.

1.8 Summary and the link

This chapter, which served as the introduction to the thesis, provided an overview of the research area, including the context of the study and the justification for selecting this particular research area. After presenting the purpose and objectives of the study, this chapter provides a summary of the research methodology. The expected contribution to knowledge was then outlined, along with the structure of the thesis. The next chapter will begin with a review of the relevant literature for this study

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

This chapter presents the literature review undertaken by the researcher. The chapter is organised into four main parts; Part 1: Food Security; Part 2: Climate Change; Part 3: Disaster Risk Management; Part 4: Mainstreaming of Climate Change Adaptation and Disaster Risk Reduction; and Part 5: Research Gaps. In part one of the chapter, literature related to food security and food insecurity is discussed in detail. In part two of the chapter, literature related to climate change concepts, climate change impacts, climate resilience, climate change adaptation, food security, and the nexus between climate change and food security has been discussed. Part 3 of the chapter discusses concepts of disaster risk management, climate change and disaster nexus, disasters and food security linkages, and disaster impact and planning frameworks in Sri Lanka. Part 4 of the chapter discusses risk-informed climate change adaptation, disaster risk reduction, and mainstreaming processes in detail. It discusses the concepts of climate change adaptation, upscaling DRR as an adaptation option, the convergence between disaster risk management and climate change adaptation, and the mainstreaming of CCA and DRR. The chapter also discusses the literature on the current scope of the risk-informed adaptation planning process, related policies, frameworks, and strategies for combating food security issues in Sri Lanka. In Part 5, the chapter ends with identifying and finalising research gaps for framing the research aims and objectives and the rationale and a conceptual framework for undertaking the research based on the findings of literature reviews.

Part One: Food Security

2.2 Food Security Concepts and Context

2.2.1 What is Food Security?

Literature suggests that “food security” emerged in the mid-1970s due to the global food crisis. Initial discussions on the term “food security” focused on the physical supply of foods to ensure the continued supply of foods at international and national levels. The concept has evolved over the years, specifically during the negotiations at the World Food Conferences. Currently, the term “food security” refers to “the situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO, 2006)

Food security is defined as ‘physical, social, and economic access to sufficient, safe, and nutritious food by all at all times to meet their dietary and food preferences for an active and healthy life’ (Moyo & Clarke, 2007). They argue that food security has three distinct but interrelated components, food availability; food access or effective demand; reliability of food and food distribution.

The concept of food security emerged five decades ago during the global food crisis in the early 1970s. It has evolved over the years and given more than 200 definitions, highlighting the contextual dependent features of food security. However, the current and most widely accepted definition of food security refers to the definition stated in the Food and Agriculture Organization (FAO) Annual Report of 2001, published in 2002 (Peng & Berry, 2019). According to the authors, the most recent revision to this definition was made in 2009, when the fourth dimension - stability - was added as a short-term time indicator of food systems' ability to withstand natural or man-made shocks. The food availability dimension depends on local food production and importation from abroad. Food accessibility dimension is dependent on the transportation infrastructure and purchasing power of the consumers. Such physical and economical accessibility also attributed by the socio-cultural accessibility ensuring the food is culturally and socially accepted and the presence of social safety nets to support those who cannot afford to access them. Under the food utilisation dimension, an individual must be able to eat adequate amounts in both quantity and quality in order to live a healthy and full life and realise his or her potential. Food and water must be safe and clean, so adequate water and sanitation are also required at this level. A person must also be physically healthy in order to digest and utilise the food consumed. The fourth domain of Stability is concerned with the ability of a nation, community, household, person to withstand shocks to the food supply system caused by natural disasters (climate, earthquakes) or by man-made disasters (wars, economic crises). As can be seen, food security exists on multiple levels. National Availability; Household Accessibility; Individual Utilization; Stability - may be viewed as a time dimension that affects all levels (Peng & Berry, 2019). Recent developments emphasise the significance of sustainability, which can be thought of as the long-term time (fifth) dimension of food security. According to the authors, more recent evolution of the food security emphasizes the importance of sustainability, which may be considered as the long-term time (fifth) dimension to food security. The concept of sustainability refers to the incorporation of indicators of ecology, climate change, and biodiversity at the supranational and regional levels, in addition to the sociocultural and economic factors that will influence the food security of future generations.

2.2.2 What is Food Insecurity?

Food insecurity can be defined as a condition in which a person lacks regular access to food that is both safe and nutritious for normal growth and development, leading to a life that is less active and healthier overall (FAO, 2023). Most countries around the world suffer from food insecurity, but the common determinants have not yet been identified. (Smith et al., 2017). In this backdrop, the Food Insecurity Experience Scale (FIES) was designed as a survey protocol to measure people's direct experiences of food insecurity at the individual level on a global scale. Food insecurity is posing a major concern around the world, and it has been on the rise since 2015 (Saint Ville et al., 2019). The authors argue that, according to global estimates, one in every three people suffers from malnutrition, which manifests as undernutrition, micronutrient deficiencies, overweight, or obesity. According to international food, nutrition, and agriculture organizations, worldwide malnutrition will reach one in every two people by 2030 if current trends continue (FAO et al., 2017). To eradicate hunger and stop all forms of malnutrition by 2030, it is imperative that all nations and stakeholders work together, in line with 2030 Agenda for Sustainable Development and the UN Decade of Action on Nutrition 2016–2025. In 2022, there likely to be between 691 and 783 million hungry people in the world, resulting 122 million more individuals than in 2019, prior to the global pandemic, experienced hunger, based on the midpoint (about 735 million). In 2030, it is predicted that about 600 million individuals will have chronic undernourishment (FAO et al., 2023). More than 3.1 billion people worldwide, or 42 percent, were not able to afford a healthy food in 2021, according to an FAO analysis. They also point out that in 2022, there were an estimated 148.1 million stunted children worldwide, 45 million wasting children, and 37 million overweight children, totalling 22.3 percent of all children under five. While overweight was slightly more common in urban areas, stunting and wasting were more common in rural areas.

2.2.3 Types of Food Insecurity?

Based on the duration of the food insecurity, food security analysts have distinguished between two broad categories of food insecurity, namely chronic food insecurity and transitory food insecurity as discussed in Table 2.1 (FAO, 2022).

Table 2-1: Types and characteristics of food insecurity

	Chronic Food Insecurity	**Transitory Food Insecurity**
Considered as	Persistent or long-lasting.	Temporary and short-lived.
This happens when	People are unable to meet their basic dietary needs for an extended length of time.	There is an abrupt decrease in the ability to generate or obtain enough food to sustain a healthy nutritional status.
Because of	Prolonged poverty, a lack of possessions, and insufficient access to productive or financial resources are all factors.	Short-term shocks and fluctuations in food availability and access, such as year-to-year changes in domestic food production, food costs, and household incomes.
It is possible to overcome through	Typical long-term development strategies, such as education or access to productive resources, such as loans, are also utilized to address poverty. They may also require greater direct access to food in order to increase their productive capability.	Food insecurity is generally unpredictable and can appear suddenly. This complicates planning and programming and necessitates multiple capacities and forms of intervention, such as early warning capacity and safety net programs.

Source: (FAO, 2022)

2.2.4 The Severity of Food Insecurity?

When analysing food insecurity, it is important to understand not just how long people have been experiencing the problem, but also how intense or severe the impact of the identified problem is on overall food security and nutrition status. This understanding will influence the nature, scope, and urgency of support required by affected demographic groups. According to the Integrated Food Security Phase Classification, food insecurity can be categorised into five main phases as described in Table 2.2 (IPC, 2023).

Table 2-2: IPC Classification and Measuring Indicators

IPC Phase Classification	Measuring Indicators
Generally, Food Secure	√ Crude Mortality Rate
Chronically Food Insecure	√ Malnutrition Prevalence
Acute Food and Livelihood Crisis	√ Food Access/ Availability
Humanitarian Emergency	√ Dietary Diversity
Famine / Humanitarian catastrophe	√ Coping Strategies
	√ Livelihood Assets

Source: www.ipcinfo.org

2.2.5 Sustainable Development and Food Security

2030 sustainable development agenda has given high priority for the food security sector. The Sustainable Development Goal 2 focus on ending hunger, achieving food security and improved nutrition and promote sustainable agriculture (UN, 2021). It aims to ensure that everyone has enough good-quality and nutritious food to lead a healthy life. Providing better access to food and promoting sustainable agriculture will be necessary to achieve this Goal. This requires improving small-scale farmers' productivity and incomes by providing equal access to land, technology, markets, agricultural practices, and sustainable food production systems. The productivity of agriculture in developing countries must also be bolstered through international cooperation. Despite some progress, SDG goal 2 is beyond the reach by many. According to UN (2021). More than 790 million still suffer from hunger globally and they lack regular access to quality and adequate food. The 2030 Zero Hunger target of the SDGs would be substantially missed if the current trajectory continues (UN, 2021). According to them, hunger is no longer caused by a lack of food. Rather, in many countries that did not meet the Millennium Development Goals (MDGs) hunger target, natural and human-caused calamities or political instability have resulted in widespread food insecurity. Food insecurity is highest in Sub-Saharan Africa. More than half of the adult population in that region has been food insecure, with one-quarter suffering from acute food insecurity. Southern Asia has the highest occurrence, with about 25% of adults having moderate or severe food insecurity, and 12% suffering severe levels.(UN, 2021).

Zero Hunger Goal of the SDG call for;

- There were no stunted children under the age of two.
- All year round, there is complete access to adequate food.
- All food systems are self-sustaining.

- Increase in smallholder productivity and income by 100 percent.
- There is no food loss or waste.

Part Two: Climate Change

2.3 Climate Change Concepts and Context

Climate change is among the most debated subjects in the 21st century among policymakers, scientists, academicians, journalists, and practitioners. A comprehensive analysis of 1,372 research datasets, publications, and citations concludes that 97-98% of researchers support the trends of anthropogenic climate change arguments made by the Intergovernmental Panel on Climate Change (IPCC). However, a smaller group of researchers concluded against the trends and findings of the IPCC (William et al., 2010). The challenge is the uncertainty of the estimates. It is difficult for scientists, policymakers, and the general public to identify location-specific impacts in temperature, rainfall, and sea-level changes due to climate change (Pancost, 2017). They further argue that the disconnect between robust understanding, knowledge, and literature between the fundamentals of climate change science and their location and sector-specific impacts is one of the main obstacles to designing effective strategies and plans. Therefore, part one of the literature review chapter discusses the fundamentals of climate change and its impacts on various sectors.

2.3.1 Climate Change Definition

The term "climate change" is defined as a "change in the state of the *climate* that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer" (IPCC, 2014). Human activities could be directly or indirectly attributable to climate change, which alters the variables of the global atmosphere, such as temperature, in addition to natural variability. It is essential to distinguish between climate change attributable to human interventions and climate variability due to natural causes. The term *"Global Warming"* is an oversimplification and misleading terminology, as the general public gets the impression that the only temperature is slightly increasing. It does not give the complex relationships on climate change impacts (Post, 2013).

2.3.2 Climate Change Impacts

Increasing global warming and sea-level rise have multitudes of impacts on the ecosystem and society. If human and industrial interventions continued at the same or higher rate for the next

200 years, the world we know today would have fundamental changes (Howard-Grenville et al., 2014). Authors argue that climate change will impact water resources, ocean acidification, cultivation seasons, and coastal floods. The public, private, and non-profit sectors have less awareness of or attention to the climate change impacts, possibly due to the imbalance between climate time horizons and effects on current business (Howard-Grenville et al., 2014). They further argue that climate change impacts depend on social, political, and economic choices we made in the past, present, and future. Climate change affects value change and industries, reshaping interactions and relationships between sectors and institutions (Howard-Grenville et al., 2014).

Climate projections indicate that the future climate will depend on the combined warming caused by past emissions, future emissions, and natural climate variability (IPCC, 2014). The global mean surface temperature change for 2016–2035 will likely be in the range of 0.3°C to 0.7°C (medium confidence) (IPCC, 2014). However, global surface temperature change for the end of the 21st century (2081–2100) will likely exceed 1.5°C for RCP4.5, RCP6.0, and RCP8.5 (high confidence). Warming is likely to exceed 2°C for RCP6.0 and RCP8.5 (high confidence), more likely than not to exceed 2°C for RCP4.5 (medium confidence), but unlikely to exceed 2°C for RCP2.6 (medium confidence) (IPCC, 2014).

According to the IPCC, the global mean sea level rise will continue during the 21st century, very likely at a faster rate than observed from 1971 to 2010. For 2081–2100, the rise will probably be in the ranges of 0.26 to 0.55 m for RCP2.6 and 0.45 to 0.82 m for RCP8.5 (*medium confidence)*. By the end of the 21st century, the sea level will likely rise in more than 95% of the ocean's area. About 70% of the coastlines worldwide are projected to experience a sea-level change within ±20% of the global mean (IPCC, 2014).

The fundamental policy framework related to climate change is the United Nations Framework Convention on Climate Change (UNFCCC), adopted in 1992, and the associated Kyoto Protocol (Howard-Grenville et al., 2014).

2.3.3 The Concept of Climate Resilience

Literature suggests that "resilience" originated from early psychiatric research that studied children's personality traits. Early in the research, the word "invulnerable" was used; it was later replaced by the term "resilience" (Rutter, 1985), and a new generation of theories and research was born from there onwards. In the early stages of resilience theories, it was defined as the ability to bounce back or cope successfully despite substantial adversity (Rutter, 1985). The word

"resilience" comes from the Latin word "resilio", or resile from shocks and bounce back (Paton et al., 2001). The term "disaster resilience" can be defined as "the ability of a system, community, or society exposed to hazards to resist, absorb, accommodate for, and recover from the effects in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (UNDRR, 2023).

"Climate resilience" has overlapping meanings with "disaster resilience." Literature suggests that "climate resilience" evolved from ecological theories in the 1970s. Accordingly, resilience was defined as "the amount of disturbance an ecosystem can withstand" (Holling, 1973). It is very close to modern thinking and the definition of "resilience" in climate change adaptation. The Intergovernmental Panel on Climate Change defined the term "climate resilience" as the "ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change" (Parry et al., 2007).

The concept of "resilience" has been widely used in the DRR and CCA domains. It emphasises that at-risk communities should anticipate shocks, prepare for worst-case scenarios, adapt their practices, face the shock, and bounce back or recover from shocks as early and effectively as possible. Building resilience can be achieved through the adaptation of the economic and social activities of communities to unprecedented changes and uncertainty (Howard-Grenville et al., 2014).

Based on the literature mentioned above, the meaning of the term "resilience" in this research context can be defined as the ability of national, sub-national, and local systems, including at-risk communities, to anticipate the impacts of climate change and climate-induced disaster risks on the food security sector, adapt to and recover from acute extreme events, and longer-term chronic impacts. The concepts of disaster resilience and climate resilience are interlinked and overlapping. Therefore, it is crucial to understand how climate change can affect the agriculture and food security sectors and their linkages with disaster risks.

2.3.4 Climate Change Impacts on Food Security

2.3.4.1 Climate Change and Food Security

In addition to the direct impact of climate-induced disasters on food security, climate change has also had long-term effects on the agriculture and food security sectors. The agriculture sector, the most prominent global freshwater user, is highly vulnerable to climate change (Calzadilla et al., 2013). It could be due to changes in atmospheric parameters such as precipitation, temperature,

and relative humidity. The World Bank recognises five main climate change factors affecting crop productivity. Those are precipitation changes, temperature, carbon dioxide fertilisation, climate variability, and surface runoff (Kurukulasuriya et al., 2006). Literature also suggests climate change will affect crop yields and cultivation patterns due to changes in the atmospheric concentration of greenhouse gases, specifically CO_2. It may have both positive and negative impacts (Singh, 2016). He argues that higher atmospheric CO_2 concentrations will positively impact the photosynthesis of C3 crops such as wheat and rice compared to C4 crops such as maise, sorghum, sugar cane, and grasses. Therefore, he argues that doubling atmospheric CO2 could increase biomass by nearly 36 per cent. However, he also argues that the impacts of climate change on agriculture and food security are very complex. The temperature increase can reduce the crop duration, increase respiration and evapotranspiration, decrease fertiliser use efficiency, and become favourable to pest infestation, reducing crop production and productivity.

Further, the literature reveals that dryland crops and livestock farmers are vulnerable to temperature changes. Irrigated crops benefit from climate change in relatively cold areas, as irrigation reduces the water shortage resulting from climate change (Kurukulasuriya et al., 2006). They also argue that if the precipitation increases with climate change in relatively dry areas, net revenue will rise in dryland crops and livestock. They argue that the marginal impacts of climate change depend on the initial temperature and precipitation of individual farms.

The impact of climate change on the food security sector is more significant than projected in the scientific models (Schmidhuber & Tubiello, 2007). The authors argue that a wide range of additional 5 million-170 million people will be in hunger by 2080 due to climate change impacts, depending on the social, economic, and political decisions of the countries. They propose developing new assessment methodologies to assess the local impacts.

Scientists emphasise that rain-fed and irrigated agriculture face different climate risks (Calzadilla et al., 2013). They argue that irrigated agriculture is less vulnerable to climate change than rain-fed production. The IPCC explains that temperature and soil moisture affect the growing season. Generally, higher temperatures will shorten the frost period, supporting the cultivation of cool-climate croplands. On the other hand, a higher temperature will reduce the cropping cycle and crop yields in arid and semi-arid regions (Parry et al., 2007).

2.3.4.2 Climate Change Impacts and Food Security in Sri Lanka

Climate change, climate variability, and extreme events pose a significant risk to the food and livelihood security of Sri Lanka (Esham et al., 2018b). The authors argue that food security indices developed by international organisations indicate that Sri Lanka's vision of becoming a food-

secure nation is beyond its reach, with mixed results. They also argue that Sri Lanka has failed to achieve the Millennium Development Goals for undernourishment by reducing them to 50 per cent. The authors suggest four main issues related to climate change and food security in Sri Lanka: agriculture productivity decrease, supply-chain-related food losses, the susceptibility of rural livelihoods, and child malnutrition and undernourishment. A timely need is to institutionalise a holistic approach to the food system through climate-smart agriculture (Esham et al., 2018b). Twenty-eight per cent of the livelihoods of Sri Lankans are related to agriculture. Climate change impacts the highly fragile agriculture sector, affecting the food security of the entire population (Ministry of Mahaweli Development & Environment, 2016). The ministry further says that those who are marginally above the poverty line will again be below it due to the impacts of climate change. The National Disaster Management Plan (NDMP) of the Government of Sri Lanka has identified a range of climate change impacts (DMC, 2014). Some of the significant effects outlined in the plan include

a) Reduction of water regulation in the mountain catchment areas
b) Shortage of water in arid and semi-arid regions of the country
c) Negative Consequences on ecological systems and Biodiversity
d) Impacts on the magnitude and reliability of renewable hydro-power
e) A decrease in agricultural productivity
f) Impacts on the production and productivity of the fishery sector
g) Impacts on food security
h) Sea-level rise
i) Inundation of lowlands and reducing their agricultural productivity
j) Increase in vector-borne diseases for both humans and crops

The NDMP has identified agriculture, fisheries, tourism, infrastructure, and coastal development as fragile sectors. It recommends designing and implementing appropriate climate change adaptation strategies, policies, and actions at various levels to ensure the food security of the people.

Part one of this chapter discussed the fundamentals of climate change, its impacts and consequences on the food security sector. In addition to the chronic long-term effects of climate change discussed in this section, the IPCC emphasises the relationships between climate change and extreme events. In a special report titled "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation," the IPCC highlights the complex relationship between climate change and climate-induced hazards. The authors argue for disaster risk management as

an adaptation option (Murray & Ebi, 2012). Therefore, Part 2 of this chapter discusses disaster risk management, disaster impacts, and disaster risk management planning frameworks in Sri Lanka.

Part Three: Disaster Risk Management

2.4 Concepts of Disaster Risk Management

Disaster risk management (DRM) is an evolving discipline and practice area. It is relatively new to other scientific domains and is considered an interdisciplinary subject. The concept dates back to the late 1980s with the declaration of the International Decade for Natural Disaster Reduction (IDNDR), from January 1990-December 1999, by the United Nations General Assembly, following the adoption of Resolution 44/236 on December 22, 1989 (Lechat, 1990). During the decade, it gained the momentum and attention of international partner agencies and national governments, accelerating efforts to reduce disaster losses. In 2005, UN member states at the World Conference on Disaster Reduction endorsed the Hyogo Framework for Action (HFA: 2005-2015) following the adoption of Resolution A/RES/60/195. The HFA aimed to enhance the resilience of countries and communities to disasters through a detailed action plan. HFA is the first global plan to explain, describe, and detail the work required from all sectors and actors to reduce disaster losses. The goal of the HFA was to substantially reduce the loss of lives and social, economic, and environmental assets by 2015, enhancing the resilience of countries and vulnerable communities to disasters (UNISDR, 2015). The Sendai Framework for Disaster Risk Reduction (SFDRR: 2015-20130) was adopted at the Third World Conference on Disaster Risk Reduction as the first post-2015 global policy instrument of the United Nations. The SFDRR was developed through extensive global, regional, and country consultations (Aitsi-Selmi et al., 2015). The SFDRR is the latest global policy framework to guide disaster risk management frameworks, strategies, and plans at regional, national, and sub-national levels.

Disaster risk management (DRM) is a broad concept and a process that has evolved over the years. There are closely interrelated concepts and practises of DRM. Therefore, this section of the chapter discusses the fundamental concepts of disaster risk management, related policy instruments, and linkages with climate change.

2.4.1 Hazards

A “hazard” can be defined as a natural or human-made phenomenon, condition, or activity that can cause loss of lives, damages to properties, livelihoods, economic activities, or disturbances to the social, economic, or environmental conditions of a given area in a given time (UNDRR, 2023). Hazards originating from natural phenomena are classified as “Natural Hazards,” whereas hazards originating from human interactions are classified as “Anthropogenic Hazards.” UNDRR further classifies them as biological, geological, hydro-meteorological, and technological hazards based on the triggers or sources of their origin (UNDRR, 2023).

2.4.2 Vulnerability

Vulnerability can be defined as features and situations that make a particular community, system, or property more fragile to the impacts of hazards (UNDRR, 2023). They further state that vulnerability can be attributed to physical nature, social conditions, economic activities, or environmental factors. Therefore, vulnerability can be categorised into physical, social, and economic vulnerability (UNDRR, 2023). They further state that it is a dynamic condition and changes over time and context.

2.4.3 Exposure

All the elements, such as people, properties, infrastructure, and systems located in the hazardous zone and thereby subjected to potential losses, can be defined as “exposure” (UNDRR, 2023). According to UNISDR, the level of damage varies based on the vulnerability of exposed elements; therefore, vulnerability and exposure are closely interrelated concepts.

2.4.4 Disaster Risks

Probabilistic estimation of how many lives, assets, or whether or not a system, society, or community might be lost, injured, or destroyed within a given time period, based on hazard, exposure, vulnerability, and capacity (UNDRR, 2023). They state that risk perception varies from person to person based on risk awareness, education, and level of exposure, among many other factors.

2.4.5 Disaster

The term “disaster” is referred to as “severe disruption of the functioning of a community or a society involving widespread human, material, economic, or environmental losses and impacts that exceed the ability of the affected community or society to cope using its resources” (UNDRR, 2023). Disaster-related implications include deaths, injuries, and losses to properties, the environment, infrastructure, services, and livelihoods.

UNDRR (2022b) argues that disaster trends in the number of events and impacts are increasing at an increasing rate. Some leading disaster events include the Kobe Earthquake in 1995, Hurricane Katrina, Rita, and Wilma in the USA in 2005, the Sichuan Earthquake in China in 2006, floods in Thailand in 2011, and Hurricane Sandy in the USA in 2012. Globally, disasters cause a $ 250 -300 billion loss annually (Albrito, 2018). The author further argues that more than 80 per cent of these losses are reported from hydro-meteorological hazards. More than 26 million people fall back into poverty yearly due to disasters. In 2016 alone, natural hazards displaced 19.2 million in 113 countries. Climate change increases the intensity and frequency of extreme events and slow-onset hazards (Albrito, 2018).

The majority of hazards are climate-induced hydro-meteorological events. Floods, storms, and droughts take a massive toll on the overall impacts of disasters. Based on the UNISDR special report published in 2015, Asia is the most disaster-prone region globally, accounting for 71.8 per cent of events reported in 2015. For the past decade, from 2005 to 2014, 55.6 per cent of disasters have been reported in Asia, while the Americas reported 31.6 per cent.

2.4.6 Disaster Preparedness

Disaster preparedness is a proactive measure before a hazard becomes a disaster. It refers to the measures taken by governments, professional response and recovery organisations, at-risk communities, and individuals to anticipate the likely impacts and negative consequences of impending or current hazardous events or conditions (UNDRR, 2023). Such measures include capacity and knowledge development, strategy formulation, establishing appropriate early warning systems and protocols, stockpiling humanitarian aid and equipment, training, drills, and information management.

2.4.7 Disaster Mitigation

Disaster mitigation can be defined as all the measures taken to reduce the adverse consequences and impacts of hazards and disasters once they occur (UNDRR, 2023). They further argue that

the impacts of disasters cannot be prevented entirely, specifically large-scale disasters such as floods, droughts, tsunamis, and earthquakes. However, applying various structural and non-structural measures can mitigate their impacts. Disaster mitigation includes some engineering measures, such as disaster-resistant infrastructure, or non-engineering measures, such as land use planning.

2.4.8 Disaster Resilience

When Disaster strikes, if the systems, communities, and society can face the negative consequences, resist, if possible, absorb the shocks, bounce back, transform and recover from the impacts of disasters in a timely manner, it can be defined as disaster resilience. A disaster-resilient society or systems can preserve or quickly restore the essential basic infrastructure, critical services, and functions (UNDRR, 2023). They further argue that community resilience depends on the level of preparedness to utilise their resources in an organised manner in case of a disaster.

2.4.9 Disaster Risk Reduction

Disaster risk reduction aims to prevent new disaster risk, reduce existing disaster risk, and manage residual risk, all of which contribute to increased resilience and, as a result, to the accomplishment of sustainable development (UNDRR, 2023). It can be achieved by reducing exposure to hazards, lessening the vulnerability of exposed elements, wise management of land use planning and the environment and increasing the capacity to face disasters through preparedness. Disaster risk reduction is a proactive approach before Disaster strikes to ensure that measures and systems are in place to reduce the negative impacts.

2.4.10 Disaster Risk Management

Disaster risk management is the use of disaster risk reduction policies and measures to prevent new disaster risk, decrease existing disaster risk, and manage residual risk, thereby contributing to resilience building and disaster loss reduction. (UNDRR, 2023). There are three types of disaster risk management actions: prospective disaster risk management, corrective disaster risk management, and compensatory disaster risk management, also known as residual risk management.

Prospective disaster risk management activities address and seek to avoid the development of new or increased disaster risks, whereas corrective disaster risk management activities address and seek to eliminate or reduce disaster risks that are already present and must be managed and

reduced immediately. Compensatory disaster risk management actions, on the other hand, increase individuals' and communities' social and economic resilience in the face of residual risk that cannot be adequately minimized. They encompass actions such as preparedness, response, and recovery, as well as a variety of finance tools such as national contingency funds, contingent credit, insurance and reinsurance, and social safety nets (UNDRR, 2023).

Linkages between climate change and natural hazards are no longer a mystery. Therefore, policymakers, scientists, and practitioners need to consider the influence of climate change on natural hazards when designing and developing appropriate disaster risk management policies, strategies, and frameworks. Therefore, the next session discusses the nexus between climate change and disasters.

2.5 Climate Change and Disasters Nexus

The climate change and disaster nexus is an ongoing debate. The IPCC (2014) in its special synthesis report, argues that "surface temperature is projected to rise in the 21st century under all assessed emission scenarios." They further say that heat waves will occur more often and last longer on the one hand, while extreme precipitation events and floods will become more intense and frequent in many regions on the other. Therefore, they conclude that climate change will amplify existing risks while creating new ones for humans and ecosystems. They further suggest that risks are unevenly distributed and are more significant for disadvantaged people and communities in countries at all levels of development (IPCC, 2014). Therefore, adapting to climate change and reducing disaster risk will significantly enhance community resilience and food security.

In order to have an integrated approach to climate change and disaster risk management, relevant policies at global, regional, and country levels need to converge. Coherence among policies has been considered in post-2015 agendas; therefore, the SFDRR and the Paris Agreement have built convergence (Mysiak et al., 2018). The goals, targets, and approaches of SFDRR and the Paris Agreement are prerequisites for SDGs. They argue that SFDRR advocates for multi-hazard, inclusive, science-based, and risk-informed planning processes and practices. On the other hand, the Paris Agreement advocates for global adaptation goals to mitigate the negative impacts of climate change and extreme events and enhance overall climate resilience.

Disaster risk management is at the core of post-2015 development agendas. Global targets of the SFDRR, namely the reduction of mortality, the reduction of people affected, the reduction of

economic losses, and the reduction of damage to critical infrastructure by natural hazards, are necessary conditions for achieving the SDGs. Further, the approaches to adaptation stated in the SFDRR and SDGs align with the Paris Agreement. Therefore, policy coherence is required to successfully implement global frameworks at local levels to achieve greater impacts on sustainable development (Albrito, 2018).

While reflecting on the convergence of policies at the global level is essential, it is crucial to recognise that real integration and coherence happen locally. Local governments use policies, strategies, and plans as entry points for promoting the integration of climate change and disaster risk reduction (Mysiak et al., 2018). Based on their research in selected local governments in Australia, the authors argue that climate change increases the frequency and intensity of natural hazards; therefore, local governments design their common goals in climate change and disaster risk management strategies, policies, and related documents, demonstrating the nexus between two domains.

2.6 Disasters and Food Security

Disasters could impact the availability, access, and reliability of foods, as agriculture is one of the critical sectors susceptible to disasters such as floods, droughts, heat and cold waves, and landslides. Therefore, sectoral preparedness and well-tested recovery strategies can be crucial in ensuring food security for at-risk and affected communities. The right to food is a fundamental human right (Ofreneo & Hega, 2016). They argue that this fundamental right has not been met in many countries where disasters and poverty are part of everyday life. For example, in the Philippines, hunger has increased by more than 20 per cent since 2009, correlating with several factors, including the impacts of disasters (Mahar & Mangahas, 2013). Excessive rainfall or a lack of rainfall and high temperatures associated with climate change can lead to crop failures and losses to crops and their infrastructure.

The Food and Agriculture Organization (FAO) argues that alleviating hunger and reducing poverty correlate with disaster risk reduction. They suggest that incidents of food crises are induced by severe adverse weather, natural hazards, economic shocks, conflicts, or a combination of these shocks (FAO, 2013).

2.7 Disaster Impacts in Sri Lanka

Sri Lanka is prone to five major disasters: tsunamis, floods, droughts, landslides, and cyclones (Wickramaratne et al., 2012). The authors argue that these disasters are ranked based on severity

and impacted area. Out of these five major disasters, except for tsunamis, all others are climate-induced, and there is a direct link with climate change. The FAO highlights that a severe drought followed by floods in 2017 has resulted in over 900,000 people suffering food insecurity in Sri Lanka. The FAO further argues that the drought in 2016 and 2017 has reduced the production of Sri Lanka's staple food by 40 per cent. It further says that the income of one-third of the drought-affected people has been reduced by half (EFE, 2017). The authors suggest applying climate change adaptation and mitigation measures to combat the impacts of natural disasters on the food security sector.

According to the Ministry of disaster management, the most affected people have been reported from floods, followed by droughts, tsunamis, storms, and landslides. (Ministry of Disaster Management, 2019). The UNDRR under its DesInventar data base estimates that majority of the affected people are associated with droughts followed by floods as depicted in figure 2-1.

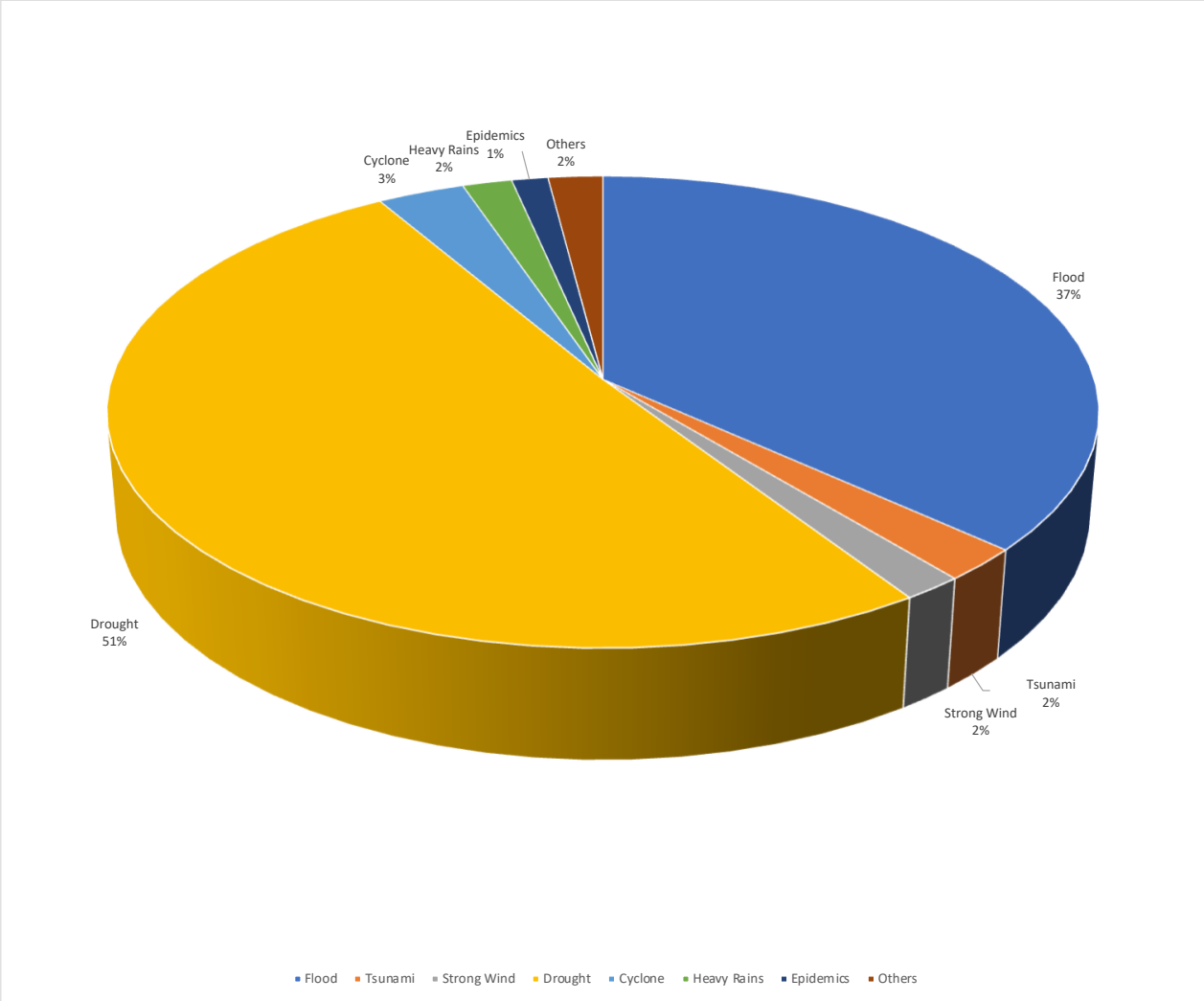


Figure 2-1: People by different disasters in Sri Lanka (1965-2019)

(Adopted from DesInventar.net (2023))

According to the World Bank Group's Think Hazards web portal, the following hazards have been identified and categorised based on severity and frequency (World Bank, 2019).

Table 2-3: Risk Classification of Hazards in Sri Lanka

Hazards	**Severity / Risk**	**Description**
River floods	High	Based on the currently available data and flood models, potentially life-threatening and damaging river floods may occur at least once in the next ten years.
Urban floods	High	Based on the currently available data, potentially life-threatening and damaging urban floods may occur at least once in the next ten years.
Cyclone	High	Based on the currently available data, there is more than a 20% probability of potentially damaging winds occurring in the next ten years.
Wildfire	High	Based on the currently available data, there is greater than a 50% probability of encountering weather that could trigger a significant wildfire that will likely result in life and property loss in any given year.
Coastal foods	Medium	Based on the currently available data, there is more than a 20% probability of potentially damaging coastal floods that may occur in the next ten years.
Tsunami	Medium	Based on the currently available data, there is more than a 10% probability that a potentially damaging tsunami may occur in the next 50 years.
Extreme heat	Medium	Based on the currently available data, there is more than a 25% probability of at least one prolonged exposure to extreme heat, resulting in heat stress, that will occur in the next five years.
Water Scarcity	Low	Based on the currently available data, there is a 1% probability of drought that may occur in the coming ten years.
Earthquake	Very Low	Based on the currently available data, there is less than a 2% probability of a potentially damaging earthquake in the next 50 years.
Landslides	No data	Currently, no data is available in this tool.

(Think Hazards Web portal, Word Bank, 2022)

In addition to the above-stated major hazard types, coastal erosion and deforestation have impacted the country with long-lasting and significant repercussions over the years (Wickramaratne et al., 2012). Five main rivers, namely the Mahaweli, Kelani, Kalu, Gin, and Nilwala, cause annual floods among the 103 river basins of the country. The Kelani River flows across the central capital city, Colombo, and causes annual floods (Wickramaratne et al., 2012). Major floods were reported in 1907, 1913, 1940, 1947, 1957, 1967, 1968, 1978, 1989, 1992, and 2003, impacting lives and properties (Jayasekara, 2009). Illegal and unauthored constructions, reclamation of lowlands, poor maintenance of drainage systems, and a lack of proactive approaches and long-term planning processes are the main reasons for floods, specifically flash floods in major cities (Jayasekara, 2009).

The DMC maintains a hazard database called DesInvetar (www.DesInventar.lk), which has collected data since 1974. In a report published by the Consortium of Humanitarian Affairs (CHA) analysing the data from the DesInventar database, the authors argue that there has been an increasing trend of natural hazards since 1974 (CHA, 2016). The report further states that the number of reported disaster events has increased 22 times in the last decade, compared to the decade ending in 1983 since the data collection started in 1974. They further argue that such an increase is predominantly associated with hydro-meteorological hazards. The report says the frequency of floods has increased by 56 per cent, while the frequency of droughts has increased by 18 per cent. It reported that landslides had increased by 16 per cent, while high wind frequency had increased by 10 per cent. Over 36 million people have been affected by various hazards for the last four decades, with an average of 900,000 people affected yearly (CHA, 2016).

The hazard profile of Sri Lanka has identified Rathnapura, Kalutara, Galle, Kurunegala, and Ampara as the most flood-prone districts of the country (Disaster Management Center, 2023). According to the DMC, leading causes of floods are river overflows, flash floods (in the mountains and narrow valleys), localised floods (in urban areas with inadequate drainage systems), reservoir operations (opening of spillway gates), and dam/reservoir breaches (Disaster Management Center, 2023). The center further states that there has been an increasing trend in flood hazards in the last reported ten years compared to the preceding ten years since 1974.

Drought is another common hazard in Sri Lanka. The hazard profile of Sri Lanka classifies drought into three main categories: meteorological, agricultural, and hydrological drought. Meteorological drought can be defined as a lack of sufficient rainfall in a pre-determined period,

while agricultural drought is a deficiency in soil moisture for cultivation and farming. Hydrological drought is defined as deficiencies in surface and underground water supplies. Socio-economic drought is defined as the gap between the supply and demand of water for economic activities, goods, or supplies (UNDRR, 2023).

According to the hazard profile published by the disaster management center (DMC), the government of Sri Lanka, the North, North Central, East, and South-East provinces and their districts have been categorised as "very highly prone areas" to droughts. It further identified districts of the intermediate zone as "highly prone" to droughts (Disaster Management Center, 2023).

The DMC has identified three main reasons for meteorological droughts in Sri Lanka. One of the scenarios occurs during the Northeast monsoon season (December -February) when the air stream to the country comes from the northern hemisphere high-pressure system through the dry mainland of the Indian subcontinent. Another scenario occurs due to decreasing weather systems in the Bay of Bengal from October to January, which may result in dry spells throughout the country. Another scenario occurs during the southwest monsoon from May to September as the air stream of the monsoon is relatively dry due to variations in the flow path. Therefore, dry spells prevail in the districts of wet and intermediate zones (Disaster Management Center, 2023).

The cyclonic storm is another potential hazard to Sri Lanka. According to the DMC, nineteen major cyclonic storms have been reported from 1981 -2011. As stated in Table 2.2, most cyclonic storm events were reported in December, followed by November.

Table 2-4: Seasonality of Historical Cyclone Events in Sri Lanka

Month	**Number of Events**	**Year**
January	1	1906
February	-	
March	2	1907, 1925
April	1	1939
May	-	
June	-	

July	-	
August	-	
September	-	
October	1	1967
November	6	1912, 1922, 1925, 1966, 1978, 1992
December	8	1908, 1913, 1919, 1931, 1964, 1967, 1980, 2000

(Disaster Management Center, 2023)

According to the hazard profile of Sri Lanka, the location with proximity to the Bay of Bengal is one of the main reasons for cyclones exposure. An average of five to six cyclonic events develop yearly in the Bay of Bengal (Disaster Management Center, 2023). On the other hand, the frequency of landslides has increased in hilly areas in the recent past, according to the disaster management center.

Sea-level rise is another hazard identified in the hazard profile of Sri Lanka. Table 2-3 indicates the number of hectares vulnerable to inundation due to sea-level rise in the next 25, 50, 75 and 100 years, respectively.

Table 2-5: Inundation of area due to sea level rise in Sri Lanka

	Total Inundation Area (ha)			
District	**25 Years**	**50 Years**	**75 Years**	**100 Years**
Colombo	959.00	1,133.00	1,327.00	1,534.00
Gampaha	3,638.00	4,154.00	4,631.00	5,073.00
Puttalam	11,334.00	12,583.00	13,716.00	14,809.00
Mannar	8,024.00	8,262.00	8,518.00	8,758.00
Jaffna	10,321.00	11,164.00	12,014.00	12,891.00
Mullaittivu	912.00	1,004.00	1,092.00	1,180.00
Trincomalee	2,315.00	2,529.00	2,791.00	3,033.00
Batticaloa	2,325.00	2,443.00	2,568.00	2,702.00
Ampara	1,180.00	2,175.00	2,479.00	2,762.00
Hambantota	4,265.00	5,553.00	6,516.00	7,322.00
Matara	1,277.00	1,634.00	1,994.00	2,401.00
Galle	5,622.00	6,462.00	7,249.00	8,014.00
Kalutara	1,956.00	2,370.00	2,790.00	3,203.00

Total	**54,128.00**	**61,466.00**	**67,685.00**	**73,682.00**

(Disaster Management Center, 2023)

The National Disaster Management Plan (NDMP: 2022-2030) has identified the following major disasters leading to the loss of lives and properties

a) Floods
b) Cyclones / high winds
c) Droughts
d) Landslides
e) Lightening
f) Tsunamis
g) Sea level rise
h) Storm surge
i) Coastal Erosion
j) Fire
k) Human elephant conflict

As shown in Table 2-4, the NDMP has categorised those major hazards according to the frequency of occurrences.

Table 2-6: Hazards ranking based on the frequency.

Frequent Hazards	**Floods, Landslides, Lightning, Tornados**
Intermediate Hazards	Droughts, Cyclones, Storm Surges, Coastal Inundation, Epidemics
Rare Hazards	Tsunamis

(Disaster Management Center, 2022)

The NDMP has also recognised the non-life threatening but equally critical hazards with long to medium-term impacts, specifically due to climate change. Those include droughts, erosion, sedimentation, salinity intrusion, contamination of water bodies, and bush/forest fires.

2.8 Disaster Risk Management Frameworks

Disaster Risk Management is a broad and multidisciplinary field. It requires policies, strategies, and plans at various levels to advance risk reduction measures. Therefore, this session of the

chapter discusses disaster risk management frameworks at global, national, and sub-national levels.

2.8.1 Sendai Framework for Disaster Risk Reduction (SFDRR: 2015-2030)

The SFDRR was adopted at the end of the Third World Conference on Disaster Risk Reduction in March 2015 as the first post-2015 global development agenda. It is the global blueprint for disaster risk reduction, where countries agree on priorities and seven targets, as stated below. (Mysiak et al., 2015).

- Substantially reduce mortality at the global level;
- Substantially reduce the number of affected people at the global level;
- Substantially reduce the direct economic losses due to disasters on the global GDP;
- Sustainably reduce the damage to critical infrastructure, facilities and services;
- Substantially increase the number of countries that have implemented national and local level disaster risk reduction strategies;
- Substantially increase international cooperation for disaster risk reduction, specifically for developing countries;
- Substantially increase the availability of functional end-to-end early warning systems, access to early warning messages and risk analytics.

Although SFDRR has identified seven targets, one of the key limitations of this global blueprint is that it does not explicitly set the quantitative targets; instead, it says “substantially’ increase or decrease; therefore, it is very subjective depending on the context (Mysiak et al., 2015). Furthermore, the first five years (2015-2020) of the SFDRR have been identified to establish the frameworks and baseline at the national and sub-national levels. The progress of implementing SFDRR will be measured from 2020 -2030 against the baseline. The SFDRR also does not have country or region-specific targets; instead, it has global targets; therefore, measuring country and regional-specific progress will be difficult (Mysiak et al., 2015).

The SFDRR is a non-binding voluntary agreement endorsed by the UN member states. It recognises that the primary responsibility for risk reduction is with the respective governments. It encourages mobilising other partner agencies, such as the private sector and key non-state actors, for risk management (Mysiak et al., 2015). It has four priority areas.

- Priority one: understanding disaster risks;

- Priority two: strengthening disaster risk governance to manage risk;
- Priority three: investing in disaster risk reduction for resilience;
- Priority four: enhancing disaster preparedness for effective response and to "build back better" recovery, rehabilitation and reconstruction.

The respective governments must translate this global blueprint into local-level implementation strategies and plans at national and subnational levels. The role of local governments has been recognised and embedded in the SFDRR through the call for strengthening local governance, "all of the society approach," and coordination (Albrito, 2018).

2.8.2 National Disaster Risk Management Framework in Sri Lanka

Disaster Management Ecosystem in Sri Lanka started to move faster after the 2004 Tsunami, the enactment of Disaster Management Act No 13, May 2005 and the subsequent establishment of the Disaster Management Center and the Ministry of Disaster Management. In line with Global Disaster Risk Management Frameworks, the respective countries, national governments, and local governments must develop disaster risk management strategies at different levels. Accordingly, several national and sub-national frameworks and policy instruments have been developed, as stated in the next section.

2.8.2.1 National Policy on Disaster Management, Sri Lanka

The National Policy on Disaster Management of Sri Lanka (2010) provides the overarching principle and desired outcomes of disaster risk management in the country. The National Council on Disaster Management, an inter-ministerial committee headed by the President, approved the policy on December 28, 2010. The overall goal of the policy is a 'safer and resilient Sri Lanka'. The policy supports the multi-hazards and multi-phase approach covering pre, during and post-disaster-related interventions. The policy has identified climate change as a sector which needs to be integrated into disaster risk management. The policy supports a multi-layer approach and collective decision-making processes at the national, provincial, district and local levels. The policy also highlights the need to invest in short, medium, and long-term strategies, which is critical for the climate change adaptation processes (NCDM, 2010). The policy has also endorsed the participatory decision-making process involving government, the private sector, NGOs, and at-risk communities at various levels. It has recognised that at-risk communities have the 'right to participate' in the planning, decision-making, implementing, and monitoring of risk reduction

processes. The policy recommends developing and updating multi-hazard risk profiles and tools for disaster risk management. The policy also recommends that guidelines be readily available for mainstreaming disaster risk reduction into development planning processes at national, provincial, district, divisional and local levels.

2.8.2.2 National Disaster Management Plan

The DMC adopted the National Disaster Management Plan (NDMP: 2013-2017) on May 2, 2014. The plan was developed following the provisions of the Disaster Management Act No. 13 of 2005. It aims to reduce disaster impacts on communities, critical infrastructure, lifelines, livelihoods, ecosystems and development actions. The plan was revised and updated as NDMP 2022-2030, The plan provides overall institutional systems, coordination mechanisms and strategies to implement at various levels. It also establishes horizontal integration between national institutions and ministries. Figure 2-2 illustrates the disaster management planning frameworks stated in the NDMP.

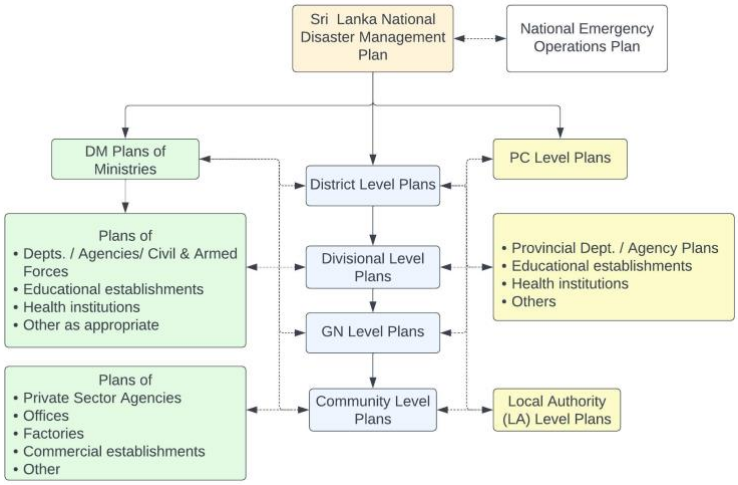


Figure 2-2: Disaster Management Planning Framework of Sri Lanka

(Adapted from Disaster Management Center (2022))

The NDMP covers all phases of the disaster management spectrum. It is a guiding document covering major interventions related to mitigation, preparedness for response, early warning, emergency operations, post-disaster relief, rehabilitation, and reconstruction. Figure 2.3 illustrates the coordination and implementation arrangements for disaster management interventions at various levels.

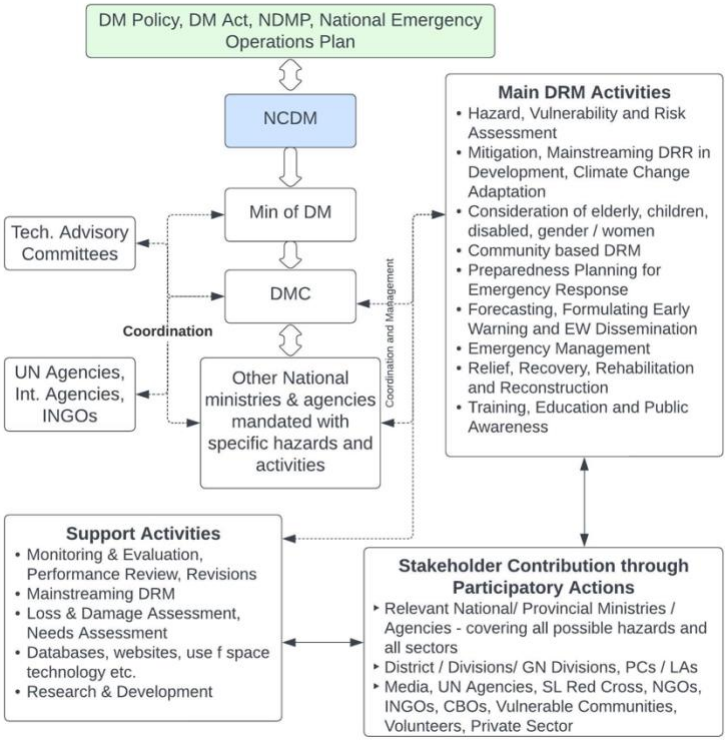


Figure 2-3: Core DRM activities in the Disaster Management Plan

(Adapted from Disaster Management Center (2022))

The NDMP also recognise the roles of multiple actors in the disaster management processes at various level and their corresponding coordinating and technical roles in the disaster risk management processes. The plan recommends establishing disaster management committees at national, ministerial, provincial, district, divisional, local authority, Grama Niladari and community levels. Figure 2-4 shows the linkages between national and local-level disaster risk management committees.

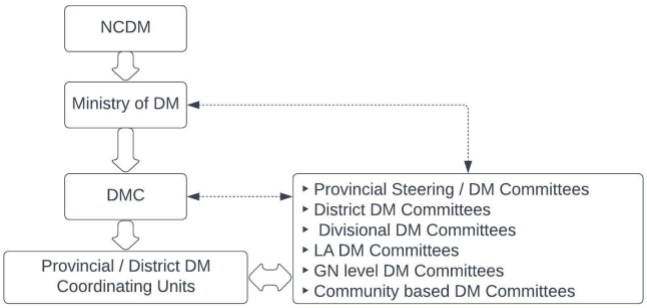


Figure 2-4: Disaster Management Committees at different levels

(Adapted from Disaster Management Center (2022))

The NDMP provides an overall disaster management planning framework at the national level. Early warning is one of the critical interventions outlined in the NDMP. It highlights the

importance of establishing the warning system up to the last mile. It also recommends a similar planning approach in horizontal and vertical layers of governance, as shown in Figure 2-5.

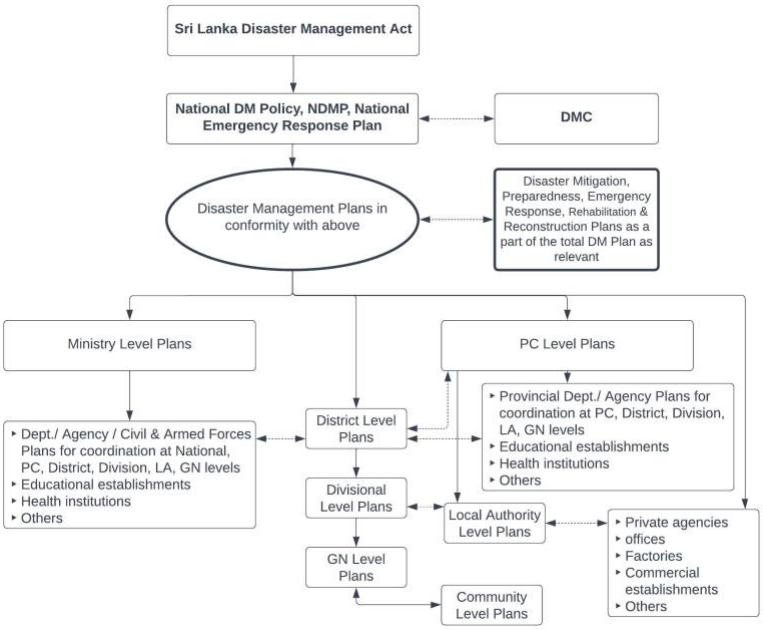


Figure 2-5: Disaster management planning processes at different levels in Sri Lanka.

(Adapted from Disaster Management Center (2022))

Chapter one of the NDMP 2022-2030 depicts specific inventions and priorities related to disaster mitigation, DRR mainstreaming and climate change adaptation. It recommends developing and implementing the DRR interventions through;

- Commitments at the national level, along with a suitable policy and legal environment, to risk-sensitive development planning.
- Enforce laws that will enable sectoral organizations to operate more efficiently and adopt integrated risk reduction strategies.
- Develop comprehensive, human-centered, multi-hazard early warning systems and climate services while increasing societal awareness of risks to support impact-based decision-making at all levels.
- Create a planning process that integrates institutional capabilities and is supported by solid scientific data by taking into account potential vulnerabilities in the contexts of the physical, human, environmental, social, and economic domains.
- Make sure disaster risk reduction regulations are adhered to for national physical plans, zone plans, land use plans, and major project development.

- Create an environment of equal opportunity and data sharing for all stakeholders, from the national to the community level, to participate in all stages of disaster risk reduction actions.
- To promote strong integration with social protection mechanisms towards household food security by managing disaster response and relief operations under one umbrella.
- Encourage inclusive risk management planning at the subnational and local levels, using a no-one-left-behind approach to ensure accountability and equity in gender and disability.
- Create an enabling environment for successful disaster recovery mechanisms, such as relocation, livelihood, and infrastructure support.
- Enhance interagency relationships, harness planning, and share responsibilities for implementing integrated disaster risk management projects.
- Establish partnerships in disaster risk management with local, national, and international stakeholders to foster resilience.
- Ensure the efficient use of monitoring and evaluation systems in accordance with national monitoring frameworks through integrated data management and reporting mechanisms under global and national frameworks.

The NDMP also proposes climate change mitigation by reducing greenhouse gas emissions and climate change adaptation by implementing the recommendations of global frameworks such as the Bali Action Plan (COP 13) and the Paris Agreement on Climate Change. The NDMP has identified benefits of CCA, such as reducing climate-related losses and efficient use of financial and human resources. It has also recognised the increased sustainability of DRM and CCA initiatives through close collaboration between NDMP and climate change-related policy instruments, including the National Adaptation Plan for Sri Lanka (2016-2025).

Part three of the literature review chapter discussed the concepts of DRM, the nexus between climate change and disasters, disaster impacts on food security, disaster impacts in Sri Lanka, global disaster management frameworks and their applications in the Sri Lankan context. This section helped the researcher to understand the overall approach for managing disaster risks and linkages with climate change and food security issues.

Part three of the literature review chapter focuses on CCA as a critical process for resilience. It discusses the concepts of CCA, convergence between CCA and DRM, upscaling DRM and CCA

for food security, the current status of risk-informed CCA policies, strategies and frameworks for combatting food security challenges, CCA planning frameworks, CCA governance, and roles of end-users in CCA in Sri Lanka.

Part Three: Climate Change Adaptation

2.9 Climate Change Adaptation Concepts

Adaptation to climate change has gained recognition in national and international policy debates. Adaptation requires policy instruments and tools to make informed decisions and change how we live to cope with climate risks. According to the literature, "adapt" means making necessary changes and making them more suitable (Smit et al., 2000). They argue that the term "adaptation" can be defined as both processes of adapting and the condition of being adapted.

Intergovernmental Panel on Climate Change (IPCC) defines "adaptation" as "the adjustment process to actual or expected climate and its effects" (IPCC, 2014). In the adaptation process, at-risk communities seek to avoid or minimise harm and optimise opportunities. Adger et al. (2009) argue that adaptation is constructed around three dimensions. Those are ecological and physical limits, economic limits, and technological limits. Further, some scientists have used the five-dimension model as a reference for adaptation in the agriculture sector. Those are (1) non-climatic determinants of vulnerability, (2) general trends in livelihood strategies, (3) the perception of climatic trends, (4) climate impacts in agriculture and (5) potentials and obstacles for adaptation (Below et al., 2015).

2.9.1 Upscaling DRR as an Adaptation Option to Climate Change

Upscaling disaster risk reduction can be defined as increasing thresholds to withstand future climate-induced hazards. The magnitude, frequency, and intensity of future hazards could be higher than the current levels. Therefore, current thresholds in disaster preparedness and mitigation options will not be sufficient. Hence, increasing thresholds and upscaling ongoing disaster risk reduction practices can be an adaptation option. The literature argues the need for more coherently integrating climate change adaptation and disaster risk reduction (Birkmann & von Teichman, 2010b). However, crucial differences between CCA and DRR have hindered their integration into common practices. Some key challenges in integrating DRR and CCA include funding structures, the association of two practice communities into different ministries and insufficient data on the impacts of climate change at local levels. Birkmann and von Teichman

(2010a) argue that practical barriers to integrating DRR and CCA can be categorised into (1) scales, (2) knowledge and (3) norms. They emphasise the need to understand scale mismatches, norm mismatches (legislation, cultural and behavioural), and knowledge mismatches to integrate DRR and CCA holistically.

2.9.2 Climate Change Adaptation and Disaster Risk Management Convergence

Both CCA and DRM aim to reduce adverse impacts on the people, properties and the environment and advance sustainable development. There is no one-on-one relationship between disasters and climate extremes. Extreme events may lead to disasters if the communities and their system are exposed to them and unsafe conditions (Christopher B. Field et al., 2012). Figure 2-6 shows the nexus between CCA and DRR in the context of sustainable development. Although both disciplines have the same objectives, they tend to follow independent paths, different interpretations, strategies, policies, and institutional frameworks.

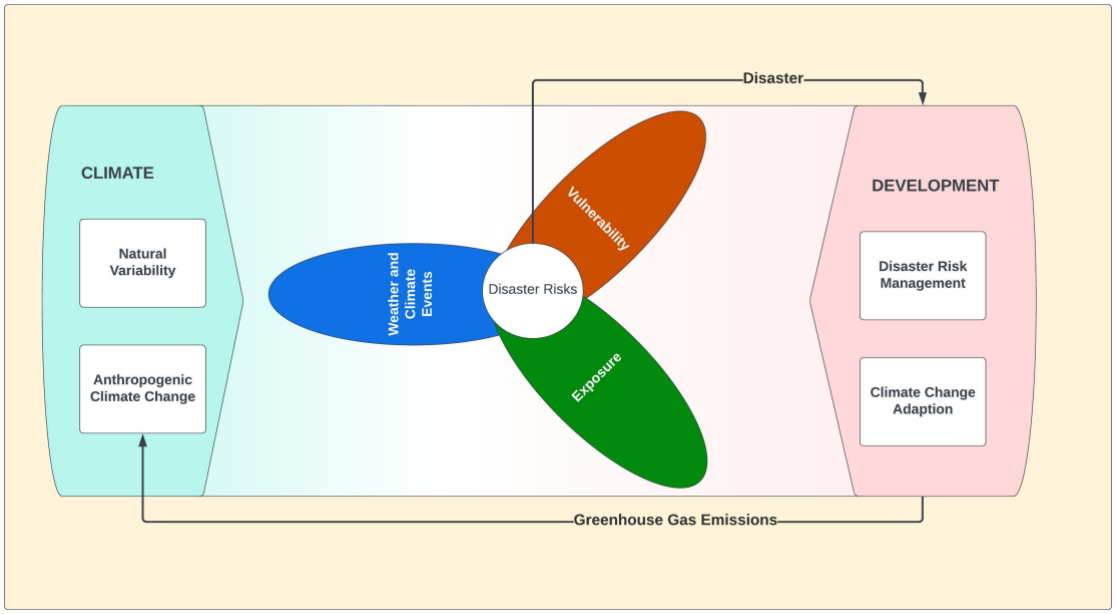


Figure 2-6: Nexus between CCA, DRR and Sustainable Development.

(Adapted from (IPCC, 2014)

2.9.3 Climate Change Adaptation and Upscaling DRR for Food Security

Recent disasters such as floods and droughts have threatened millions of lives and agricultural production, thereby threatening food security (Li, 2012). According to the special report on the State of Food Security and Nutrition by the World Food Program, Food and Agriculture Organization and World Health Organization, hunger is an increasing trend in many countries

(WHO, 2018). It further says that 804 million people were under-nourished or facing chronic food deprivation in 2016 increased to 821 million in 2018 globally. The report highlights the direct and indirect impacts of climate change on food security and malnutrition. Droughts reported in many countries during 2015/2016 have contributed to global food insecurity because of crop failures. Di Falco et al. (2011) argue that a group of farmers who adapted to climate change scenarios have different characteristics. They further emphasise that adaptation to climate change increases food productivity. Therefore, adaptation strategies are crucial for the most vulnerable farm households. Although there are dialogues among international, regional and national policymakers, integrating CCA and DRR is a significant challenge (Birkmann & von Teichman, 2010a). They emphasised that the international community is more coherently discussing ways and means of addressing climate change and DRR. They argue that adaptation to climate change needs interventions in different sectors, such as agriculture, health, and infrastructure, in which the adaptation measures will be implemented or scaled up. The CCA community has recognised DRR as one of these sectors, although there is an ongoing debate on their relationship (Birkmann & von Teichman, 2010b)

The impacts of climate change are no longer a mystery, and more impacts will have in the coming years. Therefore, urgent actions must be undertaken in sensitive sectors such as agriculture (Asner et al., 2009). Adaptation in the agriculture sector must be addressed more coherently. There are many options for adaptation in the agriculture sector by marginal changes in response to moderate impacts of climate change (Howden et al., 2007). Authors further argue that effective adaptation in the agriculture sector requires more targeted resource allocation and integration of CCA into the overall risk management strategies. They further state that CCA must be integrated into other policy domains, such as sustainable development and DRR. Comprehensive policy reforms are required while considering the farmers' choices and risk profiles (Howden et al., 2007). The authors argue that science must be adapted as a multidisciplinary approach and serve as the interface between policymakers and end-users. An effective adaptation planning framework should be relevant, robust, and easy to implement by multiple stakeholders (Howden et al., 2007). CCA can be integrated into different phases of DRR. On the other hand, upscaling DRR while considering climate change impacts can be a very effective way of adapting to climate extremes.

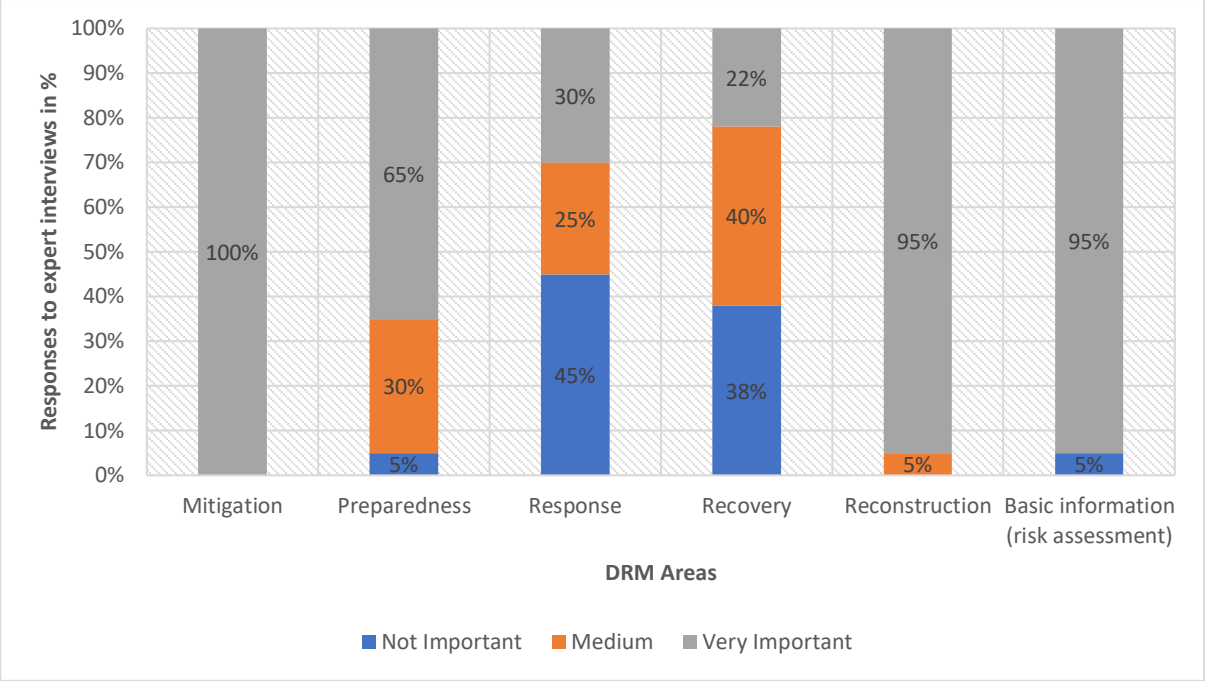


Figure 2-7: Integration of Climate Change Adaptation into DRR phases

(Created from data source: Birkmann and von Teichman, 2010)

Figure 2.10 shows experts' opinions on integrating CCA into different phases of DRR (Birkmann & von Teichman, 2010a). Experts fully agree with 100 per cent of respondents saying that it is imperative to integrate CCA into the disaster mitigation phase when designing and implementing mitigation investments. Regarding the preparedness phase, 65 per cent of respondents agreed that it is crucial to integrate CCA into disaster preparedness. In comparison, 30 per cent of expert respondents said it is of medium importance. Only 5 per cent of the expert respondents said it is not essential to integrate CCA into the preparedness phase. In the disaster response phase, only 30 per cent of respondents agreed that it is very important to integrate CCA. In comparison, another 25 per cent of expert respondents agreed that it is of medium importance. In the recovery phase, 22 per cent of the experts opinion that integrating CCA into recovery is very important. In comparison, 40 per cent of experts agreed that it is of medium importance. In the reconstruction phase, 95 per cent of experts expressed that it is imperative to integrate CCA into the reconstruction phase to ensure reconstructed infrastructures are resilient to future climate and disaster shocks. Further, 95 per cent of the experts interviewed in the research agreed that it is crucial to integrate climate change adaptation into basic information, specifically in the risk assessment process.

Based on the above literature research, the researcher believes that CCA can be integrated into all the phases of DRM; however, importance, applicability and acceptance vary in the respective

phases of the DRM spectrum. Disaster mitigation, preparedness, reconstruction, and risk assessment phases have shown high potential and acceptance for integrating CCA into DRM, while response and recovery phases have shown less importance comparatively.

Both CCA and DRR aim to reduce vulnerability and enhance resilience. Therefore, linking them at policy, strategic and operational levels will benefit DRR and CCA fields of practice (Begum et al., 2014). Figure 2-8 shows how CCA and DRR have been approached and integrated into a common process.

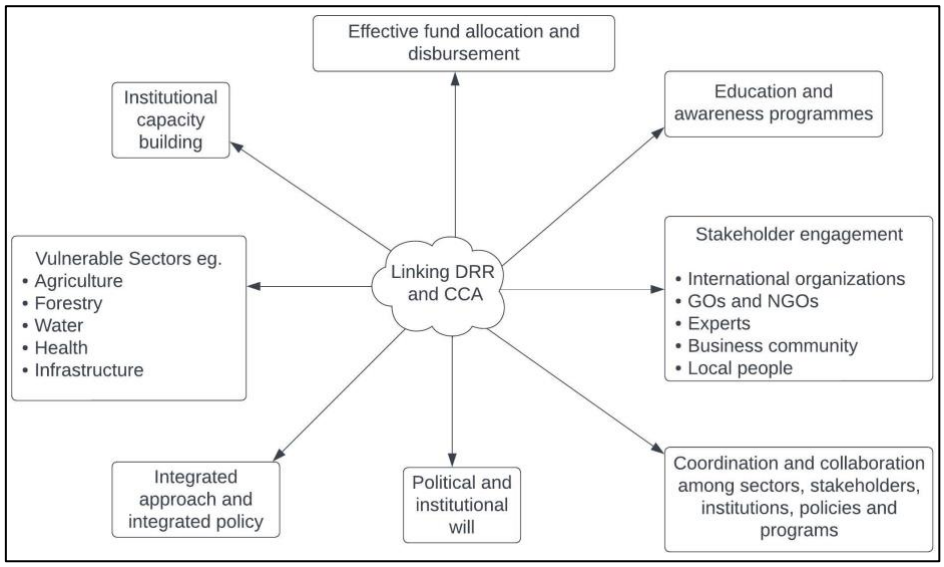


Figure 2-8: Factors involving the effective integration of CCA and DRR.

(Adapted from Toward conceptual frameworks for linking disaster risk reduction and climate change adaptation Begum et al., 2014)

As shown in Figure 2-08, one of the key entry points for linking CCA and DRR is to build the capacity of institutions. That will enhance the knowledge, skills and understanding of DRR and CCA, making the integration faster and easier. Also, DRR and CCA can be integrated into the sectoral planning process in vulnerable sectors such as agriculture, forestry, water, and health. Authors also argue that an integrated policy would link CCA and DRR to standalone policies. Multi-stakeholder engagement, effective coordination and collaboration, education and awareness programs, and resource allocation are considered enabling factors for integrating CCA and DRR into common thinking processes. The political will and support from the policymakers are critical factors to the successful integration of DRR and CCA (Begum et al., 2014).

2.9.4 Mainstreaming Climate Change Adaptation and DRR into Development Planning

There is a rising acknowledgment for adopting initiatives to integrate disaster risk reduction (DRR) activities with climate change adaptation (CCA) strategies in order to achieve sustainable development goals. The Sendai Framework of Action (SFA), 2015-2030, has highlighted this need, encouraging national governments to establish strategies, conduct additional research, and seek for coherence across policies, institutions, goals, indicators, and measurement systems for implementation (Dash & Akhter, 2023). Despite the existence of DRR-CCA mainstreaming laws and policies, their implementation is still in its early stages (Gabriel et al., 2021). A systematic procedure is required to identify areas in which DRR is not or is insufficiently incorporated as a basic concern across policy sectors, as well as how it could be improved (Dovers et al., 2022). There is increasing consensus among experts that disaster risk reduction must be mainstreamed into development planning and policy to lessen disaster-related risks. The term "mainstreaming" refers to the seamless integration of tributaries into the larger mainstream of a river, a process in which disparate flows are integrated into one (Tiepolo et al., 2017). Thus, according to writers, "mainstreaming risk reduction" refers to integrating disaster risk reduction (DRR) initiatives into relief and development initiatives. When applied to mainstreaming, it requires an analysis of how potential hazards can affect the performance of policies, programs and projects, and on the other hand, it should also consider how these hazards might affect vulnerable landscapes. The findings of these analyses can assist in developing risk sensitive policies, which are now widely recognized as a critical component of sustainable development (Tiepolo et al., 2017) . They further highlight that climate change must also be incorporated into mainstreaming processes, as appropriate, and additional priority interventions must be considered. Monitoring and forecasting of climate change (both science-related and policy-related) are essential components of this process. Several other interventions are also required, such as budgeting and financial support for adaptation, including integrating adaptation into national systems and leveraging special funding sources and mechanisms for mainstreaming. Local authorities should prioritize disaster risk reduction (DRR) as a priority, and it is important that scientists assist in bringing science-based solutions to the attention of decision-makers before major disasters occur (Uchiyama et al., 2021). There are more synergies than discords between climate change adaptation and climate-related disaster risk reduction (DRR) that should be harnessed and mainstreamed into development practices (Banda et al., 2022). The integration of climate change adaptation (CCA) and disaster risk reduction (DRR) into development planning is essential to reducing vulnerability and risk. In spite of some efforts to mainstream DRR and CCA, the processes for development planning have seen them as

separate things (Wijaya, 2018). Insufficient guidance on how to integrate CCA and the lack of instruments and capacity in this area hinder improved integration of CCA into planning (Rivera, 2014). At all levels of governance, mainstreaming efforts can be incorporated into development plans, processes, and initiatives, as well as at subnational and national levels. It is also possible to mainstream risk management principles into decision-making processes, legislation, regulations, protocols within organizations, and subsidy regimes. Mainstreaming is largely focused on the core sectors of development activities used by most governments worldwide, regardless of their governance or administrative level. They include agriculture, transportation, utilities, housing, health, and education, among others (Tiepolo et al., 2017).

2.9.5 Current Status of Risk-Informed Climate Change Adaptation Policies and Strategies for Combatting Food Security Challenges

Countries recognise the importance of developing climate change adaptation policies and strategies at different levels. The strategizing human-environment interactions reinforce the need for climate change-related policies to support sustainability agendas through adaptation and mitigation options (Li et al., 2011). Authors further highlight that, for example, Chinese policymakers have recognised the need to integrate climate change adaptation and mitigation into development policy instruments such as: "China's National Programme in Response to Climate Change" by the State Council in 2007 and a White Paper in 2008. However, Lemieux et al. (2014) argue that despite the increased empirical knowledge of the process and commitment to address climate change by governments worldwide, climate change adaptation policies remain scarce. They have identified key adaptation planning challenges such as short project duration, financial resources scarcity, lack of expertise, and difficulty in assessing complex sectoral vulnerabilities. They concluded that "an enabling policy directive, leadership, local support, adequate planning time, and resources are required to facilitate science-based policy development." Research conducted in the Pacific countries, namely Vanuatu and Timor-Leste, suggests that the current scales of adaptation strategies in those countries are relatively too small; therefore, researchers question whether it will have a significant impact in the future (Rosegrant et al., 2016). They further suggest that there is a need for an aggressive but judicious increase in investment in climate change adaptation strategies and policy development. They conclude that climate change adaptation strategies and policies should be developed to the conditions in each country and location.

Research conducted in the Yongqiao District of China shows that Farmers' risk preferences, risk perception, and risk knowledge play an essential role in adaptation to climate change in the

agricultural sector. They found that most farmers in the study area were aware of climate change. Therefore, they are applying adaptation measures against perceived changes to the local climate (Jianjun et al., 2015). A similar study conducted in Ethiopia and South Africa states that understanding farmers' perceptions of climate change, current adaptation measures in practice, and the decision-making process is crucial for developing risk-informed adaptation policies in the agriculture sector (Bryan et al., 2009). They further argue that an enabling environment to support adaptation policies can be created by increasing access to climate information and risk knowledge, resources, credit, and markets and improving the reach of small-scale subsistence farmers.

2.9.6 Climate Change Adaptation Planning Frameworks

Climate change adaptation has moved from the awareness phase to a critical phase of developing strategies, policies, frameworks and their implementation (IPCC, 2015). National frameworks play a vital role in the adaptation planning processes, while adaptation responses are diverse at subnational and local levels. The authors argue that those national-level actors and institutions provide coordination, information, policy framework development, legal frameworks, and actions for protecting the most vulnerable groups and financing adaptation at various levels, both in horizontal sectors and vertical administrative layers. Sub-national and local planning agencies and actors struggle to develop strategies without access to information and data. Even in some cases with access to data, they are given options from choosing adaptation measures without knowing the consequences. Therefore, involving various stakeholders at different administrative levels will lead to a robust planning process and implementation. (IPCC, 2015). The authors further suggest that climate change adaptation planning is a learning and iterative process involving multiple stakeholders. They further argue that there is no single approach to planning. Therefore, key stakeholders need to adopt an appropriate approach based on the present context and nature of adaptation. Top-down and bottom-up planning frameworks have gained recognition in the literature; however, in most cases, a combination of both approaches is being used (IPCC, 2015). Actors use various tools for designing climate change adaptation frameworks depending on the process's costs, context, and manageability. It includes tools related to information and risk knowledge, risk communication across time scales, advanced decision support system (DSS), monitoring, early warning, insurance-based tools and ecosystem-based tools. (IPCC, 2015).

2.9.7 Climate Change Adaptation Governance

According to the IPCC, CCA Governance is a critical component for transitioning from the planning phase into the implementation phase. Institutions and their governance are essential for mainstreaming CCA in the development planning and implementation processes (IPCC, 2015). The authors have recognised the following key barriers or enablers of the governance for the implementation of climate change adaptation strategies and actions;

- Multilevel institutional coordination between administrative boundaries;
- Key actors promoting and supporting CCA mainstreaming;
- Horizontal coordination between actors, sectors and their policies at similar administrative levels;
- Political will and their support in the planning and implementation;
- Coordination and collaboration between formal governments and other stakeholders such as the private sector, civil society groups and local NGOs.

2.9.8 Role of End-user Groups in Climate Change Adaptation

Multilevel actions are required for productive and successful adaptation. Recognising the complementary roles of actors, their strategies, policies, plans and actions at different levels is critical to successful adaptation (IPCC, 2015). The national-level focal agency is crucial in coordinating and collaborating with international, national, sub-national and local agencies (Ministry of Mahaweli Development & Environment, 2016).

2.10 Climate Change Adaptation Context in Sri Lanka

Climate change adaptation is an emerging theme in Sri Lanka. Basic institutional arrangements, policies and planning instruments are currently being developed. The Climate Change Secretariat under the Ministry of Environment is leading the CCA coordination process while specialized agencies and other ministries are implementing specific interventions as stated in the below sections.

2.10.1 National Adaptation Plan for Climate Change in Sri Lanka

Sri Lanka is highly vulnerable to climate change impacts. Therefore, national-level agencies and their actions are crucial in adaptation planning and implementation. (Ministry of Mahaweli

Development & Environment, 2016). CCA strategies and policies in Sri Lanka are vital for subsistence farmers to ensure food security (Esham & Garforth, 2013a). The authors further argue that understanding farmers' perception of climate change and associated risks, actual adaptation at local levels and identifying the driving or constraining factors to adapt is necessary to develop appropriate adaptation strategies and institutional frameworks. They conclude that understanding the local communities' socioeconomic, cognitive, and normative aspects is crucial for formulating and implementing adaptation strategies. There is growing advocacy for the government to reform environmental, institutional and economic conditions to promote CCA by the farmers to overcome key barriers such as shortage of water, resources, raw materials, and inadequate adaptation planning processes and practices (Menike & Arachchi, 2016). Traditional knowledge and experience in climate change and water resource management are required for integrated and inclusive planning approaches to climate change adaptation in the dry zone of Sri Lanka (Withanachchi et al., 2014)

National Adaptation Plan (NAP) for Climate Change in Sri Lanka (2016-2025) was developed through a consultative process by the Climate Change Secretariat, Ministry of Environment, Government of Sri Lanka. NAP was developed based on the guidelines set by the United Nations Framework Convention for Climate Change (UNFCCC), as stated in Figure 2.11. In the NAP, nine sectors have been identified as the most vulnerable and fragile in Sri Lanka to climate change impacts (Ministry of Mahaweli Development & Environment, 2016). Those are

a) Food Security Sector
b) Water Sector
c) Coastal Sector
d) Health Sector
e) Human Settlements Sector
f) Bio-Diversity Sector
g) Tourism Sector
h) Recreation Sector
i) Export Development and Industry-Energy-Transportation Sector

The NAP has been developed using 'Logical Criteria', which are based on projections of climate change, identification of vulnerabilities, assessing impacts and looking at socioeconomic outcomes of the sectors.

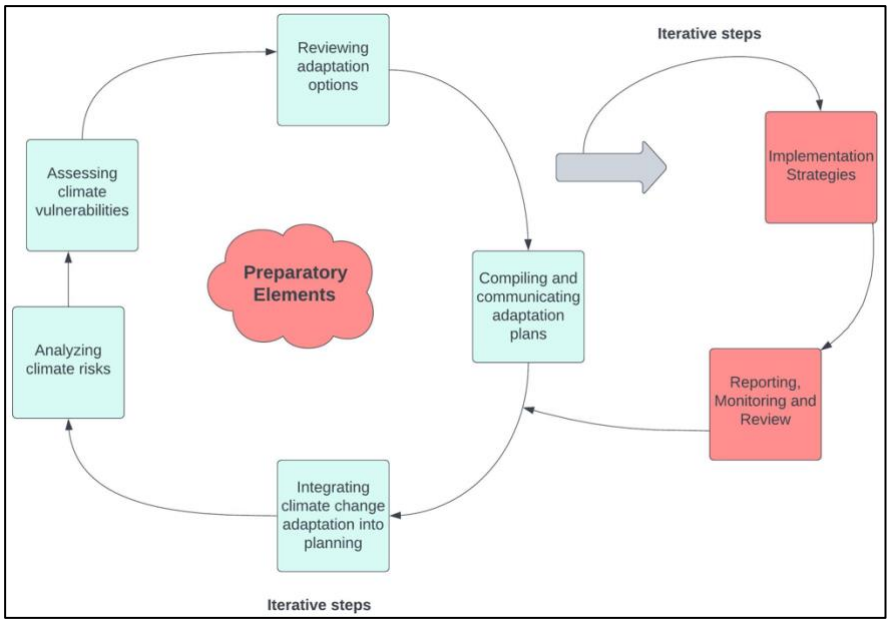


Figure 2-9: Iterative Steps for the development of NAP in Sri Lanka.

(Adapted from the NAP, Ministry of Mahaweli Development and Environment, 2016)

The NAP has used past studies to assess generic climate change impacts than assessing location-specific climate vulnerability and risks. However, as Jianjun et al. (2015), farmers' perception and risk knowledge of climate change play a vital role in adaptation planning and implementation.

The NAP has identified and prioritised the following sectors and sub-sectors for developing climate change adaptation options and strategies in Sri Lanka. The Climate Change Secretariat is the lead agency for coordinating and implementing NAP at the national and sub-national levels (Ministry of Mahaweli Development & Environment, 2016).

The NAP has been developed based on the vulnerabilities and adaptive capacities of the sectors and key stakeholders. The vulnerability profiles for five sectors have been developed and used in the NAP process. However, limited literature and research on the 'adaptive capacity' exists. NAP identifies the following adaptive capacities for implementing adaptation strategies at various levels.

- Livelihood assets
- Knowledge and skills
- Technology

- Institutions
- Information

The NAP has been developed to build the capacity and knowledge of all decision-makers at various levels, including national, sub-national and supra-national levels (Ministry of Mahaweli Development & Environment, 2016).

Table 2-7: Vulnerable sectors and priorities for CCA in Sri Lanka

Vulnerable Sectors of the NAP	Priority Areas
Food Security: Agriculture, Livestock and Fisheries	• Rice • Other Field Crops (OFC) • Horticultural Crops • Sugarcane • Livestock • Fisheries • Agriculture and land degradation
Water Resources	• Water for Agriculture • Water for human consumption • Water for industry and energy • Degradation of watersheds
Coastal and Marine Sector	• Coastal Zone Management • Beach stability • Coastal biodiversity • Ocean Acidification
Health	• Climate altering pollutants • Diseases: Spread and outbreaks • Hazardous Events: Health Impacts • Heat / thermal stress
Human Settlements and Infrastructure	• Urban settlements and infrastructure • Rural settlements and infrastructure • Estate settlements and infrastructure • Coastal settlements and infrastructure
Ecosystems and Biodiversity	• Forests

	• Wildlife • Wetlands • Agroecosystems: home gardens • Loss of ecosystem services
Tourism and Recreation	• Coastal tourism • Tourism and biodiversity • Cultural assets
Export Agriculture Sector	• Tea • Rubber • Coconut • Export Agricultural Crops
Industry, Energy and Transportation	• Industry • Energy • Transportation

(Ministry of Mahaweli Development and Environment, 2016)

According to the NAP, critical gaps and barriers to adaptation in Sri Lanka are

- Information gaps
- Technology gaps
- Policy and governance gaps
- Institutional coordination gaps
- Financing and resource mobilisation gaps

The NAP has been developed to address those gaps holistically so that the adaptive capacity of the sectors and actors can be enhanced (Ministry of Mahaweli Development & Environment, 2016). There is no single approach to developing a NAP. It has to be flexible and can use a variety of tools (UNFCCC, 2012). The authors further suggest that it must be a complementary approach, and steps and stages of the planning processes are not fixed. Such flexible approaches benefit least developed and developing countries as they do not have enough data to facilitate the NAP processes (UNDRR, 2023). As each country faces different circumstances, the flexible approach will allow the stakeholders to use the most appropriate processes and tools for the adaptation planning processes. It concludes that rigid methodologies and approaches in NAP will not result in desired change processes and the implementation of the NAP; therefore, actors are encouraged

to develop and use customised tools and approaches in designing climate change adaptation frameworks for the sectors (UNDRR, 2023).

2.10.2 Paris Agreement on Climate Change

The Paris Agreement is a treaty within the boundaries of the Vienna Convention on the laws related to treaties. It has a mix of binding and non-binding obligations with regard to climate change mitigation, but it also has adaptation and financing obligations for climate change impacts (Bodansky, 2016). The government of Sri Lanka signed the Paris Agreement in April 2016. Intended Nationally Determined Contributions (INDCs) of the Government of Sri Lanka with regard to the Paris Agreement have been designed in line with NAP and their priority actions in the sectors.

2.10.3 National Climate Change Policy of Sri Lanka (NCCP)

The national climate change policy is a broad policy statement for mainstreaming climate change issues within the development planning frameworks and instruments in Sri Lanka. The vision of the policy is a future where climate change will have no adverse consequences on Sri Lanka' (Ministry of Environment and Renewable, 2011). It provides 25 policy statements, one of which is climate change adaptation. They focus on sensitising vulnerable communities to climate change and taking appropriate measures for adaptation to climate change impacts on people, their livelihoods, and ecosystems.

2.10.4 National Climate Change Adaptation Strategy for Sri Lanka (NCCAS)

Considering the high vulnerabilities and inadequate adaptive capacities of Sri Lanka, the Ministry of Environment developed the National Climate Change Adaptation Strategy (NCCAS), identifying priority actions and investment framework for the period from 2011 -2016 (Ministry of Environment and Renewable, 2011). The focus of the strategy is on adaptation. It has identified five strategic thrust areas, twenty-five thematic areas and ninety-one priority adaptation measures. The ministry further says that NCCAS identifies some broader adaptation options; therefore, actors can choose from the menu of options. The main strategic thrust areas include

- Mainstreaming CCA into national planning and development;
- Enable climate-resilient and healthy human settlements;
- Minimise climate change impacts on food security;
- Improve climate resilience of key economic drivers;

- Safeguard natural resources and biodiversity from climate change impacts.

2.10.5 Other Related Policies, Programs and Strategies

Several other directly or indirectly related policies, strategies and programs support the adaptation planning processes. One such plan is 'the National Adaptation Plan for Haritha Lanka', which focus on climate mitigation measures and some selected adaptation options such as infrastructure level adaptation, land use planning, and rainwater harvesting. The National Action Program for Combatting Land Degradation (NAPCLD) is another vital instrument which has identified climate change as one of the root causes of land degradation. The ministry also identifies the Coastal Zone Management Plan (CZMP) and the National Physical Development Plan (2011-2030) as important policy instruments in adaptation to climate change in the coastal zones and infrastructure spheres.

2.11 Summary of Literature Review

The researcher organised the literature review chapter into three main parts. Part one discussed the concept of food security and food insecurity. Part two focused on the climate change domain. It discussed fundamental concepts of climate change, climate change impacts; climate resilience; climate change impacts on the food security sector; and finally, climate change impacts in Sri Lanka, specifically focusing on the food security sector. Part three of the chapter was on the disaster risk management domain. It discussed fundamental concepts of disaster risk management; climate change and disaster nexus; impacts of disasters on food security; disaster impacts in Sri Lanka; and the disaster risk management frameworks in Sri Lanka. Part four of the chapter discussed the climate CCA and DRR mainstreaming domains. It discussed climate change adaptation concepts; upscaling DRM for CCA; CCA and DRM convergence and mainstreaming; the current status of the risk-informed climate change adaptation strategies, policies and plans; the importance of CCA governance; roles of end-user groups in CCA; and finally, CCA context and CCA planning frameworks and instruments available in Sri Lanka.

The literature review chapter helped the researcher identify research gaps and organise steps and approaches to addressing them. Major research gaps found during the literature review process are

a. Disaster risk management, climate change adaptation and sustainable development are interrelated domains and needs coherent at the global, regional, national, sub-national and local levels. Although coherent is embedded into post-2015 agendas (SFDRR, SDGs and the Paris Agreement) globally, translating them into national and local levels in implementing strategies, plans, and programs is a significant gap. It requires a holistic approach at the national, sub-national, and local levels, bringing science-based tools, local evidence and practices into the planning and implementation processes. Literature highlights the scale issue of current climate change adaptation and disaster risk reduction processes as they do not have positive impacts on the ground due to a lack of holistic approach, engaging multiple stakeholders and sectors for risk assessments, and designing and implementing appropriate adaptation, risk reduction and mainstreaming frameworks, strategies, and policies.

b. Literature highlights the need for having an 'all of society approach' for effective CCA and DRR. Roles of the multiple stakeholders at the national, sectoral, provincial, district, divisional, and village levels have been emphasised in a vast amount of literature as well as national planning instruments related to CCA and DRR in Sri Lanka. The roles of end-user groups, such as communities and farmers and their front-line service providers, such as extension workers, cannot be underestimated. However, one of the major gaps identified during the literature review process is the engagement of at-risk communities and farmers (end-user groups) in designing national and sectoral adaptation planning strategies, policies, and frameworks. The literature further emphasises the need for designing and implementing sector-specific strategies, plans and frameworks based on the engagement of multiple actors at different levels. It also highlights the need for having an integrated approach to bringing CCA and DRR domains into a common framework, specifically at the sub-national and local levels.

c. Climate change adaptation planning faces a methodology challenge due to the uncertainties of impacts at the local level. The impacts assessments process is complex and needs to tailor to the local context. The lack of context-specific planning processes is a major gap considering the cultural, social, economic, environmental, and political dimensions of adaptation. Literature has highlighted the importance of the place value of CCA. Effective adaptation at the national, sub-national and local levels needs close collaboration and a multi-sector approach in designing and implementing strategies, policies, and programs. This is a significant gap at this stage.

d. Literature also highlights the need for bringing local evidence in risk analysis, planning processes, implementation, monitoring, and evaluation of adaptation actions. It is a major gap as current CCA and DRR planning frameworks are being designed without adequate local evidence and the participation of end-user groups. When translating international planning instruments, guidelines, and frameworks at the local level in an integrated manner, the capacities and needs of local-level institutions and the most vulnerable groups should be kept at the core of planning processes.

e. Generalised planning frameworks and instruments are major gaps. Fragile and vulnerable sectors to climate change need to be identified, and sector-specific adaptation and DRR mainstreaming frameworks need to be designed based on the level of risks, context (place value) and engagement with multiple stakeholders, including the end-user groups and at-risk communities. Fragile sectors such as food security need to get priority as it is vulnerable to chronic long-term impacts of climate change, climate-induced extreme events, and other hazards. Food security has been identified as a priority sector among the most vulnerable sectors to climate change in Sri Lanka on multiple fronts. Although generic national planning instruments are available, designing a sector-specific planning framework is a timely need. Sector-specific plans must consider the climate and disaster risks integrated with local evidence.

f. Finally, the perception of at-risk communities and the end user groups matter the most regarding successful or unsuccessful adaptation and risk reduction. Risk perception and perception towards adaptation will determine the level of engagement and acceptance of national, sub-national and local strategies, plans and programs. However, risk and adaptation perceptions of the at-risk communities and end-user groups are not considered in the planning processes.

Based on the above-stated major gaps, the researcher frames his intervention rationale for addressing them in his research. According to the literature analysis, achieving or maintaining food security in a changing climate can be achieved through two main options: accelerated adaptation to future climate change and proper management of agricultural risks due to climate variability and extreme events (Vermeulen et al., 2012). While recognising the importance of global, regional and national efforts for CCA, researchers and development practitioners have

increasingly emphasised the need for community-based adaptation (CBA) for climate change in the food security sector. However, researchers and development practitioners need to acknowledge the specific challenges in the CBA approaches due to the complexity and uncertainty of climate change impacts. Without a proper assessment of risks and uncertainty, institutional structures, multilevel adaptation policies, programs, and practices are unlikely to support effective CBA outcomes at local levels (Dodman & Mitlin, 2013). Therefore, this research will focus on designing a comprehensive planning framework for mainstreaming CCA and DRR into the food security sector planning at the sub-national level in Sri Lanka. The reason for selecting this approach is due to the lack of such comprehensive planning frameworks for mainstreaming CCA and DRR and their application in the food security sector, particularly in developing countries like Sri Lanka. Dodman and Mitlin (2013) argue that opening multiple options to obtain technical advisories equips the local low-income communities to acquire the expertise to assess and understand the consequences of climate change and their uncertainties and deal with multiple scales of options and interventions at local levels.

On the other hand, adaptation strategies and options vary from sector to sector and place to place (Schipper et al., 2014). Therefore, smart climate agriculture and adaptation investments are most successful through community-based adaptation processes led by local stakeholders and the farming community with the working knowledge of ongoing and future agricultural investments. The role of research scientists and experts is to monitor and ensure convening scientific knowledge and resources to the local communities to minimise facilitator biases (Andrieu et al., 2017).

Therefore, in line with the identified research gap, this research is scoped down to design a framework for mainstreaming climate change adaptation and disaster risk reduction into the food security sector in Sri Lanka. Thus, this research aims to develop a framework for mainstreaming CCA and DRR into the food security sector planning of the district government (sub-national level) of Sri Lanka. Based on the research gaps, aim, objectives, and literature, the researcher designed the conceptual framework for the research discussed in the next chapter.

CHAPTER 3 : CONCEPTUAL FRAMEWORK

3.1 Introduction

The thesis began with an Introduction Chapter and a detailed literature synthesis in Chapter 2. This chapter discusses the process used to establish the initial conceptual framework for this study. Accordingly, the chapter is organized as follows:

- Firstly, the need for and importance of a conceptual framework is discussed.
- Secondly, the key issues identified through literature and the opinions of international experts are summarized.
- Thirdly, the process of developing the conceptual framework is described.
- Fourthly, the conceptual framework of the study is presented.
- Finally, the chapter is summarized and linked to the next chapter.

3.2 The need for and importance of a conceptual framework

A conceptual framework explains the main themes to be studied graphically or narratively. It includes key factors, constructs, or variables and the presumed relationships among them (Miles & Huberman, 1994). According to the authors, the frameworks can be "rudimentary or elaborate, theory-driven or commonsensical, descriptive, or causal". The conceptual framework illustrates the core themes or variables in the study and their presumed linkages to one another, usually in diagram form (Punch, 2014). The framework guides the researcher in determining the type and nature of data to be collected and the types of concepts and relations to be studied as the research progresses. The conceptual framework provides a logical sense for interrelated concepts important to the research problem. The conceptual framework is a network of interconnected concepts that, when combined, provide a thorough understanding of a phenomenon or phenomena being studied (Jabareen, 2009). According to the author, a conceptual framework is more than just a collection of concepts; it is a construct in which each concept plays an important role. He argues that the conceptual framework provides an interpretative approach to social reality rather than a causal/analytical setting.

This research aims to develop a framework to mainstream CCA and DRR into food security sector planning at sub-national levels. Therefore, the aim of the research is to develop useful theories applicable to the food security sector through case studies following an inductive approach. However, Yin (2018) argues that the researcher should begin constructing preliminary theoretical propositions related to the research question as part of the case study research design before data

collection begins. It emphasizes the importance of developing a theory or conceptualizing the phenomenon, related concepts, and their interactions before collecting and analyzing empirical data. According to Punch (2014), the conceptual framework can be developed beforehand or emerge as the study progresses. The conceptual framework also influences how much-predetermined structure a study will have (Punch, 2014). Inductive approaches typically begin with empirical observations, and it is critical to have an initial definition of the research questions before building a theory from case studies (Yin, 2018). According to the author, this forces the researcher to develop a preliminary theory before data collection and analysis, allowing the researcher to identify the main concepts, their relationships, and research boundaries. Thus, developing a conceptual framework was essential to this research and guided the researcher in data collection and analysis. Therefore, before collecting primary data, this study designed a conceptual framework. The conceptual framework was designed using the literature and then refined based on the international experts' opinions and inputs. It explains how CCA and DRR can be mainstreamed into the food security sector planning processes of district governments in Sri Lanka.

3.3 Key Issues Identified for Developing a Conceptual Framework

A comprehensive literature review was conducted at the beginning of the research, looking at global and Sri Lanka-specific literature. Based on the literature review, the researcher identified key themes and research areas for further studies. Prioritized research areas were further screened and refined based on the opinions and feedback received from international experts. The conceptual framework was developed based on the literature review findings and international experts' input. The literature review with opinions and inputs from international experts identified the following key areas for the study: climate change impacts on food security (see Section 2.3.4); increasing disaster impacts in Sri Lanka (see Section 2.7); the climate change and disaster nexus (see Section 2.5); disaster impacts on the food security sector (see Section 2.6); and the need for mainstreaming CCA and DRR into the food security sector (see Sections 2.9). Specific details of the identified key areas are discussed below.

3.3.1 Climate change impacts on food security

In addition to the direct impact of disasters on food security, climate change has long-term effects on the agriculture and food security sectors. Agriculture is the world's largest user of freshwater, making it extremely vulnerable to climate change (Calzadilla et al., 2013). Changes in atmospheric

conditions and parameters such as precipitation, temperature, and relative humidity could be to blame. The World Bank has identified five major climate change-related factors impacting crop productivity. These include changes in precipitation, temperature, carbon dioxide fertilization, climate variability, and surface runoff (Kurukulasuriya et al., 2006). According to the literature, climate change will affect crop yields and cultivation patterns due to changes in the atmospheric concentration of greenhouse gases, specifically CO_2. It could have both positive and negative consequences (Singh, 2016). He argued that higher atmospheric CO_2 concentrations would benefit C3 crops such as wheat and rice more than C4 crops such as maize, sorghum, sugar cane, and grasses. As a result, he claims that doubling atmospheric CO_2 could increase biomass by nearly 36%. He does, however, assert that the effects of climate change on agriculture and food security are extremely complex. Temperature increases can shorten crop duration, increase respiration and evapotranspiration, reduce fertilizer use efficiency, and make crops more susceptible to pest infestation, reducing crop production and productivity.

Furthermore, research shows dryland crops and livestock farmers are particularly vulnerable to temperature changes. Irrigated crops benefit from climate change in relatively cold areas because irrigation alleviates water shortage issues caused by climate change (Kurukulasuriya et al., 2006). They also argue that if precipitation increases with climate change in relatively dry areas, net revenue from dryland crops and livestock will increase. They assert that the initial temperature and precipitation of individual farms determine the marginal effects of climate change. Climate change impacts on the food security sector are greater than what scientific models predict. Climate change will cause an additional 5 million to 170 million people to hunger by 2080, depending on countries' social, economic, and political decisions (Schmidhuber & Tubiello, 2007). They propose developing new assessment methodologies to assess the local impacts of climate change on the food security sector.

The international experts also acknowledged that climate change impacts food security globally and in their respective countries. One expert stated that *"climate change affects the food production and food access both directly due to extreme events and changes of atmospheric conditions",* indicating further studies and specific details should be found to address the specific issues related to the food security sector.

3.3.2 Increasing disaster impacts in Sri Lanka

Tsunamis, floods, droughts, landslides, and cyclones are the most common natural disasters in Sri Lanka (Wickramaratne et al., 2012). According to the authors, these disasters are ranked based on their severity and the affected area. All five major disasters are climate-related and directly

linked to climate change, except for tsunamis. According to the United Nations Food and Agriculture Organization (FAO), a severe drought followed by floods in 2017 resulted in food insecurity for over 900,000 people in Sri Lanka (EFE, 2017). Furthermore, according to the EFE news service, the FAO claims drought in 2016 and 2017 reduced rice production in Sri Lanka by 40%. It goes on to say that the income of one-third of the drought-affected people has been cut in half. The authors propose implementing climate change adaptation and mitigation measures to combat the effects of natural disasters on the food security sector.

According to the Ministry of Disaster Management in Sri Lanka, floods have affected people the most, followed by droughts, tsunamis, storms, and landslides (Ministry of Disaster Management, 2019). The world bank group's think hazards web portal has identified key hazards that Sri Lanka regularly faces and categorizes them based on their severity and frequency, as stated in Table 2-4 (World Bank, 2019). Coastal erosion and deforestation have had long-term and significant consequences for the country over the years (Wickramaratne et al., 2012). The Mahaweli, Kelani, Kalu, Gin, and Nilwala rivers cause annual floods in the country's 103 river basins. The Kelani river flows through Colombo's central business district, causing annual flooding (Wickramaratne et al., 2012). Major floods were reported in 1907, 1913, 1940, 1947, 1957, 1967, 1968, 1978, 1989, 1992, and 2003, affecting people and property (Jayasekara, 2009). The leading causes of floods, particularly flash floods in major cities, are illegal and unauthorized constructions, reclamation of lowlands, poor drainage system maintenance, and a lack of proactive approaches and long-term planning processes (Wickramaratne et al., 2012)

DesInvetar (www.DesInventar.lk) is a disaster inventory database maintained by the DMC that has collected information dating back to 1974. The authors of a report published by the CHA analyzing data from the DesInventar argue that natural hazards have increased since 1974 (CHA, 2016). According to the report, the number of reported disaster events has increased 22 times in the last decade, compared to the decade ending in 1983, since data collection began in 1974. They also claim that such an increase is mostly associated with hydrometeorological hazards. According to the report, the frequency of floods has increased by 56%, while the frequency of droughts has increased by 18%. It reported that the frequency of landslides had increased by 16%, while the frequency of high winds had increased by 10%. Over the last four decades, various hazards have affected over 36 million people, with an average of 900,000 people affected each year.

The body of published research unequivocally demonstrates that the frequency and severity of natural disasters in Sri Lanka have steadily risen over the past two decades. Because of this,

additional research is required to determine the detailed effects on crucial sectors such as food security.

3.3.2 Climate Change and Disaster Nexus

The relationship between climate change and disasters is still being debated. IPCC (2014), in its special synthesis report, argues that "surface temperature is projected to rise over the 21st century under all assessed emission scenarios". They also predict that heat waves will become more frequent and last longer, while extreme precipitation events and floods will become more intense and frequent in many regions. As a result, they conclude that climate change will exacerbate existing risks while creating new ones. Climate risks are unequally distributed and are more severe for disadvantaged people and communities in countries at all stages of development (IPCC, 2014). As a result, adapting to climate change and increasing disaster risk reduction plays a vital role in improving community resilience and food security.

To have an integrated approach to climate change and disaster risk management, relevant global, regional, and national policies must be synchronized. Coherence among related policies has been considered in post-2015 agendas, resulting in convergence in the SFDRR and the Paris Agreement (Mysiak et al., 2018). They argued that SFDRR promotes multi-hazard, inclusive, science-based, and risk-informed planning processes and practices. The Paris Agreement, on the other hand, advocates for global adaptation goals for mitigating the adverse effects of climate change and extreme events and overall climate resilience. SFDRR goals, targets, approaches, and the Paris Agreement are prerequisites for SDGs.

3.3.3 Disaster Impacts on the Food Security Sector

Climate change exacerbates disasters affecting food availability, access, and reliability. The agriculture sector is vulnerable to floods, droughts, high winds and cyclones, heat and cold waves, and landslides. Sectoral preparedness and well-tested recovery strategies can be critical in ensuring food security for at-risk and affected communities. Excessive or insufficient rainfall, combined with high temperatures caused by climate change, can result in crop failures and losses to crops and infrastructure. The right to food is a fundamental human right (Ofreneo & Hega, 2016). They argue that this fundamental right will not be met if disasters and poverty are part of everyday life. In the Philippines, for example, hunger has increased by more than 20% since 2009, correlating with various factors, including the effects of disasters (Mahar & Mangahas, 2013). According to the FAO, reducing disaster risk is strongly linked to reducing hunger and poverty.

They argue that food crises are caused by severe adverse weather, natural disasters, economic shocks, conflicts, or a combination of these shocks (FAO, 2013).

3.3.4 The need for mainstreaming CCA and DRR into the food security sector

Disaster risk management is integral to post-2015 development frameworks. Global targets of the SFDRR, namely the reduction of mortality, the number of people affected, economic losses, and damage to critical infrastructure caused by natural disasters, are prerequisites for achieving the SDGs. Furthermore, adaptation approaches in SFDRR and SDGs are consistent with the Paris Agreement. Therefore, policy coherence is required in implementing global frameworks at the local level to achieve the overall impacts of sustainable development (Albrito, 2018).

While it is crucial to reflect policy convergence at the global level, it is also essential to recognize that true integration and coherence occur at the local level. Local governments promote integrating climate change and disaster risk reduction into development sectors and actions through policies, strategies, and plans (Mysiak et al., 2018). Based on their research in selected Australian local governments, the authors argue that climate change increases the frequency and intensity of disasters; thus, local governments design their common goals in CCA and DRR strategies, policies, and related documents, demonstrating synergy between the two domains.

Despite dialogues among international, regional, and national policy groups, mainstreaming CCA and DRR remains a significant challenge (Birkmann & von Teichman, 2010a). They emphasized that the international community is debating how to address CCA and DRR more coherently. They also argue that adaptation to climate change necessitates interventions in various societal sectors, such as agriculture, health, and infrastructure, where adaptation measures will be implemented or scaled up. The CCA community of practice has identified DRR as one of the sectors, though the relationship between CCA and DRR is still being debated (Birkmann & von Teichman, 2010a).

Climate change impacts are no longer a mystery; more will be felt in the coming years. Thus, immediate actions are required in sensitive sectors such as agriculture (Asner et al., 2009). Agriculture sector adaptation must be addressed more comprehensively. There are numerous options for adaptation within existing agricultural systems through minor changes in response to moderate climate change impacts (Howden et al., 2007). The authors argue that effective adaptation in the agriculture sector necessitates more targeted resource allocation and the

incorporation of CCA into overall risk management strategies. They say climate change adaptation must be mainstreamed into other policy domains, such as sustainable development and DRR. Comprehensive policy reforms and risk-sensitive development are required to overcome CCA barriers while considering farmers' choices and risk profiles (Howden et al., 2007).

3.4 Development of the Conceptual Framework

As depicted in Figure 3.1, the literature review helped the researcher identify core issues for the study, thereby establishing key concepts, interrelationships between key concepts, and the boundaries wherein the concepts and interrelationships are relevant. The initial conceptual framework was refined with inputs and feedback from international experts. Figure 3-1 illustrates the process undertaken in the development of the conceptual framework.

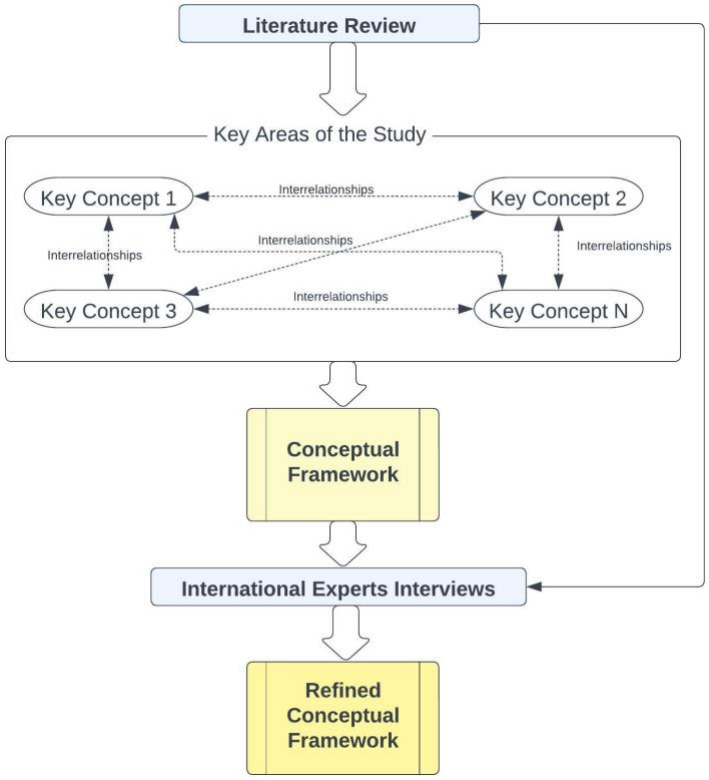


Figure 3-1: Conceptual Framework development process

3.4.1 Key Concepts

As stated in Section 3.3, five key concepts were identified through the literature review and further validated through international expert consultations. The literature and international experts agreed that the food security sector is becoming more vulnerable to climate change and disasters, making SDG-2, zero hunger, resilient agriculture and food systems beyond the reach of most

countries. Accordingly, the importance of mainstreaming CCA and DRR into the food security sector has been emphasized. The literature further highlighted the need for mainstreaming CCA and DRR into policies, strategies, and programs of the food security sector at national, sub-national and local levels. The international experts also acknowledged the need for mainstreaming CCA and DRR into food security sector planning processes as food is a fundamental human right and a critical goal of SDGs. Both literature and experts agreed that multiple stakeholders at different levels should be mobilized in mainstreaming CCA and DRR into food security sector planning processes. They further agreed that districts and sub-national government entities should be empowered to do so. Following identifying the key concepts, the next session discusses their interrelationships.

3.4.2 Interrelationships between key concepts

Following identifying key concepts, the next task was identifying inter-relationships among them. Therefore, it is critical to identify the inherent and systemic vulnerabilities of the food security sector to climate change and disasters to formulate effective mainstreaming strategies and solutions. That leads to the identification of challenges and bottlenecks in mainstreaming CCA and DRR into the food security sector at the sub-national level. Based on the challenges and bottlenecks identified, several recommendations are made on how such challenges can be overcome to mainstream CCA and DRR into the food security sector and empower district governments and other local actors to take the lead in mainstreaming processes.

3.4.3 Boundaries of the key concepts and Interrelationships

Following identifying key concepts and their interrelationships, the next task was to define the boundaries of the key concepts and inter-relationships. Food security can be ensured by effectively mainstreaming CCA and DRR into the food security sector planning process. As discussed in the literature review chapter, planning processes play a critical role and provide a window of opportunities for mainstreaming CCA and DRR into the food security sector. In line with the literature findings, international experts also recognized and acknowledged the opportunity provided by planning processes for mainstreaming CCA and DRR into the food security sector. Therefore, the study established food security sector planning processes at the sub-national level as the research boundary and investigated how CCA and DRR can be mainstreamed in the food security sector planning processes at district government levels.

Figure 3-2 depicts the resulting conceptual framework, which incorporates the key concepts, interrelationships, and boundaries.

3.5 Conceptual Framework of the Study

Figure 3.2 depicts the conceptual framework of the study, which illustrates the process of mainstreaming CCA and DRR into food security sector planning at the subnational level to achieve food security for all following SDG-2. The framework was designed based on the literature review findings and international experts' opinions. In addition, the conceptual framework identifies the unit of analysis for the study, which is "mainstreaming CCA and DRR into district-level food security sector planning."

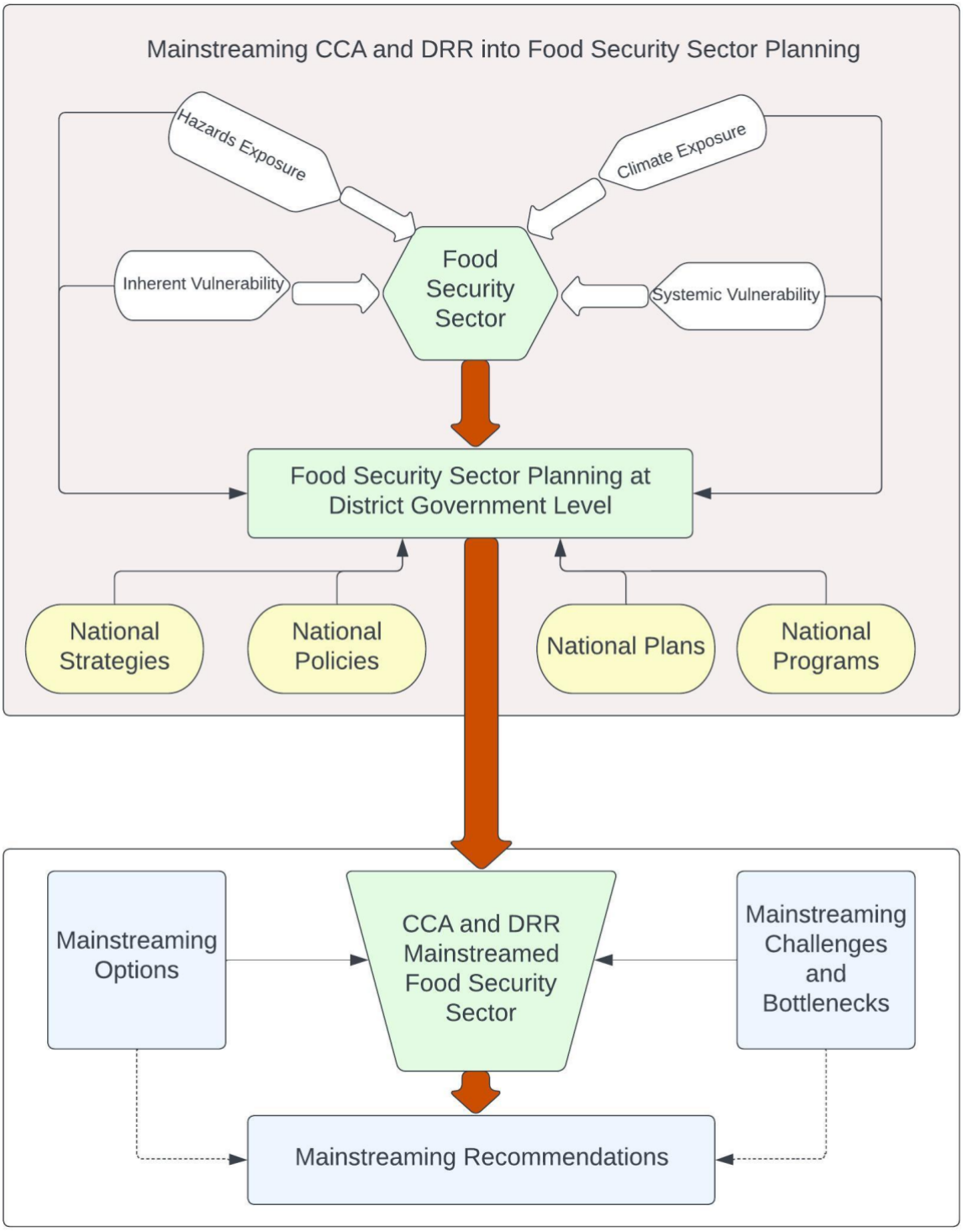


Figure 3-2: Conceptual Framework of the study.

3.6 Summary and Link

This chapter elaborates on how the conceptual framework of the study was developed. The process entails identifying the key concepts, their interrelationships, and the boundaries of the investigation. The conceptual framework is derived from the literature review and refined based

on opinions and experts inputs received from international experts. Accordingly, the developed conceptual framework depicts the process of mainstreaming CCA and DRR into food security sector planning processes at the district level. Following the development of the conceptual framework, the next chapter discusses the research methodology.

CHAPTER 4 : METHODOLOGY

4.1 Introduction

This chapter discusses the overall research methodology and its design for undertaking the research. Firstly, it presents the type of research, establishes the research problem, the purpose of the research and the research strategy. Then it presents the research design, detailing the research philosophy, strategy and associated research techniques the researcher applies in undertaking the research. Accordingly, this chapter discusses the following sections:

- Firstly, the type of research and its rationale.
- Secondly, it discusses the research problem, the purpose of the research and the research strategy.
- Thirdly, the research design detailing the research philosophy, research strategy and techniques.
- Fourthly the validity and reliability of the research design.
- Finally, it discusses and summarises the entire research methodological design.

4.2 Background and Rational for Using Social Research

Social research focuses on human behaviour. Social research is rigorous and extensive work to discover new ideas and theories based on human behaviour and society (Sarantakos, 2017). Academics and social scientists widely use social research to broaden the knowledge base, inform the communities about new findings and advocate for evidence-based policy formulation by governments. Traditionally, social science gathers data from society to help us understand society. However, the trend has changed the usage of findings and impacts of social research methods and related techniques used by scientists in other sectors for broader social and academic discourse (Bailey, 2008). The basic social science disciplines include psychology, sociology, anthropology, economics and political sciences (Punch, 2014). However, applied social science goes beyond the basic social science disciplines. Those include education, organizational behaviour studies, government policy-related research, human resource administration, health research, marketing policy analysis and other economic and social development-related fields (Punch, 2014). Therefore, according to Punch's definition of social research, this research can be considered applied social research as it investigates how an integrated CCA and DRM mainstreaming framework can be designed for the food security sector planning in Sri Lanka. Knowledge, opinions, recommendations and good practices from experts and practitioners from selected case study areas were used to understand the overall process, related protocols and tools. They were

selected as key informants and interviewed to understand hazards, climate exposure, and their nexus with food security. Further details of the existing vulnerability, challenges and limitations in their existing organizational systems, related planning tools, enabling environment, policies and regulations were gathered. Experts' opinions on reforming the planning processes that enable mainstreaming CCA and DRR into the food security sector were gathered during the interviews. According to Sarantakos (2017), social research has a long history and extensive practice over more than 2000 years. Social research can be qualitative or quantitative. Ethical standards are a vital part of the research, which include professional practice, the researcher-respondent relationship and the researcher-researcher relationship. The aim of social research varies based on the methodology (Sarantakos, 2017). Conducting social research is a way of finding an answer to a real issue that we face in society. It answers how and why a group of people and individuals behave in a particular way and how that affects institutions and surrounding systems shaping society. In this context, people constantly discuss, negotiate, share, interact, and adapt to the social world (Clark et al., 2021). The same rationale is applied to this research. Developing a CCA and DRR mainstreaming framework into food security sector planning is an interactive process involving multiple sectors, organizations, groups and individuals. The social researcher's role is to investigate these dynamics, address the research questions methodically and scientifically and interpret the findings for social progression and overall socio-economic development.

4.3 Formulation of the research problem

The research problem can be defined as the *"problem or issue that leads to the need for a study"* (Creswell & Creswell, 2022). According to the authors, it can be derived from multiple sources such as experiences of the researcher's personal life or workplaces, literature discussions, or policy debates from the government and other practitioners in the sector. Establishing a research question is an iterative process of formulating, clarifying and refining research questions until it is practical and acceptable to the researcher and the research audience (M. N. K. Saunders et al., 2019). According to the authors, the researcher needs to know what he/she wants to investigate before commencing the research, which is the most critical yet complex part. During the process, one or more research questions should be formulated with aims and research objectives. Clearly defined research questions help the researcher to design the most appropriate research strategy, data collection methodology and data analysis techniques (M. N. K. Saunders et al., 2019). In qualitative studies, research questions continue to review, refined and reformulated as the study

progress. Qualitative researchers formulate at least one primary research question supported by several sub-questions (Creswell & Creswell, 2022).

4.3.1 Researcher's Area of Interest

The research will not be inspirational and interesting if it is not within the researcher's interests. It is a long-term engagement and in-depth analysis, which require extensive efforts and motivation by the researcher. Researchers generally know their research interests and practice areas, so it is relatively easy to identify the focus area. Often they face more difficulty selecting a research topic and specific research questions they need to study further and focus on (Punch, 2014). Selecting a subject area for research starts with listing out topics of interest to the researcher, followed by identifying personal strengths and weaknesses, topics of current interest in the practice area, data required for each topic and research limitations for each topic. Interest-driven research is an extremely helpful approach to enhance the knowledge and experience of the researcher while minimizing personal weakness (Fellows, 2015). In addition to the researcher's interest, Fellows (2015) highlights that assessing the resources required to undertake a study is important. It broadens the researcher's experience, expertise, and insights into his research interests (Fellows, 2015). As research is hard work, the satisfaction and sense of achievement after completing the research justify the worthiness and efforts.

With changing climate, increasing disaster impacts on the food security sector, and its effects on SDGs, the selected subject area is highly relevant and in high demand. Initial research interest in the research area came from the researcher's interests, expertise, experience, and practice areas. Therefore, the research field has been defined as "mainstreaming climate change adaptation and disaster risk management into sustainable development". Building upon the initial research interests of the researcher, a comprehensive literature review has been undertaken to formulate the research problem for this study.

4.3.2 Literature Reviews

A comprehensive literature review was undertaken to formulate the research problem. A review of previous studies and related literature supports the development of more precise, sharper and more insightful research questions about the field of study (Yin, 2018). The literature review is a process of making reasoned judgments and presenting the researcher's views and thoughts based on previous studies in the same or related field of practice (M. N. K. Saunders et al., 2019). According to Punch (2014), the literature review often becomes part of formulating the research

questions. It helps collect evidence from previous studies about this research question and summarize current knowledge and related theories (Punch, 2014). The preliminary or initial inquiry must be revisited to refine and further focus on the research problem based on the critical literature reviews. It helps researchers choose the research topic and develop research questions, aims and objectives (M. N. K. Saunders et al., 2019).

As outlined in section 4.3.1, the research area has been established to mainstream CCA and DRR into sustainable development. Building upon the initial research interests, a comprehensive literature review was conducted by reading journal articles, books, handbooks, reports, news articles, websites and conference proceedings published by various institutions and publishers. The researcher gained in-depth knowledge through literature reviews about mainstreaming CCA and DRR into sustainable development. The literature review helped the researcher narrow down the specific study area to the food security sector, which is related to SDG#2, Zero Hunger. The food security sector also aligns with the researcher's research interests, expertise, and strengths. By doing an in-depth literature review related to the subject domain, the researcher was able to identify specific gaps and research problems that he wished to investigate further. Through the literature review, the researcher established multiple connections related to the food security sector at different levels. Subnational governments are critical stakeholders in ensuring food security. That includes district administration, divisional administration, and government presentations at village levels. The researcher identified specific gaps in each level and related planning framework, tools, and protocols through the literature review. Thus, it helped the researcher to enhance his understanding and establish a thorough knowledge base in the specified subject area in undertaking the research further.

Punch (2014) argues that research questions can change as the study progress. Therefore, there is no requirement to make research questions pre-prescribed and concrete before the research commences. The author further highlights that it is desirable to follow a strategy to identify and refine research questions as the study progress, allowing them to emerge, clarify and refine at different stages of the study (Punch, 2014). It is common in qualitative studies to have research questions under continual review and reformulation as research advance into different stages of the study (Creswell & Creswell, 2022).

After completing the initial literature review related to the research area, the researcher conducted a detailed and comprehensive literature review related to the following specific areas.

- Climate change, disaster risks and food security nexus.
- Planning frameworks at the national, sub-national, and local levels.

- Roles of the sub-national governments in development planning and mainstreaming CCA and DRR into planning frameworks.
- Issues, limitations and challenges in mainstreaming CCA and DRR into subnational planning frameworks.
- Reforming and restructuring planning framework to be climate and disaster risks inclusive.

Having completed a critical literature review about the current situation in the food security sector, the researcher was able to further develop the research problem, the aim and the objectives and drafted a conceptual framework for the study. As discussed above, it is an evolving process; therefore, it was further refined with input from expert opinions and discussions as the research progressed into the next stage.

4.3.3 Expert Opinion.

Having formulated the research problem, aim and objectives, the researcher moved into the next step: conduct expert interviews to improve the concepts and the preliminary conceptual framework developed through the literature review. Semi-structured interviews were conducted with four international experts, who are extensively engaged, and active in DRR, CCA and food security domains. Following their opinions, and technical inputs, the researcher was able to finetune the research problem, clarify the aim and revise the objectives and the preliminary conceptual framework. The formulated research problems through this process are stated in Section 3.3.

As discussed in the chapter 3: Conceptual Framework, the rationale behind conducting expert interviews is to gather inputs, emerging theories and identify key themes related to the research problem. Therefore, 4 interviews were conducted with the subject experts in Asia, representing DRR, CCA, socioeconomic development and food security sectors. The experts were selected based on their subject knowledge, expertise, years of practice, and engagement in policy discussions in the subject area through purposive sampling technique. Table 4-1 presents details and profiles of the experts who participated in the study in developing the conceptual framework.

Table 4-1: Details of the International Experts who participated in the study to refine the Conceptual Framework

Expert Code	Organization and the role within the organization	Type of Organization
E001	Program Manager, DRR and CAA	International organization operates in India.
E002	Program Manager, DRR	International organization operates in the Philippines.
E003	Senior Technical Specialist, Climate Resilience	International organization headquartered in Thailand.
E004	Program Manager, DRR and former UN expert	International organization operates in Nepal.

4.3.4 Research Aim, Objectives, and Research Question.

As stated in Chapter 1, this research aims to develop a comprehensive framework to mainstream CCA and DRR into the food security sector planning at the sub-national levels (Chapter 6). Based on the literature review and experts' inputs (Chapter 2), specific objectives were formulated to achieve the aim as stated in Section 1.3

Research questions are central to the research and its findings. The following key research questions were developed based on the research objectives and conceptual framework to investigate the research problem.

a) What is the current food security status in the country/ district?
b) How do disasters and/or climate change impact the country/ districts?
c) Why is the food security sector highly vulnerable to climate change and disasters?
d) How does the overall Socio-Economic Development Planning process, in general, and sectoral planning process, in particular, take place at different levels (national, sub-national and local)?
e) How does the mainstreaming of CCA and DRR into food security sector planning processes take place?

f) What are the specific planning processes and/or instruments/tools used for the planning process?
g) How is the effectiveness of such planning frameworks and their implementation be assessed?
h) What are the existing policies, strategies, plans, and programs related to CCA, DRM and the food security sector?
i) Why are those various plans not integrated into a common and comprehensive planning framework?
j) How should we integrate end-users and public views in such planning processes?
k) How and up to what level such integrated planning processes be institutionalized at sub-national levels?
l) What are the specific challenges and barriers to integrated planning processes?
m) What are specific options or recommendations in reforming and/or restructuring the existing planning process to make those plans climate and DRR-inclusive?
n) What are the enabling conditions and prerequisites required for the integrated planning process?

Having formulated the research problem, the aim, objectives, and related research questions, the following section discusses how the research methodology was designed to fulfil the research objectives and achieve the aim of the research.

4.4 Methodological Design

The research design is the *"general plan of how you will answer your research questions"* (M. N. K. Saunders et al., 2019). According to the authors, it comprises clearly defined objectives based on the research questions and specific details about data collection methods and analyzing those data while discussing ethical issues and constraints that the researcher may encounter during the research. According to Punch (2014), the research design is the *"basic plan for research"*. It includes four main ideas: strategy, conceptual framework, the question of who or what will be studied and the tools and procedures to collect and analyse empirical evidence (Punch, 2014). The "onion" model of M. N. K. Saunders et al. (2019), described in Figure 4-1, was used to develop the methodological design for this research. The onion model provides the guidelines and framework for selecting the most appropriate research methodology. It has six layers, each indicating a critical aspect that the researcher needs to consider when deciding an appropriate methodology for the research. The six layers include research philosophy, approach, strategy, choices, time horizons, and techniques and procedures. It provides a flexible model of methodology development as it allows the researcher to choose more suitable theories or practices referring to the existing layers of the "onion" to address the research questions in a structured manner, following a step-by-step process (Melnikovas, 2018). Outer layers of the onion are equally crucial, so the researchers need to understand and pay attention to explain rather than peel them through away in their research design (Saunders et al., 2015). The subsequent sections describe the methodological design of the research, based on the research "onion".

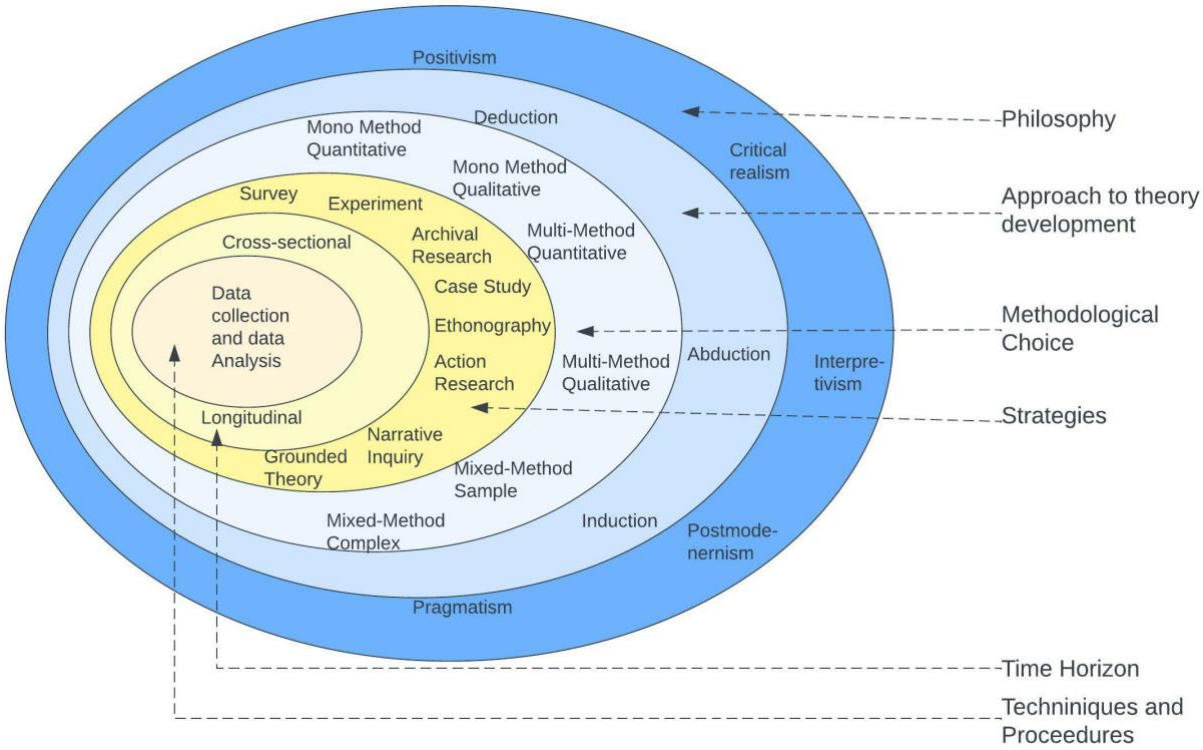


Figure 4-1: The Research Onion Model.

(Adapted from Saunders et al., 2019)

4.5 Research Philosophy

Research philosophy is defined as a set of beliefs and assumptions about the curation and development of knowledge. When a researcher is undertaking research, he or she develops and contributes to knowledge in a particular field of study (M. N. K. Saunders et al., 2019). According to the authors, the researcher makes a series of assumptions at every stage of the research journey, which includes, but are not limited to

- Assumptions about the realities the researcher faces while undertaking the research (ontological assumptions).
- Assumptions about human knowledge (epistemological assumptions).
- Assumptions about the extent and ways the researcher's values influence the research process (axiological assumptions).

The relationship between the data and theory is the main aspect of research philosophy. If the researcher has failed to look at such philosophical issues, it adversely affects the quality of the research. Therefore, it is central to the research design. The researcher examines how differing views about philosophical positions affect the research outcomes and related activities

(Easterby-Smith et al., 2021). The following section discusses three main assumptions and beliefs under the research philosophy: epistemology, ontology, and axiology.

4.5.1 Ontology

Ontology can be defined as the *'assumptions about the nature of reality'(M. N. K. Saunders et al., 2019).* Ontological assumptions dictate the way the researcher thinks and study about organizations, individuals, and events. Ontology makes assumptions about what reality looks like. It assumes what the form and nature of reality are and, therefore, what can be researched and further studied by the researcher (Punch, 2014). Assumptions and related questions of ontology depend on the nature of social entities. As ontological issues refer to the nature of reality and its features, different researchers attribute them to different realities (Creswell & Poth, 2016). The main question that the researcher needs to look at is whether social entities can and should be studied as objective entities that have a reality outside of the social actors or whether they should be considered social constructions formed from the opinions and actions of social actors (Bryman, 2016). These two perspectives are referred to as *'objectivism and constructionism'.* In objectivism, the ontological position determines that social reality confronts us as external factors. Therefore, the actors do not have the reach or influence over them. In contrast, the constructionism ontology position provides an alternative position, which assumes that reality is determined by actors with different viewpoints (Bryman, 2016). Some authors defined constructionism as a nominalist ontological assumption.

This research investigates ways and means of mainstreaming CCA and DRR into the food security sector. It will also investigate how local actors can be empowered to play a significant role in mainstreaming CCA and DRR into the food security sector at local levels. There are no pre-determined structures and rules for developing integrated planning frameworks and related tools for mainstreaming CCA and DRR. Therefore, suitable approaches and recommendations could be varied on the place, organizations, leadership and viewpoint of the critical actors. Thus, the ontological position of this research could be placed more toward the nominalist position.

4.5.2 Epistemology

Epistemology refers to assumptions about knowledge, detailing what makes standard, authentic and acceptable knowledge and the means of disseminating them to others (M. N. K. Saunders et al., 2019). Epistemological questions are referred to as what is or what should be regarded

as acceptable knowledge in the respective discipline. In social research, the key issue is whether such research should be studied following the same principles, procedures and norms as natural sciences (Bryman, 2016). There are three main epistemology assumptions, which are referred to as positivism, realism and interpretivism. The positivist position promotes applying the methods of natural sciences to research social reality and beyond. In contrast, the realism position backs that the natural and the social sciences can and should use the same methodologies for data collection and interpretation while recognizing that there is an external reality to which scientists direct their attention. On the other hand, the interpretivism position provides an alternative position to the positivism position. It views that different approach and strategy is required to research people, their constructed organizations, and related processes. Researchers need to clench the subjective meaning of complex social actions and interactions (Bryman, 2016). With the epistemological assumptions, researchers try to relate to the participants being studied as closely as possible while conducting qualitative research. Thus, subjective evidence is formed based on individual reflections, opinions and views, and knowledge is known over the subjective experience of people being studied. The researchers will 'know more what they know' if they spend more time in the field and get to know participants better (Creswell & Poth, 2016).

4.5.3 Axiology

Axiology refers to the values and ethics of the researcher that affect the research choice and conduct (M. N. K. Saunders et al., 2019). The researcher must make the axiological choice to determine to what extent he/she wishes to view the impact of the researcher's values and ethics on his research as a positive factor. Irrespective of the field of study, all researchers add value to their respective studies. However, qualitative researchers make their values recognized in the study. In other words, qualitative researchers acknowledge the value-laden nature of their studies, document their values and biases, and report the value-laden nature of the information collected from the field (Creswell & Poth, 2016).

The research philosophers need to choose their assumptions scattered along a multi-dimensional set of continua between two opposing extremes, which are referred to as Objectivism and Subjectivism (M. N. K. Saunders et al., 2019). Objectivism encompasses the assumptions of the natural sciences, reasoning that the social reality is external to us, and social actors being studied as part of the research. Therefore, objectivists view that social and physical phenomena are independent of individuals' views, hence considered universal and persistent;

therefore, they should be studied in the same way we study natural sciences. In contrast, 'subjectivism' assumes social reality is built from social actors' beliefs, perceptions, and actions (M. N. K. Saunders et al., 2019). Ontologically, subjectivism promotes 'nominalism', which is an extreme form and considers that the researchers and other social actors craft order and structures of the social phenomenon of our research. According to M. Saunders et al. (2019) social constructionism is a less extreme version which assumes that reality is constructed intersubjectively through social interactions (M. N. K. Saunders et al., 2019).

Having discussed the three major types of philosophical assumptions of research, which are ontology, epistemology, and axiology, it is critical to understand and position methodological perspectives of the research philosophy. This research aim is to design a framework for mainstreaming CCA and DRR into the food security sector planning, which is a complex process involving multiple sectors and actors. Therefore, it cannot be theorized by defined laws or rules as in natural sciences. Thus, the theoretical perspective of this research can be positioned as an interpretive stance. Interpretivisms argue that people and their interactions with the real world cannot be researched following the same principles as physical phenomena. Hence social science researchers need to follow different positions from natural sciences. Interpretivism creates new and richer knowledge, understanding, and reflections of social worlds and contexts (M. N. K. Saunders et al., 2019). Interpretivism is also referred to as social constructivism by some authors (Creswell & Poth, 2016). In social constructivism, individuals seek to understand their world and work based on subjective meanings negotiated socially through interactions with others.

In summary, Figure 4-2 describes and places the philosophical position of the research with reference to ontology, epistemology, axiology and the theoretical perspective.

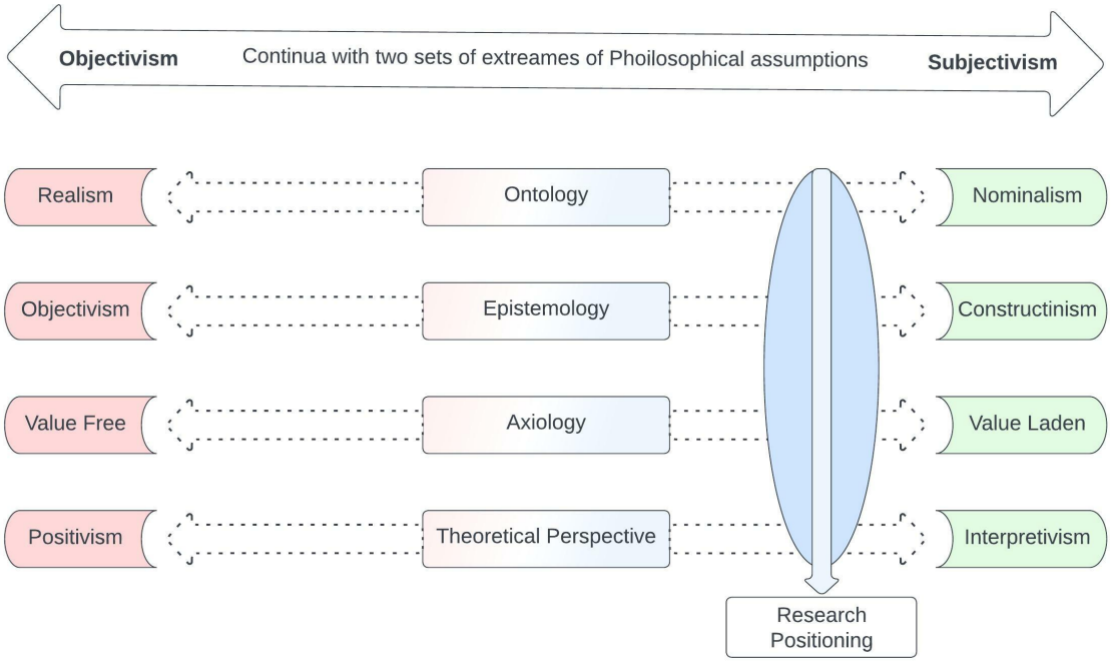


Figure 4-2: Research positioning within the philosophical assumptions.

4.6 Research Approach

The research approach defines and clarifies how the researcher relates research findings to theory development. There are three main research categories, namely deductive, inductive and abductive approaches (M. N. K. Saunders et al., 2019). If the researcher commences his research with a theory often developed based on literature reviews and then designs the research strategy to test the theory, it can be classified as a '*deductive approach'* to the theory development. In contrast, if the researcher commences his research works by collecting data and then establishing and building the theory, specifically conceptual frameworks, then it can be classified as an *'inductive approach'* to theory development. On the other hand, if the researcher is gathering data to investigate a phenomenon, identify concepts and discusses trends and patterns to establish new or amend a prevailing theory, which the researcher then validates through additional data, then it can be classified as an *'abductive approach'* to theory development (M. N. K. Saunders et al., 2019). According to the authors, deductive approaches are widely used in scientific research, which involves developing theory subject to rigorous tests. It is the fundamental research approach in natural science, which has laws for the explanation, acknowledges anticipation of phenomena, and envisages the occurrences; therefore, it can be controlled (M. N. K. Saunders et al., 2019). Researchers use deductive reasoning to build themes that have consistently been validated against the data (Creswell & Poth, 2016).

On the other hand, induction is an alternative approach to developing the theory. It allows the researcher to better understand the context and nature of the issues. The researcher's task is to utilize and make sense of the collected data by analysing them. Researchers will develop new theories based on the analysis, specifically in the form of conceptual frameworks. In the inductive approach, theory follows data (M. N. K. Saunders et al., 2019). Researchers generate theories or patterns of meaning from data in an inductive approach instead of starting with a theory (Creswell & Creswell, 2022). Induction is a bottom-up approach, which organizes data and analytics to develop themes. Researchers work back and forth between the themes and the database to establish a comprehensive and meaningful set of themes. In the inductive approach, researchers interactively collaborate with research participants during the data collection phase to derive themes from the process (Creswell & Poth, 2016). It builds from data to themes, emphasizes the individual meanings of each theme and recognizes the importance of documenting and reporting the complexity of the situation in developing the theory (Creswell & Creswell, 2022).

The induction approach enables researchers to explore how humans interpret and interact with their social world; thus, it is more connected to humanities and the importance of subjective interpretations. Therefore, the inductive approach will likely be cognizant of the interpretivism philosophy (M. N. K. Saunders et al., 2019). The abduction approach follows a dual-track approach. It moves back and forth between theory and data, combining deduction and abduction approaches (M. N. K. Saunders et al., 2019). Abduction begins with exploring ‘surprising facts’, which could emerge at any stage of the research process and then undertaking further analysis to find plausible theories to justify how this could have transpired. The abductive approach needs complex reasoning skills throughout the research process, and the researcher goes back and forth between theory, data and findings (Creswell & Poth, 2016). In their research and publications, some authors call abduction approaches a ‘reduction’; it is the original abduction label (M. N. K. Saunders et al., 2019).

	Deduction	Induction	Abduction
Logic	In a deductive inference, when the premises are true, the conclusion must also be true.	In an inductive inference, known premises are used to generate untested conclusions.	In an abductive inference, known premises are used to generate testable conclusions.
Generalisability	Generalising from the general to the specific.	Generalising from the specific to the general.	Generalising from the interactions between the specific and the general.
Use of data	Data collection is used to evaluate propositions or hypotheses related to an existing theory.	Data collection is used to explore a phenomenon, identify themes and patterns and create a conceptual framework.	Data collection is used to explore a phenomenon, identify themes and patterns, locate these in a conceptual framework and test this through subsequent data collection and so forth.
Theory	Theory falsification or verification.	Theory generation and building.	Theory generation or modification; incorporating existing theory where appropriate, to build new theory or modify existing theory.

Figure 4-3: Deduction, Induction and Abduction; From reason to theory development.

(Adapted from (M. N. K. Saunders et al., 2019)

According to M. N. K. Saunders et al. (2019), research approach choices that the researcher may make are important for three reasons. Firstly, it helps the researcher make informed decisions about the appropriate research design beyond data collection and analysis. It enables the researcher to decide what kind of data is collected, how it should be analyzed and how interpretations can be made to answer the initial research questions. Secondly, the research approach choice also helps the researcher think about strategies and methodological choices that will work or not for a given context and the research problem. For example, if the researcher investigates why a particular phenomenon happens rather than what is happening, the inductive approach is more suitable than the deductive approach. Thirdly, knowledge about different research approaches helps the researcher to make the appropriate research design, acknowledging and catering to constraints such as access to data or lack of prior knowledge and experience on the subject to frame a hypothesis (M. N. K. Saunders et al., 2019).

This research aims to develop a comprehensive and integrated planning framework to mainstream CCA and DRR into the food security sector. Data will be collected through key informants representing various sectors, organizations, and administrative levels. Then the data will be analyzed, and emerging concepts, trends, and patterns will be used to design the conceptual planning framework. M. N. K. Saunders et al. (2019) argued that the inductive approach is more suitable for theory development if it follows the data to design conceptual

frameworks, specifically in a new subject area with limited literature and knowledge available in public domains. The inductive approach is more grounded than following a particular theory given by someone else or the researcher's perspective. In this approach, researchers analysed data to develop a detailed knowledge base about the research question (Creswell & Poth, 2016). Therefore, the researcher will choose an inductive approach to theory development in designing the conceptual planning framework for mainstreaming CCA and DRR into the food security sector based on the data and their interpretations during the data analysis.

4.7 Methodological Choice

Researchers must choose the most appropriate research methodology based on the research question. It can be qualitative, quantitative, or mixed research methodology. The simple way to differentiate between qualitative and quantitative research is to distinguish between non-numerical data such as words, images, audio recordings, video clips and other similar materials and numerical data such as numbers (M. N. K. Saunders et al., 2019). Quantitative research often applies data collection techniques such as questionnaire and data analysis procedures such as graphs and statistics that generate or uses numerical data. On the other hand, qualitative research often uses data collection techniques such as interviews and data analysis procedures such as categorizing data that generate or use non-numerical data (M. N. K. Saunders et al., 2019). Some researchers may use qualitative and quantitative methods for data collection and analysis. In that sense, qualitative and quantitative methods are two ends of the continuum; thus, in practice, often, it can be a mixed method (M. N. K. Saunders et al., 2019). Researchers must select the research methodology from a broader perspective, considering the association of two philosophical assumptions and approaches to theory development and strategies. Such wider perspectives will help the researcher to use the research methodology coherently and comprehensively to address the research questions (M. N. K. Saunders et al., 2019).

Quantitative research designs are often associated with positivist philosophical assumptions, especially when the researcher applies prearranged and highly regulated data collection methods (M. N. K. Saunders et al., 2019). On the other hand, qualitative research designs are often used with interpretivism philosophical assumptions. It is interpretive because the researcher must make sense of subjective and socially constructed meanings about the phenomenon being investigated. Such research is also called naturalistic research. Researchers need to operate in the natural setting to establish trust, engagement, access to meanings and fully understand the context being studied (M. N. K. Saunders et al., 2019).

Qualitative research begins with interpretive philosophical assumptions and studies a research problem addressing the meaning of individuals, or groups attribute to a social or human problem by collecting data in a natural setting (Creswell & Poth, 2016). Regarding theory development, quantitative research is usually related to a deductive approach where data are gathered and analyzed to test the theory (M. N. K. Saunders et al., 2019). On the other hand, the range of qualitative research begins with an inductive approach to theory development, where naturalistic and emergent research design is applied to develop a theory or theoretical perspectives (M. N. K. Saunders et al., 2019).

As the researcher aims to develop a conceptual planning framework for mainstreaming CCA and DRR into the food security sector, with an interpretivism philosophy and inductive research approach, qualitative research methodology will be selected for this research. In qualitative research, meanings and relationships between research participants will be investigated using multiple data collection methods and analytical procedures to develop a conceptual framework and theoretical contribution (M. N. K. Saunders et al., 2019). One of the main characteristics of qualitative research is the 'natural setting'. Researchers often do not collect these data in a lab but instead directly collect them from the field or where they work through direct discussions and interactions with the participants (Creswell & Poth, 2016). People who consent to participate in qualitative research are not considered mere respondents but active participants in the data collection (M. N. K. Saunders et al., 2019). The researcher is a crucial instrument of qualitative research as he or she will directly collect data by themselves, reviewing documents, interviewing participants with open-ended questions and observing behaviours (Creswell & Poth, 2016).

Furthermore, meanings are derived from words and images in qualitative inquiry. Since words and images can have multiple connotations and unclear meanings, researchers must explore and clarify such details with the research participants (M. N. K. Saunders et al., 2019). Thus, researchers often apply structured or semi-structured methods so that questions, procedures, and focus may change or emerge during the research journey, which is naturalistic, interactive and real-world context (M. N. K. Saunders et al., 2019). Participants' multiple perspectives and meanings are critical to the success of qualitative research. The researcher will give full attention to the learning coming from the meanings that participants hold about the research problem or issue. This is why the themes of a qualitative research report should reflect multiple and diverse perspectives from the study participants (Creswell & Poth, 2016). Qualitative researchers follow an *'emergent design',* which means that the initial plan of the research can

be changed as it progresses into various phases and data collection. Initially, it cannot be tightly prescribed (Creswell & Poth, 2016).

Some key characteristics of qualitative research are given in Table 4-1.

Table 4-2: Characteristics of qualitative research.

The researcher is not being independent of the research participants.
Those participating in the research are called 'participants' or 'informants.' Not mere respondents.
Investigate attributed meanings and relationships of participants.
Based on meanings expressed through words such as spoken and textual and images.
Unstructured or semi-structured data collection methods are used.
Data collection led to non-standardized data generally requiring classification into categories.
Conceptualization is used for analysis.
Data analysis led to meanings derived from words spoken or text and images.

(M. N. K. Saunders et al., 2019)

Two main categories of qualitative research methods are based on the data collection technique and analysis procedure. If the qualitative research uses a single data collection method, such as semi-structured interviews and corresponding qualitative analytical procedures, it is called a '*mono method qualitative study'*. Furthermore, suppose the qualitative research method uses more than one qualitative data collection technique, such as in-depth interviews, documentary reviews, and corresponding analytical procedures. It is a *'multi-method qualitative'* study (M. N. K. Saunders et al., 2019). Qualitative researchers often collect multiple forms of data, such as interviews, documents, and observations, without relying on a single data source. They analyze and make sense of the data collected from multiple sources, classifying it into themes (Creswell & Poth, 2016). Furthermore, qualitative researchers follow 'complex reasoning' through inductive logic and build patterns, categories and themes through a bottom-up approach by systematizing data into an increasingly more abstract unit of information (Creswell & Poth, 2016).

For this research, the researcher will interview key stakeholders, policymakers, planners, and practitioners and review existing strategies, policies, programs, and other related documents

related to CCA, DRR and the food security sector. Therefore, this research can be classified as a multi-method qualitative study.

4.8 Research Strategy

Research strategy is the plan in which the researcher organizes activities to answer his research question (M. N. K. Saunders et al., 2019). It connects the research philosophy and research techniques. There are many research strategies that the researcher can choose from to suit his/ her research design. They are experiments, surveys, archival research, case study, ethnography, action research, grounded theory and narrative inquiry (M. N. K. Saunders et al., 2019). Experiments are widely used in quantitative research to test a hypothesis with controlled variables. It is primarily used in natural science and laboratory-based research with precision, high rigour, and controls. It studies the probability of changes in the 'independent' variable by altering dependent variables (M. N. K. Saunders et al., 2019). The experiment uses a predictive hypothesis rather than an open research question, which is unsuitable for this research.

Since the research focuses on developing a framework for mainstreaming CCA and DRR into the food security sector through an inductive approach, an experiment strategy will not be suitable for this research. On the other hand, the survey strategy is usually applied in research with a deductive approach (M. N. K. Saunders et al., 2019). A survey strategy is applied for research which collects data and analysis them quantitatively using statistics (M. N. K. Saunders et al., 2019). Therefore, it does not apply to this research.

The methodological choice of the research is a qualitative inquiry with an interpretivism philosophy and inductive approach. Five main research strategies can be used in qualitative inquiries: Narrative Research, Phenomenology, Ethnography, Grounded Theory and Case Study (Creswell & Poth, 2016). These are briefly discussed below.

Narrative Research: These are primarily conducted using interviews and documents. It explores the life of an individual. The data analysis strategy will be for stories, 'restoring' stories, and developing themes using a chronology (Creswell & Poth, 2016).

Phenomenology: Focus on the shared meaning of several persons of their lived experience of a concept or a phenomenon. It focuses on the universal essence (Creswell & Poth, 2016).

Ethnography: Researching culture-sharing groups, having shared, and learned patterns of behaviours, values, beliefs, and languages over a long period (Creswell & Poth, 2016).

Grounded Theory: The grounded theory research strategy goes beyond descriptions and establishes or discovers new theories. They develop the theory grounded in data collected from the field. They ground the new theory based on inputs and views from participants (Creswell & Poth, 2016).

Case Study: Case study research focuses on an in-depth study of a case or cases within a real-life setting. The case could be an individual, group, and organization partnership (Yin, 2018).
Narrative research and phenomenology focus on individuals and their lived experiences. Therefore, they do not fit this research which focuses on developing a conceptual framework to mainstream CCA and DRR into the food security sector. On the other hand, ethnography studies the culture or social world of the research participants, developing a written account of the people or a group (M. N. K. Saunders et al., 2019). Ethnography requires the researcher to spend much time in the field and interact with the participants. The researcher must be part of the group being studied to understand the phenomenon. The final product of ethnography is a 'holistic cultural portrait' of the group derived from data collected from research participants and the interpretations of data by the researcher (Creswell & Poth, 2016). The ethnography research strategy is primarily based on observations in the field (Gobo & Marciniak, 2011). In this research, the researcher is not part of the culture-sharing group of participants. It will not be able to spend a prolonged period in the field to observe participants due to time constraints and resources limitation. Furthermore, participants represent different districts and organizations and do not share the same culture and values. Thus, the ethnography research strategy will not apply to this research.
It leaves the option to choose between Grounded Theory, which follows a systematic yet flexible strategy for gathering and analyzing qualitative data to generate theories from the data themselves (Charmaz, 2014) and case study strategy, which is an empirical method that explores a contemporary phenomenon or case in greater details within real-word circumstance (Yin, 2018). The rationale for using the grounded theory is that there is no sufficient and satisfactory theory about the research problem, and researchers do not understand sufficiently to commence theorizing. If a sufficient and satisfactory theory is already present about a particular research topic, then there is no value addition to generating a new theory about the topic. Therefore, researchers must start the inquiry with an open-minded approach as much as

possible (Punch, 2014). Between the grounded theory and case study choices, the case study strategy has been selected as it allows the researcher to investigate the real-world context in greater detail to design a conceptual framework for mainstreaming CCA and DRR into the food security sector planning. The case study can cope with technically different circumstances with many more variables of interest than just data points. It relies on multiple sources of information, such as field data, reports, and documentaries (Yin, 2018). It fulfils all requirements of inquiry with its logic of inquiry, data gathering techniques, and approaches for data analysis (Yin, 2018). Understanding the context is crucial to the case study research (M. N. K. Saunders et al., 2019). Case study research is very popular when the boundaries between the phenomenon being researched and the context in which it is being investigated are not always visible (Yin, 2018).

According to M. N. K. Saunders et al. (2019), case studies are used differently for different purposes. It can be used by positivist and interpretivist researchers, 'deductively' and 'inductively' for explanatory, exploratory or descriptive purposes (M. N. K. Saunders et al., 2019). Case studies intend to comprehend the case in depth in its natural setting, recognizing its complexity and context, giving holistic focus and the wholeness of the case (Punch, 2014). In summary, the case study is a qualitative research approach in which the researcher explores a real-life, contemporary bounded system (case) or multiple bounded systems (cases) over a period of time through detailed, in-depth data collection involving multiple sources of information and then report a case description and develop case themes based on data analysis (Creswell & Poth, 2016). Furthermore, the case study research strategy can best suit the 'how' and 'why' questions of research inquiry (Yin, 2018), which is crucial for designing a conceptual framework for mainstreaming CCA and DRR into the food security sector. The type and form of research questions the researcher will ask participants will give important clues about the most suitable research strategy (Yin, 2018). According to the author, case study research is most suitable when how' and 'why' questions are being asked for a contemporary set of events over which the investigator has little or no control (Yin, 2018). A case study investigates a decision or a set of decisions, such as 'why they were taken' and 'how they were implemented' with what results. In such instances, cases of 'decisions' are the primary focus of the case studies. Other common cases that researchers investigate can be 'individuals', 'organizations', 'processes', 'programs', 'neighbourhoods', 'institutions' and 'even events'(Yin, 2018). A case study research strategy can explain apparent causal links in real-world interventions that are very difficult for other research methods, such as surveys or experiments. They describe interventions and the real-world context in which they happened.

They also illustrate specific issues and themes within an assessment descriptively. Furthermore, case study research can enlighten situations where the appraised interventions have no clear outcomes (Yin, 2018).

This research aims to develop an integrated framework for mainstreaming CCA and DRR into the food security sector in a real-world situation. It assesses the food security situation in a contemporary setting, collecting data from multiple sources and stakeholders. The research will explore the causal link between institutions, their existing strategies and programs and actions being taken by various individuals through 'how' and 'why' questions in the given context. Therefore, the case study research strategy has been selected for this research as the most appropriate research strategy.

4.8.1 Case Study Research Design

As explained in the previous section, the researcher has chosen the case study as the main and most suitable research strategy to undertake this research. Therefore, the next step is to design the case study. Designing case studies involve identifying the cases and establishing the logic of the case study. The research design connects collected data and the conclusions made to the initial research questions of the study (Yin, 2018). During the case study design process, it is critical to define the 'case' to be studied and set boundaries or limits for it (Yin, 2018). There are four major types of case study designs: single holistic, multiple holistic, single embedded and multiple embedded (Yin, 2018), as shown in Figure 4-4.

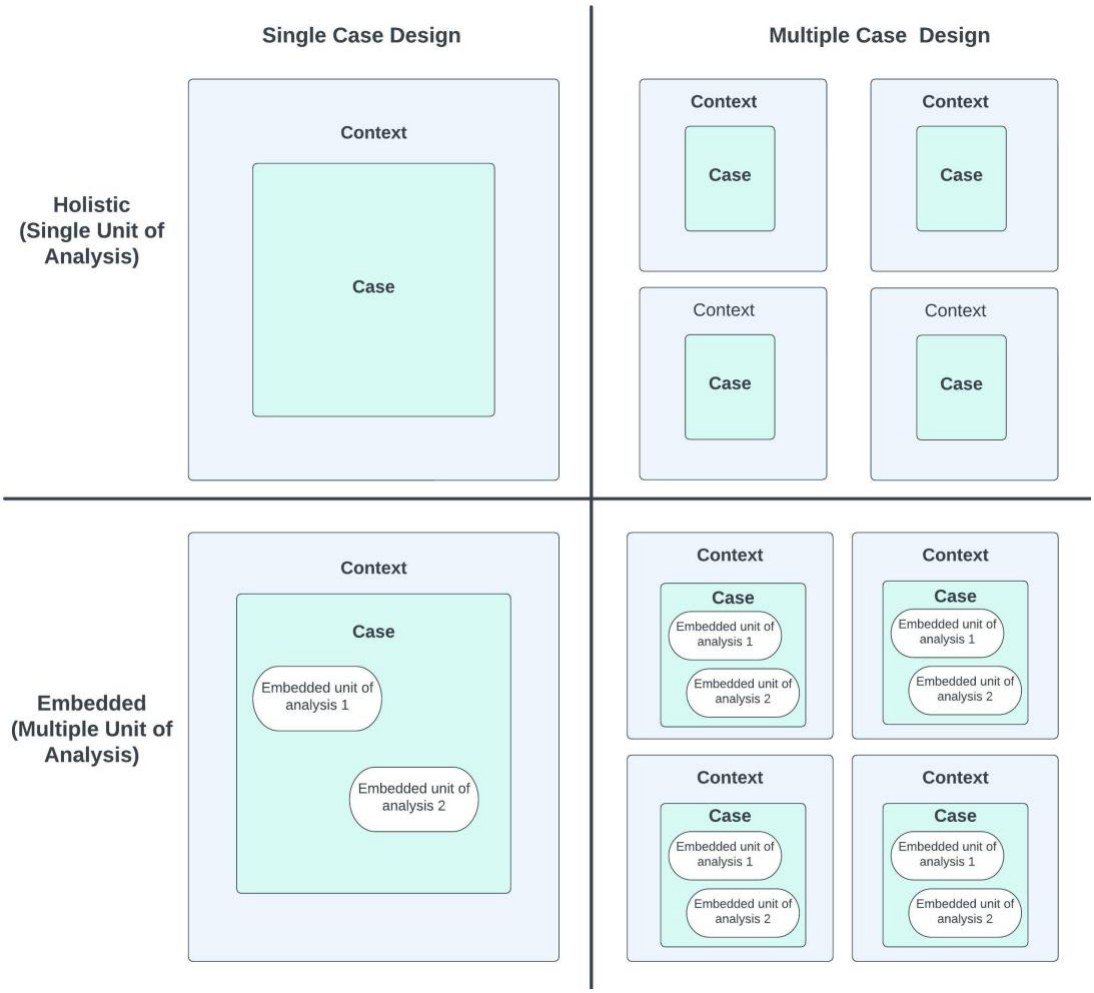


Figure 4-4: Types of case study design

(Adapted from (Yin, 2018)

4.8.1.1 Multiple versus single case studies

Before data collection, the researcher must decide whether to use a single or multiple-case design. Yin (2018) has suggested five rationales for selecting a single case design. Firstly, it should be a '*critical case'* where it would be critical to the theory or theoretical propositions. In other words, the theory should have specified a clear set of circumstances within which its propositions are believed to be true. As discussed in the research approach section, this research is guided by an inductive approach, and it is not aiming to test a theory; therefore, a single case study design will not fit this research. The second rationale for single case design will come when the case represents an *extreme or unusual* case deviating from theoretical norms or everyday circumstances. As far as this research is concerned, it will be undertaken in selected districts with different institutional systems, coordination mechanisms, stakeholders and varying levels of disaster and climate exposures, risks, and resilience. Those districts are not

extreme or unique cases; hence single case study design will not suit this research. The third rationale for selecting a single case design is when the researcher has a *'common case or typical'* case to investigate. As discussed earlier, different districts prevail different levels of exposure, vulnerability, and risks, so they pose different coping mechanisms and resilience levels; therefore, a single case design cannot be applied to this research. The fourth rationale for single case design applies when it is a *'revelatory'* case. In other words, this situation occurs when the researcher observes and analyses a phenomenon previously inaccessible to the social science inquiry. Thus, a single case design will not be suitable for this research. The last and fifth rationale for single case design comes when it is applied to a *'longitudinal'* case, studying the same single case at two or more different points in time, which is also not applicable to this research. This research does not fall into any categories or rationale discussed above; thus, a multiple case study design is preferred over a single case study design. There is no strong justification for the researcher to select a single case design in this study.

Furthermore, a multiple case study design will likely produce more evidence for the research question (M. N. K. Saunders et al., 2019). Another rationale for adopting a multiple case study design is that the researcher can observe whether findings from the first case reemerge in subsequent cases so that replication and generalizations from findings can be made (M. N. K. Saunders et al., 2019). When researchers select cases under multiple case design, they should be carefully chosen so that it either predicts similar results, referred to as *'literal replication',* or predict different results, referred to as *'theoretical replication'*, which can be substantiated with reasons especially due to the contextual factor differences (Yin, 2018).

One of the crucial considerations that the researcher needs to make is the number of cases in multi multiple case designs. Creswell and Poth (2016) suggest that there is no concrete answer to this question; however, researchers often choose no more than four or five cases. Authors also argue that researchers get motivated to select multiple case study designs due to generalizability. (Creswell & Poth, 2016). Even several decades ago, although case study research design framework and techniques had not been well developed and recognized by then, researchers had argued that evidence from multiple cases is often considered more compelling, hence overall, multiple case study designs are regarded as being more robust (Herriott & Firestone, 1983). The number of cases should be decided based on the researcher's understanding of literal and theoretical replications. The simplest multiple-case design with two cases can achieve literal and theoretical replication and provide more substantial evidence and themes than a single case study (Yin, 2018). The author also suggests that when the researcher has the choice and resources to choose multiple case designs, it is preferred over

single case designs. The analytical benefits and conclusions from two or more case designs will be substantial compared to single case designs (Yin, 2018). The author also argues that having more than two cases will produce a more substantial effect, details, and quality. Therefore, this research has selected a multiple case study design with three cases, allowing a more robust basis and rationale for replication logic and generalizability.

4.8.1.2 Unit of Analysis

Case study researchers need to identify and define the unit of analysis before commencing the research study. The unit of analysis is used to analyze data, whereas the unit of observation is used to collect data (Kumar, 2018). According to the author, several units of analysis could exist within the same study. It helps the researcher decide what data types should be collected to answer his research questions (Kumar, 2018). If a case research design has more than one unit of analysis, it is called an embedded case study (Yin, 2018). The unit of analysis is a crucial element in case study research, and it is usually a system of actions rather than an individual or group of individuals (Tellis, 1997).

It is easy to establish the unit of analysis once the case boundary has been defined. The case boundary for this research is defined as 'district', and the research is conducted in Sri Lanka, where 'district' is defined as an administrative area demarcated and governed by the central government of Sri Lanka. There are twenty-five districts across the country organized into nine provinces, and the districts are further subdivided into 331 administrative divisions and 14,022 Grama Niladhari divisions. Districts are governed under the central government jurisdiction, and various sub-offices of sectoral agencies are present in the district. Thus, a district is considered a 'case', and the research investigates the mainstreaming of CCA and DRR into food security sector planning at the district levels.

According to Kumar (2018), a unit of analysis is a critical part of the research problem-defining process. The unit of analysis depends on the research question; therefore, once the research problem has been formulated, the researcher needs to define the unit of analysis and decide the most appropriate methodology for the research work (Kumar, 2018). Therefore, considering the main research question, the unit of analysis was defined as '*mainstreaming of climate change adaptation and disaster risk reduction into food security sector planning at the district level"*. As the research involves a single process as the unit of analysis, this research can be classified as a holistic case study design. Three holistic case studies were undertaken by selecting three districts exposed to climate change and disaster risks. Then the research findings

were generalized across all districts of Sri Lanka. Figures 4-5 demonstrate the Unit of Analysis and Case boundary for this research.

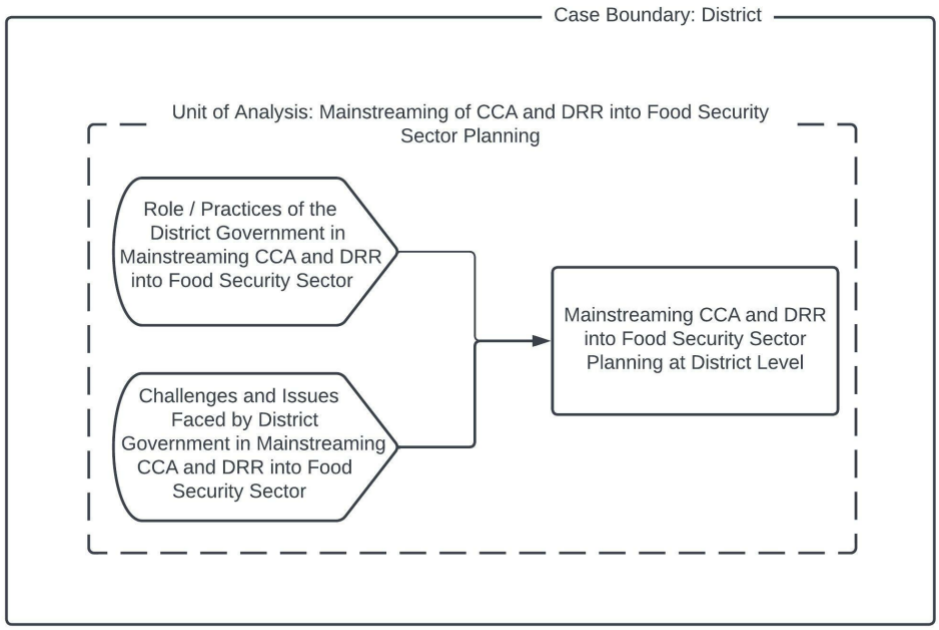


Figure 4-5: Unit of analysis and case boundary of the case study

4.8.1.3 Selection of Cases for the Study

Another step of case study research is to select the most appropriate cases for the study. This process is also known as 'case screening'. Selecting the most suitable cases to address the research question for supporting the theory development process is vital. The screening aims to ensure that the researcher has adopted a process to identify the final cases properly before formal data collection commences (Yin, 2018). There might be many qualified cases; therefore, the researcher must select single or multiple cases among them (Yin, 2018). According to the author, there are two main approaches for case screening: one phase approach and the two-phased approach. In one phased approach, the researcher has only a dozen qualified case candidates (organizations, individuals, and entities) to choose from for his or her research cases. In this process, the researcher will collect basic information from people knowledgeable about each case. The researchers should define operational criteria to choose qualified cases before collecting the screening data. If it is a single case study, the researcher needs to choose the case that is likely equal and has the most available data sources for the study. If it is a multiple case study design, the researcher needs to select cases most suitable for literal and theoretical replication design (Yin, 2018). According to the author, researchers must follow a two-phased screening procedure if there are many eligible cases (12 or more). In the first phase, the researchers should collect relevant quantitative data about the entire case pool from some

archival sources such as statistical databases or central databases. Once the quantitative data has been collected, the researcher should define some criteria for either qualifying or reducing the number of cases for the study. This process aims to reduce the number of cases to 12 or fewer, and then the researcher can move into phase one, the procedure described above, for selecting the cases for the study (Yin, 2018). According to Stake (2013), there are three main criteria for selecting cases for the researcher. Those are 'Is the case relevant to the object or phenomenon or condition to be studied?', 'Do the cases provide diversity across contexts? Moreover, 'Do the cases provide good opportunities to learn about the complexity and contexts?

Sri Lanka is one of the most vulnerable countries to climate change impacts. Sri Lanka placed sixth place in the World Climate Risk Index in 2018, according to Resourcewatch (Resourcewatch, 2018). Based on the Global Climate Risk Index by Germanwatch Climate Observatory, Sri Lanka was placed on 19th place in the world in 2020 while emphasizing the high level of risks, future climate migration and extreme weather events in 2018, which caused over 3,625 million US dollars in losses (Germanwatch, 2020). Concerning disaster risks, Sri Lanka has been classified as a high-risk country globally, considering its exposure, vulnerability and low coping capacity (Hilft, 2022). The country is prone to multi-hazards such as floods, droughts, landslides, cyclones/high winds, Tsunamis, and sea surges. The country follows a unitary government system called the 'Democratic Socialist Republic of Sri Lanka'. The country is predominantly governed by the central government, with the institutional and administrative system up to the village level. The provincial and local governments are also in place with elective representatives. There are 25 districts in the country, and the district secretary/government agents serve as the heads of the districts. At the same time, line departments and offices of all other sectors are present at the district level. As explained earlier in this section, all 25 districts are relevant for this research study as they qualified based on Stake (2013) first selection criteria, which is whether the case *'is relevant to the object or phenomenon or condition to be studied'.* Based on Yin (2018) argument discussed earlier, since the number of eligible cases is more than 12, a two-phased screening process was applied to select the most suitable cases for the study. The researcher collected quantitative data from official government sources related to food security, such as poverty (based on the poverty line in 2022, which is Sri Lanka rupees 5,972), % of food insecure people in respective districts and historical impacts of disasters and climate exposure. Based on those, 11 districts were screened in the first phase and qualified for the second phase screening. Then based on Yin (2018) approach to screening, eleven shortlisted districts were used for the second screening phase.

For that, additional documentary reviews were undertaken to identify most disaster and climate-affected districts, which will have higher risks in the future. To satisfy Stake (2013) second criterion on 'diversity', different aspects such as risk profiles and exposure to different hazards, geographical information, demographic compositions, resource base (such as irrigation systems) and administrative and governance systems were also considered. Extensive discussions were undertaken with the supervisory team to identify the most suitable case screening criteria. The researcher also conducted 15 expert interviews at the national level to gain expert knowledge about the areas and the subject, and their opinions were also considered. According to Yin (2018), in multiple case designs, the researcher must choose each case carefully and follow a replication, not a sampling logic. These cases should produce similar results, known as a *'literal replication'* or contrasting results, known as a 'theoretical replication', predicted clearly at the beginning of the investigation. Some researchers may go for two or three literal replications when the theory is straightforward, and the research question does not require excessive certainty. However, other researchers may opt for five, six or more replications if the theory is subtle or they want greater certainty (Yin, 2018).

Furthermore, a case or cases should be chosen to understand better the research problem (Creswell & Poth, 2016). The researcher also considered accessibility to the cases, the ability to collect and access the relevant data within the cases and accessibility to key informants. Based on all the criteria and considerations, three districts, namely Anuradhapura Polonnaruwa and Trincomalee, were selected for the multiple case study design, as stated in Figure 4-6

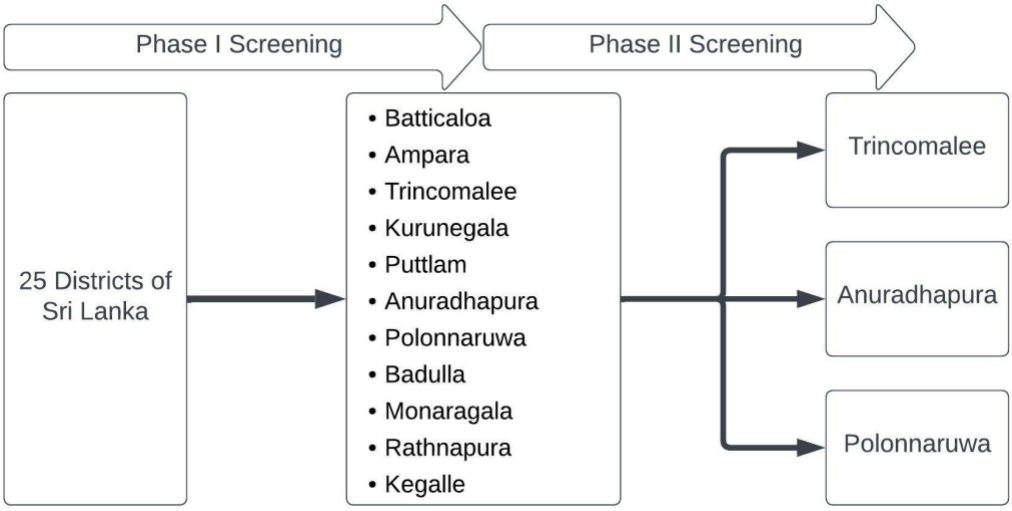


Figure 4-6: Two phase screening process of case studies

As three districts were selected based on well-developed criteria and a two-phase screening process, the researcher believes these districts are informative and can undertake in-depth multiple case studies with literal and theoretical replication. Trincomalee district is a coastal

district affected by floods, droughts, tsunamis, and cyclones, among other common hazards and exposure to climate change. It is a multi-ethnic district, having all three main ethnicities, which are Sinhala, Tamil, and Muslim, and also directly affected by 30 years of the civil war, which ended in 2009. On the other hand, the Polonnaruwa district is affected by frequent droughts and floods. It is a major rice-producing and processing district in the country, with major irrigation schemes. Lastly, Anuradhapura district is frequently affected by floods, droughts, pests and diseases, wild animal attacks and exposure to climate change. It is also bordering to the former war zone. Major irrigation schemes cover some parts of the district, while most are under cascade minor irrigation schemes. More details about these selected cases are given in Chapter 5. Selected cases, their demography and administrative divisions are depicted in Figure 4-7.

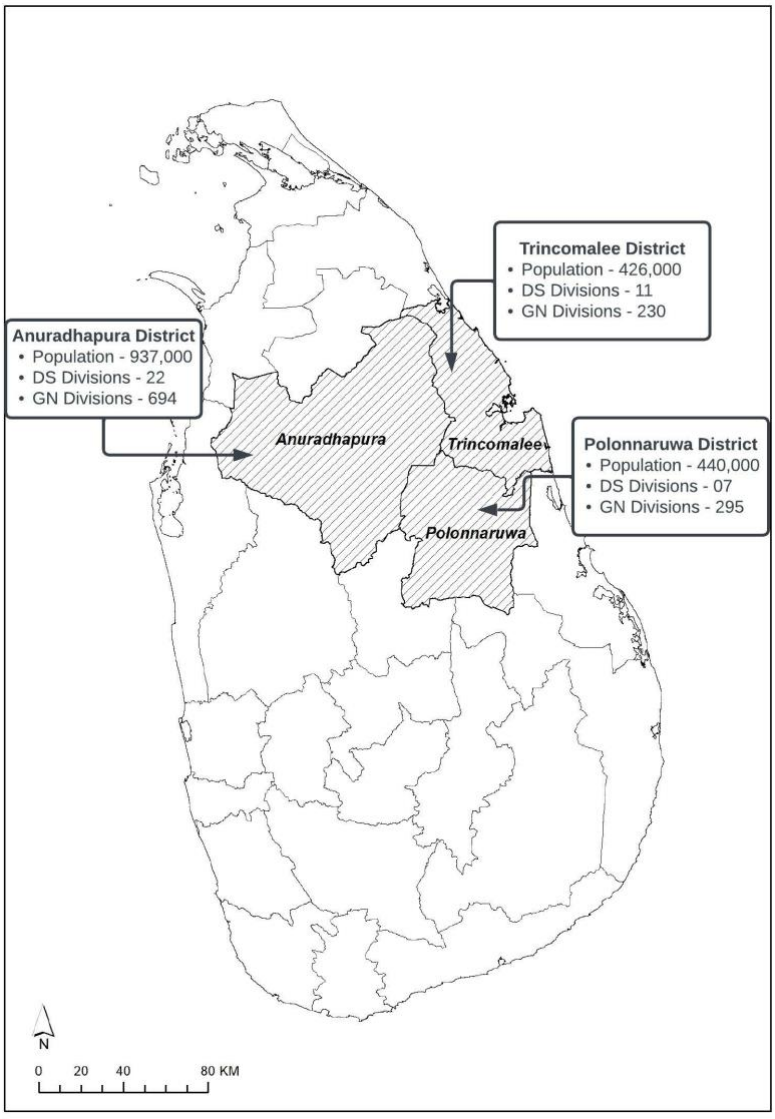


Figure 4-7: Selected cases for the study.

(Statistics Department of Sri Lanka, 2022)

4.8.1.4 Theory Development from Case Studies

This research aims to develop a conceptual framework for mainstreaming CCA and DRR into the food security sector. Thus, theories will be developed by looking at the planning instruments at the district level. The development of theories is integral to this research. Therefore, this section discusses the theory development process.

A theory can be defined as a systematic body of knowledge grounded in empirical evidence which can be used for explanatory or predictive purposes (Saunders et al., 2015). Theories are developed by examinations of concepts and facts. Clear definitions of concepts are vital for testing and developing theory in emphatical research. A *"theory uses related facts and concepts to explain or predict an outcome"*(M. N. K. Saunders et al., 2019). The theory has explanatory power with the ability to describe the relationship between concepts. As the research progresses, those explanations should be confirmed, refined, or contradict as understanding improves and changes over time (M. N. K. Saunders et al., 2019). Four main elements or building blocks to the theory development can be categorized as 'what', 'how', 'why' and a group of 'who, where, and when'(Whetten, 1989). The first element, "what," can be described as the concepts and variables the theory assesses. The second building block, 'how,' can be explained as how these concepts and variables are interrelated. A key feature here is causality, and theory is formed with cause and effect (M. N. K. Saunders et al., 2019). The third element, 'why', can describe why these concepts and variables are interrelated. It is a crucial element of theory since it explains the reasons for concepts or variables' relationships. According to Whetten (1989), 'what and how" are descriptive, whereas 'why' explains the relationships. The last building block of the theory is the group of 'whom does this theory apply to', 'where does this theory apply' and 'when does this theory apply'. Based on this group, M. N. K. Saunders et al. (2019) argue that the cause-and-effect relationship between variables could be contextual and time-bound, limiting their generalizability.

As discussed in Section 4.6, this research follows an inductive approach; therefore, new theories will be developed as part of empirical data analysis. As M. N. K. Saunders et al. (2019) argue, a researcher needs to recognize the theory during the planning stage when writing the research problem and objectives. It is because theory may also inform the research question and how theory could be developed during the analysis process. It is beneficial as the researcher can focus on the research questions and identify variables or concepts to explore and determine how and why these are related, recognizing them as critical elements or building blocks of theory (M. N. K. Saunders et al., 2019). Case study research should have at least primary theoretical consideration during the planning stage (Yin, 2018). According to the author, initial

theoretical statements will help the researcher to shape the upcoming case study. Such a theoretical proposition will lead to a sound research design and will support the researcher in identifying the type of data collected and strategies for data analysis. Therefore, some theory development is desirable before fieldwork and data collection (Yin, 2018). Thus, this research followed the deductive approach during the initial phase of this research and developed a conceptual framework, the research question, and the data collection strategy. Then the researcher applied the main inductive approach of this research in collecting, analyzing, and developing theories. In summary, it can be concluded that this multiple case study research applied a deductive approach to theory development in the initial phase and then moved to the inductive approach during the data analysis and the theory development.

As explained in the previous section, a multiple case study research strategy was chosen for this research. There are four main stages in the theory-building process of multiple case study research, which can be summarized as 'analyzing within case data', 'searching for cross-case patterns', 'shaping the hypothesis' and 'enfolding literature' (Eisenhardt, 1989). The same four-stage process was applied in developing theory in this research, where each case was analyzed and documented to identify emergent themes, concepts, and frames, followed by a cross-case analysis to identify and verify emergent relationships between the cases and finally, emergent theories were compared with a broad range of existing literature.

Furthermore, as part of this case study research, expert interviews were conducted through semi-structured interviews to triangulate information and data from multiple sources. Thus, emergent theories of the case study were compared with findings gathered through expert interviews and the comparison with existing literature.

4.9 Time Horizons

Choosing the appropriate time horizon depends on the research question. During the research design process, the researcher must understand and decide whether the research will be undertaken as a snapshot at a particular time or a series of snapshots representing events over a given period. The snapshot time horizon studies are known as cross-sectional, whereas a series of snapshots is known as longitudinal studies (M. N. K. Saunders et al., 2019). The authors further argue that cross-sectional studies could be qualitative, and many case studies are often based on interviews conducted over a short period. On the other hand, the main advantage of longitudinal research is its capacity to study change and development over time (M. N. K. Saunders et al., 2019).

This research aimed to develop a conceptual framework to mainstream CCA and DRR into the food security sector within the planning processes of districts. Considering the research question and nature, this research does not require an investigation over a long period. Thus, the research will be carried out at a given time and can be classified as a cross-sectional case study.

4.10 Research Techniques for Data and Evidence Collection and Analysis

The innermost layer of the 'research onion' is determining the most suitable techniques and procedures for data collection and analysis. The researcher must focus on designing and identifying appropriate data collection and analysis techniques, tools and procedures (M. N. K. Saunders et al., 2019). Thus, section 4.10.1. discusses and justifies the rationale for selecting the most appropriate tools and procedures for data collection, while section 4.10.2 discusses the tools, techniques and procedures applied for data analysis.

4.10.1 Research Techniques for Data Collection

There are multiple data collection methods, procedures, and tools to be selected by the researcher depending on the research strategy. For case study research, the researcher can employ a wide range of procedures as he/she builds an in-depth picture and knowledge about the case as the study progresses (Creswell & Poth, 2016). Yin (2018) has identified six data collection techniques: documents, archival records, interviews, direct observations, participant observations, and physical artefacts. As discussed in Section 4.8, the research strategy chosen for this research is the case study. Thus, this section analyses the main data collection techniques stated above and identifies the most suitable techniques for this research.

According to Creswell and Poth (2016), observation is one of the main tools often applied for gathering data for qualitative research. Based on the research purpose and questions, the researcher will observe a physical setting, participants, activities, interactions, and conversations. One of the main limitations of observation is to gain access to organizations, sites, meetings, and individuals for the study. Another challenge commonly experienced during the observations is related to the role of the researcher to assume whether he or she serves as a participant, non-participant, or middle ground position. Other key challenges include remembering to take field notes, recording quotes accurately, identifying the best time for moving from non-participant to participant, being overwhelmed with information and how to funnel broad observations to narrow the focus (Creswell & Poth, 2016). M. N. K. Saunders et al. (2019) raise ethical concerns in their observations. According to them, boundaries of what

is permissible to observe should be drawn and agreed upon before the observation. Without such boundaries and agreements, those being observed may feel that their actions are constrained or limited. Another main issue is "reactivity', which is the reactions from the participants being observed about the researcher and related research instruments (M. N. K. Saunders et al., 2019). Therefore, observation was not considered an appropriate data collection technique for this study.

Similarly, physical artefacts were not considered potential data collection techniques for this research. Physical or cultural artefacts could be technical devices, a tool, an instrument, artwork or some other physical evidence often and extensively used in anthropological research (Yin, 2018). The author further argues that physical artefacts may have less potential application in the case study. Thus, physical artefacts were also not chosen as a data collection technique for this research.

According to (Creswell & Poth, 2016), documents and audiovisual materials are typically used to supplement interviews in case studies. Documents are considered secondary data to the research, and there are three main types of documents, which can be categorized as Text, Audio and Visual /Audio-visuals. Documents are often and extensively used in research studies, which collect primary data such as interviews (M. N. K. Saunders et al., 2019). According to Yin (2018), documents can play a significant role in data collection techniques for case study research. He also argued that the most important use of documentation is to verify, substantiate and augment evidence gathered from other sources in the case study. According to the author, archival records in data files and official records are also relevant for many case studies as they provide more accurate information. However, these archival records could be used with other information from the case study to supplement the overall analysis.

According to Yin (2018), interviews are one of the most important techniques for collecting data and evidence for case studies. Interviews can especially get information related to explanations such as 'hows' and 'whys' of the research questions and provide perceptions from the participant's relativist perspective. The author further argues that case study interviews will evolve as guided discussions rather than structured questions. Interviews can occur in structured, semi-structured, and unstructured forms (M. N. K. Saunders et al., 2019). Often, researchers use semi-structured and in-depth interviews to collect data for qualitative research strategies such as case studies or grounded theory (M. N. K. Saunders et al., 2019). The author also argues that such interviews not only gather information related to the 'what' and the 'how' but also place more emphasis and importance on 'why'. It is a good tool for accessing people's perceptions, views, meanings and explanations of situations and constructions of reality

(Punch, 2014). Interviews can occur with individuals or groups through face-to-face discussions, telephones or internet-mediated platforms (M. N. K. Saunders et al., 2019).

As discussed above, multiple authors have encouraged and argued the value of using multiple data collection techniques to supplement, verify and reinforce evidence from each source. Therefore, this research has used a multi-method approach for data collection and decided that documents, archival records, and interviews as the most suitable methods for the study. By adopting such a multi-method data collection technique, the researcher collected data and evidence from multiple sources, bringing different perspectives and triangulating them to increase the construct validity of the case study (refer to section 4.12.1).

Among the selected data collection techniques, interviews were chosen as the primary data collection technique as they can collect details and a rich data set, specifically the 'how's and 'why's type of data, based on the research questions and the strategy. Structured interviews are often used to collect quantifiable data in quantitative research methodological choice. Therefore, structured interviews will not be suitable and apply for this multi-case study research. According to M. N. K. Saunders et al. (2019), semi-structured and unstructured interviews are often considered qualitative research. In semi-structured interviews, the researcher will start with a predetermined list of themes and a set of key questions related to those themes to guide the conduct of each interview. Therefore, semi-structured interviews are more suitable and applied for this research. Semi-structured interviews allow the researcher to methodically investigate each theme with every participant and relate participants' responses to each theme to find the underpinning reality of the case that the researcher seeks to uncover (M. N. K. Saunders et al., 2019). For the interpretivist approach, the researcher can apply a more flexible approach to deal with predetermined determined themes based on what research participants say(M. N. K. Saunders et al., 2019). Therefore, the researcher can change the order of these themes, omit specific themes, or modify the questions depending on how the conversation evolves and the data types that emerge. During semi-structured interviews, new themes and concepts could also emerge from the interpretations of research participants (M. N. K. Saunders et al., 2019). This research also used semi-structured interviews with experts at the initial stage to obtaining expert opinions and inputs regarding the initial research questions and the conceptual framework.

Accordingly, semi-structured interviews were deployed to collect relevant and reliable data and evidence for the multiple case study. Since the research philosophy is interpretivism and the approach to theory development is inductive, the number of interviews was not pre-identified and decided. Thus, the data collection process continued until the researcher collected

sufficient, rich qualitative data to answer the research question. The data collected through interviews were completed for each case when the researcher did not observe new evidence emerging during interviews. In addition to data collection interviews held within three cases, the researcher organized two series of semi-structured interviews with the experts in the subject area. The first series of interviews were conducted with international experts before the data collection process to obtain expert opinions and views to expand the knowledge in the subject area and develop a conceptual framework. The second series of expert interviews were conducted with national experts at the beginning of the data collection process. When interviews are conducted based on one-to-many or two-to-many and it is referred to as group interviews (M. N. K. Saunders et al., 2019). There are two main types of group interviews: focus group discussions and group interviews. According to Saunders et al., (2019), since there are several participants in group discussions, it allows a breadth of points of view to emerge and for the group to respond to these views. He further argues that a dynamic group can generate or respond to and evaluate several ideas, thus helping the researcher explore and explain concepts and themes. It also allows the group members to respond to the points raised by other members and challenge one another's views to generate rich discussions and outcomes (M. N. K. Saunders et al., 2019). Therefore, the researcher conducted a group discussion towards the later part of the research to present key findings and emerging themes and validate the framework. Conducting expert interviews and discussions with them reduces the biases in data sources. It also enhances the validity and reliability of the research conclusions as it helps to triangulate data from multiple sources and data collection techniques.

More details about the data collection techniques applied in this research are discussed in the below section.

4.10.1.1 Sampling of the Interview Participants and Selection

The research was conducted using semi-structured interviews at multiple stages such as during the conceptual framework development, interviewing national experts as early part of the data collection and key informant interviews with the selected cases. The researcher selected "Purposive Sampling" technique throughout the research to select interview participants. The approach for participant selection should be aligned with the overall logic of a study in terms of sampling (Punch, 2014). The rationale for sample selection must be matched with the study's main goals from an ontological, epistemological, and axiological standpoint (Campbell et al., 2020). A qualitative study may involve a relatively small and purposefully selected sample (Huberman, 1994) with the goal of enhancing the depth (rather than the breadth) of

understanding (Palinkas et al., 2015). Purposive sampling is used to pick respondents that are most likely to give relevant and useful information (Kelly et al., 2010) and is a method of discovering and selecting situations that will make the most use of limited research resources effectively (Palinkas et al., 2015). The aim of purposive sampling is to ensure that specific kinds of cases of those that could potentially be included in the final sample are included in the study, rather than random sampling methods (Campbell et al., 2020). Purposive sampling is justified by the concept that, given the study's aims and objectives, some types of people may hold differing and important perspectives on the ideas and issues under consideration, and hence must be included in the study (Robinson, 2014).

The most popular types of purposive sampling in studies involving multiple cases are stratified, cell, quota, and theoretical sampling (Campbell et al., 2020). Following is a brief description of the differences between these approaches. The stratified sampling process selects specific kinds or groups of participants for inclusion in a final sample. Participants or groups are then stratified according to their characteristics, with a specific number allocated to each stratum. In contrast to stratified sampling, cell sampling uses discrete categories of stratification, which overlap like Venn diagrams. In quota sampling, there is greater flexibility - instead of requiring a fixed number of cases with criteria, the minimum number required is specified for each category. The theoretical sampling process involves collecting and analyzing data after provisional sampling and some data analysis has been completed. During the process, new cases are identified from different groups, which is either a comparison or a contrast between others, or the sample is reshaped into a new set of criteria as a result of the analysis, replacing the original sampling strategy (Campbell et al., 2020).

Considering the research questions, and objectives the study, “quota purposive sampling” was employed throughout the research. Instead of fixing the sample size and number for each category, such as international experts (for the development of conceptual framework), national experts, key informant interviews with selected case districts and experts for the round table final validation, a minimum required number of respondents were specified for each category and then interviews were continued until information and data saturation has been achieved through a more flexible approach.

4.10.1.2 Semi-Structured Interviews with Experts

As discussed in the previous section, the rationale behind conducting expert interviews is to reduce biases and enhance the validity and reliability of the conclusions through triangulating

data from multiple sources and different data collection methods. Therefore, 15 semi-structured interviews, identified through quota purposive sampling, were conducted with the subject experts in Sri Lanka, representing DRR, CCA, socioeconomic development and food security sectors. The experts were selected based on their subject knowledge, expertise, years of practice, and engagement in policy discussions in the subject area. Table 4-2 presents details and profiles of the experts who participated in the study.

Table 4-3: Details of the National Experts who participated in the key informants interview.

Expert Code	Organization and the role within the organization	Type of Organization
N001	Disaster Management Center, Assistant Director	Government Nodal Agency for DRM
N002	Former Secretary to the Primary Industries and ADPC Consultant	Former Government and currently an international organization
N003	World Bank, Senior Disaster Risk Management Specialist	Multi-lateral Development Bank
N004	ADB, Consultant	Multi-lateral Development Bank
N005	Commonwealth Secretariat, Climate Finance Advisor	International Organization
N006	World Bank Consultant and former DMC Director	Multi-lateral Development Bank and Former Government
N007	IUCN, Sri Lanka, Country Director	International Organization
N008	Ministry of Health, Medical Doctor, and DRM Expert in the Health Ministry	Government Organization
N009	World Food Program (WFP), Program Specialist / Food Security Expert	United Nations

N010	Faculty of Agriculture & Technology, University of Peradeniya, Professor and Chair of the National Climate Change Expert Committee	Academia
N011	Climate Change Secretariat, Ministry of Environment, Director	Government
N012	Janathakshan, Program Director	Non-Governmental Organization
N013	Department of Agriculture, Agriculture Economist / Assistant Director	Government
N014	United Nations Development Program (UNDP), Program Field Coordinator	United Nations
N015	Faculty of Agriculture, University of Ruhuna, Senior Professor	Academia

Since the purpose of conducting interviews was to gather expert opinions and gain knowledge related to the field of study, the semi-structured interviews were mainly designed to collect evidence and data related to current practices for mainstreaming CCA and DRR into the overall development planning process in general and food security sector in particular. It also gathered data and evidence related to the role of the district government, provincial government and national government in mainstreaming CCA and DRR into the development planning processes, associated issues, challenges, bottlenecks and limitations. Interviews gather further evidence and data related to enabling environments, policy needs and recommendations for restructuring and reforming the existing planning processes. An interview guide was developed to facilitate semi-structured interviews. The researcher sent the guideline and the study brief to the expert before undertaking the interviews. Before moving into the main discussion, the researcher introduced the research topic, the aim, and the objectives at the beginning of the interview to provide the participants with a clear purpose and structure of the discussion and clarity of what is expected from the interviewee. That process made interviewees more familiar and oriented to the interview, allowing them to answer the questions more appropriately and freely. During the interview, the researcher asked questions and presented discussion points based on the interview guide; however, a flexible process followed for interviewees to elaborate further, bringing up other related issues as deemed appropriate. Such a process

facilitated the interviews to progress more proactively and participatory manner. Depending on the level of information and discussion generated, interviews lasted for a duration between 40 - 90 minutes and all interviews were conducted using an online conference platform, MS Team or Telephone as face-to-face interviews were not possible due to the COVID-19 restrictions during the active research phase. Following the research protocol, all discussions were audio recorded with the interviewee's consent. Audio recordings were beneficial to the researcher later in transcribing interviews more accurately after completing the interviews. It also helped the researcher fully concentrate on the discussions and take additional notes when needed. In addition to audio recording, the researcher took notes capturing all key points of the interviews to avoid any risk of technological issues later, such as failure to playback recordings or file errors. The researcher manually transcribed all the interviews, referring to the audio recording and notes, into MS Word and saved them in a password-protected folder. Although transcribing was a time-consuming process, it allowed the researcher to get familiar with all the detailed information that emerged during the discussion and take notes of specific themes and patterns. Such a process will eventually increase the reliability and validity of the research findings. (A sample Transcript is attached in Annex D: Sample Interview Transcript: Expert Interview).

4.10.1.3 Semi-Structured Interviews with Cases

As discussed in Section 4.8.1.3, the researchers selected three cases for the study. Accordingly, Trincomalee, Anuradhapura and Polonnaruwa districts of Sri Lanka were chosen for the case study. Interviews were designed to gather evidence and data regarding processes and practices in mainstreaming CCA and DRR into food security sector planning processes and the roles of district governments and other district-level stakeholders. It also gathered data regarding problems, challenges, and issues, as well as the enabling environment and recommendations for reforming the existing planning processes. The researcher conducted twenty-seven (27) semi-structured interviews, identified through quota purposive sampling, within three cases, which included eleven (11) interviews from the Anuradhapura district, eight (8) interviews from the Trincomalee district, and another eight (8) interviews from the Polonnaruwa district. The research achieved data and information saturation for each case with the above number of interviews in each case; therefore, interviews were completed. Among the three cases, Anuradhapura is a relatively large district, almost double in population size, administrative subdivisions, and a higher level of diversity in the ecological resource base, agriculture, and economic practices (minor cascade irrigation, major irrigation and rainfed agriculture) and disaster profile; therefore, it took a higher number of semi-structured interviews to achieve the

data saturation. In addition to conducting interviews at the case level, as discussed in Section 4.10.1.3, documents and archival records were collected for each of the cases and supplemented with national experts' opinions and knowledge (Section 4.10.1.1); therefore, biases in the information in each case were able to avoid although it had a different number of interviews. Tables 4-3, 4-4, and 4-5 provide the profile of each key informant who participated in the semi-structured interview for each case.

Table 4-4: Profile of the key informants in case study one

Expert Code	**Organization and the role within the organization**
A001	Janathakshan (Local NGO)
A002	United Nations Development Program (UNDP)
A003	District Disaster Management Coordinating Unit (DMC)
A004	'Wew Gam Pubuduwa Programme' (Rehabilitation of Irrigation Tanks Program)
A005	Agrarian Services Department
A006	Provincial and District Planning Department
A007	Field Crops Research and Development Institute, Mahailluppallama
A008	Farmers Organization / Farmers Association
A009	University of Rajarata
A010	United Nations Development Programme
A011	Agriculture Department

Table 4-5: Profile of the key informants in case study two

Expert Code	**Organization and the role within the organization**
P001	District Secretariat
P002	District Secretariat and District Samurdhi program

P003	District Agriculture Department / Farmer by practice
P004	District Disaster Relief Office
P005	District Disaster Management Coordinating Unit
P006	District Irrigation Department
P007	District Planning Secretariat
P008	District Agrarian Services Department

Table 4-6: Profile of the key informants in case study three

Expert Code	**Organization and the role within the organization**
T001	Janathaksan, Local NGO
T002	Provincial / District Agriculture Department
T003	Peace Wind (Local NGO)
T004	Climate Smart Agriculture Project (World Bank Funded), Trincomalee District
T005	District Irrigation Department
T006	Department of Animal Production and Health
T007	District Disaster Management Coordinating Unit
T008	Farmer Organization / Farmer Association

The researcher applied the same process as expert interviews (section 4.10.1.1) for conducting interviews with the cases. The interview guide and the research brief were sent to the key informants along with this schedule before the interview. The same procedure was applied for conducting the interviews, which included an initial introduction about the research purpose, aim and objectives and overall structure and consent for this interview. The researcher got consent for audio recording, recorded all the interviews, and took additional notes for manual transcription. (A sample transcription of a case interview is attached in Annex F: Sample Interview Transcript: Case Study Interviews). Similar to expert interviews, all case interviews were undertaken through online conference systems (MS Word) or telephone discussions due

to COVID-19 restrictions in Sri Lanka during the active research phase. Each case study interview took 40-90 minutes, depending on the evolved discussions.

4.10.1.4 Documents and Archival Reviews

As part of documents and archival reviews, the government and other publications related to DRR, CCA, food security, sustainable development and planning processes, ongoing programs, strategies, policies, and plans were reviewed to obtain in-depth knowledge about the selected cases. Furthermore, archival records related to each district, its demographic and geographical characteristics, disasters, and climate change profiles were also gathered and studied to supplement the information collected through interviews.

4.10.1.5 Group Validation Events

The researcher analyzed data and evidence collected via expert interviews and cases based on the process discussed in Section 4.10.1 and compared it with the literature review findings to formulate an initial framework for mainstreaming CCA and DRR into the food security sector. The developed conceptual framework supports climate and disaster-inclusive development. Once the initial framework was developed, it was presented at four academic events, as indicated in Table 4.6. Furthermore, a final validation round-table meeting was conducted, inviting national and international experts. Based on the feedback received at validation events, the conceptual framework was refined to arrive at the final validated framework.

Table 4-7: Profile of the experts who attended group validations events.

Group	Events	Number of Active Participants during the Presentation	Type of Attendees
V1	*International Symposium on Multi-hazard Early Warning and Disaster Risk Reduction (MHEW*	22	International and Sri Lankan experts representing the DRR, Climate Change and Resilience Fields.

	2020) held from 14-16,2020		
V2	*International Symposium on Disaster Resilience and Sustainable Development,* Asian Institute of Technology, Thailand, held from 24-25 June 2021.	19	Resilience and Sustainable Development Field.
V3	*4th Global Summit of Research Institutes for Disaster Risk Reduction:* Engaging Sciences with Action, Kyoto, Japan, held from 31st August to 01st September 2021	12	Resilience, Climate Change and Sustainable Development Field.
V4	Special Final Validation Roundtable meeting with senior academics from Sri Lanka, the UK and Europe held on 19 January 2023	16	International and Sri Lankan senior academics in DRM, CCA and food security sector.

A conceptual framework for data collection techniques applied for this multiple case study research is presented in Figure 4-8. It summarizes the links between different data collection techniques and the data triangulation process used in the study.

4.10.1.6 Final Validation Roundtable Discussion

Final validation roundtable discussion was organized to present the framework developed as part of the study. Eighteen senior academics and researchers from UK, Sri Lanka and other European countries, were chosen through quota purposive sampling, attended the round-table discussions. The academics and research were invited based on the subject knowledge and

expertise in the subject area of disaster risk management, climate resilience and food security sector, following the purposive sampling technique. The validation roundtable participants were coded, and their inputs were used for developing the validated framework for mainstreaming climate change and disaster risk reduction into food security sector planning in Sri Lanka. Table 4-8 presents details and profiles of the experts who participated in the final validation round-table discussion.

Table 4-8: Details of the Experts who participated in the final validation roundtable discussion.

Expert Code	Organization and the role within the organization	Type of Organization
FV01	University of Huddersfield, UK, Director, and a professor	Public University in UK
FV02	University of Huddersfield, UK, a professor	Public University in UK
FV03	Teesside University, Middlesbrough, Researcher	Public University in UK
FV04	University of Central Lancashire, Senior Lecturer	Public University in UK
FV05	University of Ruhuna, Senior Professor	Public University in Sri Lanka
FV06	University of Sri Jayewardenepura, Professor	Public University in Sri Lanka
FV07	University of Sri Jayewardenepura, Senior Lecturer	Public University in Sri Lanka
FV08	University of Sri Jayewardenepura, Researcher	Public University in Sri Lanka
FV09	University of Moratuwa, Professor	Public University in Sri Lanka

FV10	University of Ruhuna, Researcher	Public University in Sri Lanka
FV11	University of Sabaragamuwa, Professor	Public University in Sri Lanka
FV12	Eastern University of Sri Lanka, Professor	Public University in Sri Lanka
FV13	University of Sabaragamuwa, Researcher	Public University in Sri Lanka
FV14	University of Ruhuna, Professor	Public University in Sri Lanka
FV15	University of Ruhuna, Professor	Public University in Sri Lanka
FV16	University of Ruhuna, Professor	Public University in Sri Lanka
FV17	Tallinn Technical University, Estonia, Professor	University in Estonia
FV18	Tallinn Technical University, Estonia, Professor	University in Estonia

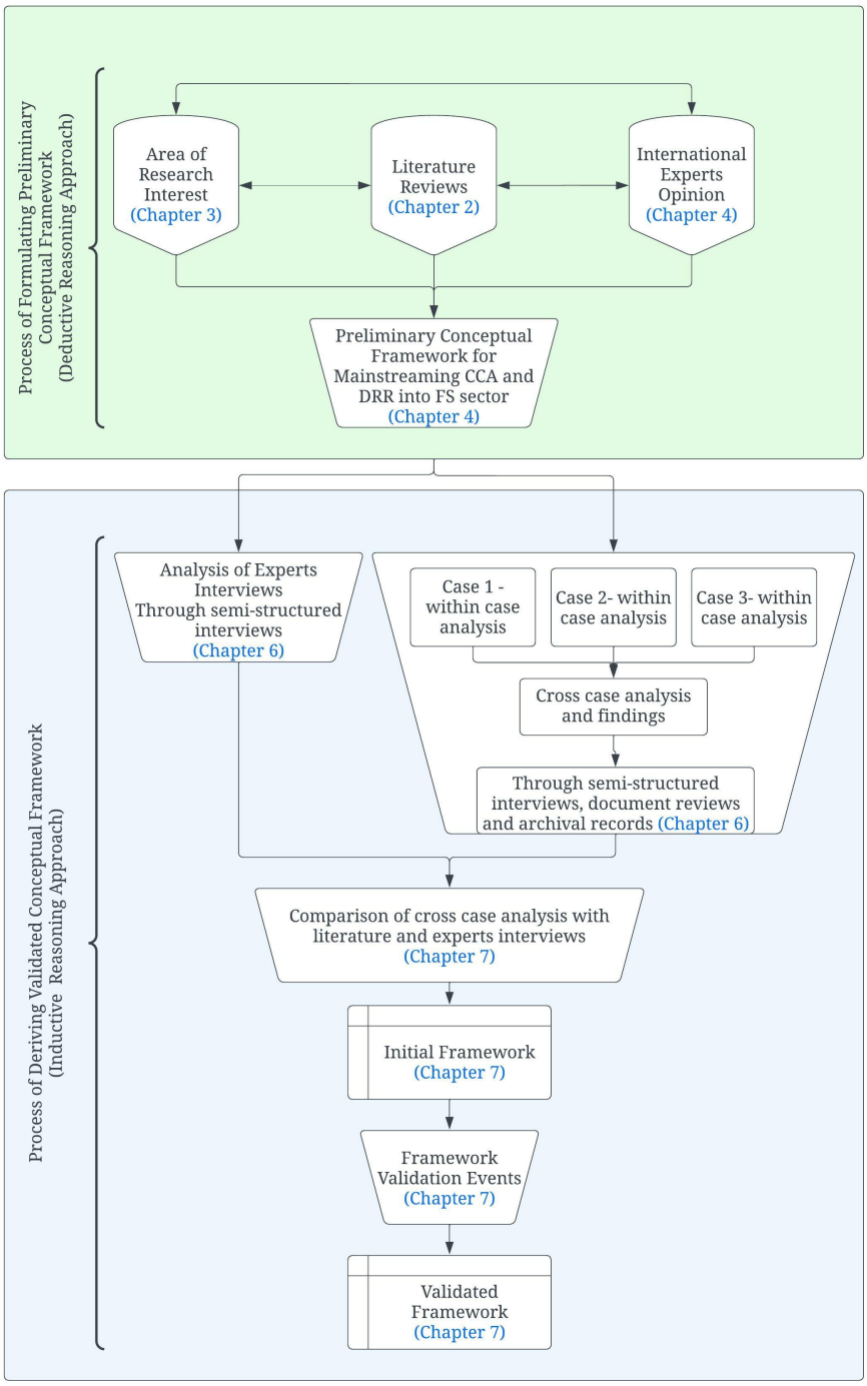


Figure 4-8: Data collection techniques and triangulation process.

The following section discusses how research objectives were achieved through different data collection techniques applied in this research.

4.10.1.7 Nexus between research objectives and data collection techniques

This section presents all the data collection techniques used to gather data and evidence against this study's research objectives. Table 4-9 depicts the tools applied against each objective, which helped the researcher triangulate data from multiple sources and methods.

Table 4-9: Nexus between research objectives and data collection techniques

Tools / Objectives	Literature Reviews	International Experts' Opinions – Semi-Structured Interviews	National Experts Interviews- Semi-Structured Interviews	Case Studies		Framework Validation Events
				Semi-structured interviews	Documents and archival records	
To investigate the need for and importance of mainstreaming climate change adaptation and disaster risk management into the food security sector.	√	√	√	√	√	
To explore effective methods and approaches for mainstreaming climate change adaptation and disaster risk management into food security sector planning processes.	√	√	√	√	√	
To design a Comprehensive Planning Framework for mainstreaming Climate Change Adaptation and Disaster Risk Management into Food Security Sector.	√		√	√		√
To make recommendations on how planning structures and processes can be reformed to ensure effective mainstreaming of climate change adaption and disaster risk reduction into the food security sector.	√		√	√		√

Having discussed the appropriate data collection techniques, triangulating data and evidence from multiple sources and methods and mapping them against all the objectives of the multiple case study, the following section provides details regarding the research technique applied for organizing and analyzing the collected data.

4.10.2 Research Techniques for Data Analysis

According to M. N. K. Saunders et al. (2019), data analysis in qualitative research is an interconnected process where the researcher collects and begins to analyze and interpret data as each interview takes place. There is a range of tools to aid the researcher in undertaking the data analysis process, such as Thematic Analysis, Template Analysis, Explanation Building and Testing, Grounded Theory Method, Narrative Analysis, Discourage Analysis, Visual Analysis and Data Display and Analysis (M. N. K. Saunders et al., 2019). Furthermore, the researcher can use a range of computer-aided qualitative data analysis software (CAQDAS) for the data analysis (M. N. K. Saunders et al., 2019). However, Yin (2018) cautioned that the researcher should not be surprised to discover that the analytical procedure for case study research is not well defined or codified into an automated software system. Thus, the researcher needs to understand, decide and make an informed decision about which analytical technique or combinations will be applied for the research based on the suitability and nature of the qualitative research (M. N. K. Saunders et al., 2019). According to the authors, unlike in quantitative research, where data analysis takes place after collecting data, concurrent collection, analysis, and interpretations of data will be applied in qualitative research. As qualitative data are derived from multiple means, such as spoken words (verbal data), written, typed or printed words (textual data), they have high diversity and analytical implications; therefore, the researcher must analyze them meaningfully and methodically. Furthermore, as qualitative data are collected in natural settings, they are likely rich in contextual details (M. N. K. Saunders et al., 2019). Philosophical assumptions of the research will also affect the design and conduct of the research, including data collection and analysis. As interpretivist researcher see reality as being socially constructed, it affects the nature and types of data being collected and analyzed as interpretivist researcher undertakes research inductively, allowing the conduct of research to follow of information and evidence being collected (M. N. K. Saunders et al., 2019). As data will reflect variations in participants' experiences and perspectives in such research, data analysis needs to recognize the breadth of these experiences and perspectives. It should be reported as it is rather than attempting to reconcile differences and diversity of viewpoints (M. N. K. Saunders et al., 2019). Qualitative analysis conducted inductively will develop a conceptual framework based on research-specific concepts and themes (M. N. K. Saunders et al., 2019). Analyzing case study data can be accomplished in various ways, such as by examining, categorizing, tabulating, testing or recombining evidence (Yin, 2018). In qualitative research, there is a high probability that the unstandardized data

collected during the research will be large in volume and complex. To condense the collected data, the researcher must process and summarize some parts. The researcher can begin their analysis by exploring the data and looking for promising patterns, insights, or concepts, with the ultimate goal of defining priorities for what to analyze and why (Yin, 2018). To analyze the data, it is necessary to code and categorize it according to themes and to connect these themes in a way that provides a framework or structure for answering the research question. These qualitative data may only be interpreted impressionistically without using such techniques. (M. N. K. Saunders et al., 2019). Data collection, analysis, and report writing are not distinct steps in the qualitative research process but are interrelated and often occur simultaneously (Creswell & Poth, 2016). According to the authors, it is a spiral with contours; therefore, they argued that data analysis should follow a spiral process. According to them, the researcher engages in the process of moving in analytical circles rather than using a fixed linear approach. Researchers explore several aspects of analysis between data and results, and within each spiral, they employ a specific analytical strategy to generate specific analytic outcomes (Creswell & Poth, 2016). As depicted in Figure 4-9, the data analysis spiral has five key processes: managing and organizing data, reading and memoing emergent ideas, describing and classifying codes into themes, developing and accessing interpretations, and representing and visualizing the data (Creswell & Poth, 2016).

Figure 4-9: Data Analysis Spiral.

(Adapted from (Creswell & Poth, 2016)

Collected data from qualitative interviews are usually stored in audio recordings and handwritten notes; therefore, they should be transcribed, and transcriptions should be prepared for each interview in preparation for detailed analysis (M. N. K. Saunders et al., 2019). Following Saunders et al., (2019) recommendation, all audio recordings of interviews were transcribed and reproduced for the analysis. It also includes contextual information and the

tone in which the key informants expressed their views on relevant research questions and thematic discussion points. As discussed in the methodology section, the researcher prepared all transcriptions manually and double-checked for accuracy in the content and context-specific details. All transcriptions were then saved in a password-protected file and named using an abbreviation code to maintain the confidentiality of the interviewees. Thus, all the national experts who participated in the research were identified as 'N' and numbered numerically from 001 - 015. The three cases were also referred to as A, P, and T. Each interview was given a numerical number starting from 001 in each case study. It was the same process for the validation meetings, where meeting notes were saved as V1, V2, V3 and V4.

To clearly distinguish between questions and responses within each transcript, all questions were written in red font, and all responses were recorded in black font. Then a summary of key points was produced, condensing the meaning of a large amount of textual information. The researcher identified principal themes and their relationships through such processes. The next step was to sort it into different categories. M. N. K. Saunders et al. (2019) recommended two activities: developing categories and assigning them to meaningful data sections. Based on the research objectives and questions, categories were identified following this study's purpose. In the next step, the researcher combined sections of data into categories that emerged from the data. The next step was to recognize relationships and develop categories, and this process continued in the search for key themes and relationships. Following this, categories were revised, subdivided, or integrated with corresponding rearranged data until explanations for the research questions and objectives were generated. To facilitate the analysis process, the researcher applied two main analytical techniques: Thematic Analysis and Cognitive Mapping. Detailed explanations of both techniques can be found in the Section below.

4.10.2.1 Thematic Analysis

Analyzing qualitative data using thematic analysis is an accessible and robust method. The thematic analysis involves systematic processes of data coding to develop themes across qualitative data, and it can be defined as a way of developing, analyzing and interpreting patterns (Braun & Clarke, 2022). According to the authors, it is necessary to employ design thinking when conducting a thematic analysis to organize, interrogate, and interpret qualitative data. This requires thinking and making choices regarding other aspects of the research process and project (Braun & Clarke, 2022). As part of thematic analysis, the researcher cords his or her qualitative data to identify themes or patterns that can be studied further according to the

research question (M. N. K. Saunders et al., 2019). It has been described as a systematic procedure which provides an orderly and logical method of analyzing qualitative data, whether those data sets are large or small, resulting in a detailed description, explanation, and theorizing (M. N. K. Saunders et al., 2019). According to the authors, thematic analysis can be used to

- Identify and comprehend the diverse and large volume of qualitative data.
- Compile related data from different transcripts and notes.
- Identify and explore key themes and patterns within a data set.
- Develop a thematic description of the data set.
- Investigate apparent thematic patterns and relationships and develop explanations and theories based on these findings.
- Make conclusions and verify them.

Thematic analysis is flexible and accessible (Braun & Clarke, 2022) as it is not restricted to a particular research philosophy; thus can be used with deductive, inductive or abductive approaches (M. N. K. Saunders et al., 2019). The researcher examines the entire data set to identify occurrences and recurring themes (M. N. K. Saunders et al., 2019).

Accordingly, thematic analysis was adopted in this research to analyze the collected qualitative data with an inductive approach. Organizing and analyzing large volumes of qualitative data is a time-consuming and energy-intensive process; therefore, authors such as M. N. K. Saunders et al. (2019) and Creswell and Poth (2016) discussed the potential of using computer-assisted qualitative data analysis software packages such as MAXQDA, ATLAS.ti, or NVivo, depending on the familiarity by researchers. Therefore, '*Nvivo 20'* software was used in this study, and the procedure followed can be found in Section 4.10.2.3.

4.10.2.2 Cognitive Mapping

The researcher used cognitive mapping, in addition to the thematic analysis, for analyzing the qualitative data. Cognitive mapping can be defined as a *method based on personal construct theory that structures a participant's perception in the form of a diagram* (Collis & Hussey, 2014). In summary, the underlying theory of cognitive mapping is that different people interpret data differently and, subsequently, solve problems differently. To make sense of the world, people create a network of diagrams based on their constructs, which assists them in understanding it better (Collis & Hussey, 2014). The authors further argue that it is difficult for decision-makers to process all the information that would be relevant when trying to resolve a new and complex problem. Still, they can use their existing cognitive maps to determine what

action is needed. Research relating to the development of strategy often relies on cognitive mapping, which can be helpful in the context of action research (Collis & Hussey, 2014). Using cognitive mapping, transcripts of interviews or other documentary data can be summarized to facilitate reflection and analysis, leading to possible solutions. The cognitive mapping technique has been used for several decades. A cognitive map can be designed to facilitate the intelligent handling of messy data and serve as a method for constructing problems and addressing each problem in a structured manner (Eden, 1988). A cognitive map provides a diagrammatic and easy-to-understand summary of qualitative data, making it an effective method of presenting complex data to readers. To identify and display key themes and relationships between themes and sub-themes in a hierarchical network, the cognitive mapping technique was also used for data analysis of this study.

The researcher used the Nvivo 20 software to facilitate the cognitive mapping process, and the following section details the basic steps involved in using the software.

4.10.2.3 Computer-assisted Qualitative Data Analysis

In the past, researchers analyzed qualitative data manually, which is a very time-consuming, exhaustive, and energy-intensive effort to manage, organize and analyze a large volume of textual data and documents. However, as encouraged by M. N. K. Saunders et al. (2019) and Creswell and Poth (2016) there are several computer-assisted qualitative data analysis software packages, such as MAXQDA, ATLAS.ti, or NVivo, in the market today. Accordingly, the researcher used Nvivo 20 software (MAC version) in this study to manage, organize and analyze qualitative data. An overview of the basic steps involved in analyzing data using Nvivo 20 is provided in this section.

All transcripts and field notes from semi-structured interviews were imported into the Nvivo20 software in the first step. Then, following the Qualitative Data Analysis Spiral (Creswell & Poth, 2016) and procedures explained by M. N. K. Saunders et al. (2019), data from all interviews were summarized, and thematic relationships between principal themes were identified and recognized. As part of this process, all interview data was thoroughly analyzed to determine the main themes aligned with the research objectives. According to the most recent Nvivo 20 for MAC, the term *'code'* refers to the ‘themes’ the researcher has identified. Afterwards, 'data coding' was used to connect the transcripts with key themes (codes) of Nvivo20. The researcher systematically assessed each interview transcript, and all relevant concepts were coded and linked to the themes defined in Nvivo20. A new theme (code) is created whenever a new concept is discovered, and relevant data is linked (coded) with the

theme. Following this approach, the data were coded by identifying meaningful and appropriate categories for a particular theme. Nvivo20 has two types of codes, which can be defined as main codes (parent codes) and child codes. The parent codes are horizontal categories/themes, while child codes are vertical branches of parent codes/ sub-themes, which can be aggregated into the parent codes. Finally, cognitive maps were developed to identify the relationship between and among codes/themes and subthemes using the 'Maps' module of the Nvivo 20 Software, which has two categories: Mind Map and Concept Map. Based on the opinions and views of key informants and the researcher, relationships between each code/theme were identified during this process.

A detailed narrative of each theme relevant to each case was analyzed when interpreting the data. Following this, the researcher conducted a thematic analysis across all the cases. (Refer to Section 4.10.2.1 Theory Development from Case Studies). Lastly, an initial framework was developed by comparing cross-case findings, inputs from expert interviews and literature reviews. Then the initial framework was presented at the validation events and subsequently validated to arrive at the final validated framework based on the inputs and opinions received from the experts who attended the validation events (refer to Section 4.10.1.4 and Figure 4.8).

4.11 Thesis Write-up

Writing and completing a thesis is the most crucial aspect of this PhD research. It is a continuous process throughout the PhD research journey. The thesis writing process started the initial stage of the research by commencing the literature review chapter. It was continuously updated, and new chapters and sections were added as the research progressed. Once the data analysis was completed, a detailed and full content outline and breakdown of the chapters were prepared and shared with the supervisory team to obtain their input and guidance. Upon receiving their comments and guidance, the content outline was updated. New chapters and related sections were populated based on the new theories, themes, concepts, and findings that emerged to arrive at the final thesis.

As discussed in this chapter, the 'research onion' methodological framework (M. N. K. Saunders et al., 2019) was applied in designing the research methodology and approach to theory development. While it is necessary to design the research using an acceptable framework such as *'research onion',* it is not necessarily sufficient to ensure the required quality of the research, leading to sound analysis, findings, theory and thesis; therefore, the

next section explains the actions taken by the researcher to maximize the quality of this research.

4.12 Need for Establishing the Quality of Research

Maintaining the quality of research throughout the qualitative research process is important. There are multi or polyvocal discourses to provide insights into the validation and evaluations of qualitative research, which help the researcher to increase its validity and quality standards (Creswell & Poth, 2016). For qualitative case studies research, there are four main criteria or logical tests for judging the quality of research design. These can be summarized as construct validity, internal validity, external validity and reliability test (Yin, 2018). More details and procedures for conducting each of these tests are discussed below.

4.12.1 Construct Validity

According to Yin (2018), a construct validity test means *'identifying correct operational procedures for the concept being studied'*. This is the first and foremost important step in case study research. The researcher can use three main strategies to increase construct validity in case studies. They can be summarized as 'use of multiple sources of evidence', 'establish a chain of evidence', and 'have the draft case study report reviewed by key informants' (Yin, 2018). As discussed in the previous section, the construct validity was satisfied by triangulation of research techniques and by collecting data and evidence from multiple sources. Data and evidence were gathered using multiple sources, including documents, archival records, and semi-structured interviews with key informants in the selected cases. Furthermore, in addition to collecting data from multiple sources, three international expert interviews were conducted to gather expert views, perspectives, and knowledge about the subject area and preliminary research framework and validate the research methodology. Thus, the researcher was able to satisfy the construct validity of the research by using multiple sources of evidence. Furthermore, the literature review process of the research also contributed to constructing validity, as it triangulated knowledge and kept concepts and related frameworks by reviewing different streams of literature throughout the research process. In addition, the triangulation of data analysis through Thematic Analysis and Cognitive Mapping also contributed to the construct validity of the research. According to Yin (2018) a chain of evidence should be maintained to strengthen overall research quality. Therefore, the researcher maintained all relevant citations on the case study database. At the same time, audio-recorded interviews and

transcripts of semi-structured interviews were uploaded into the NVivo20 software, making all the interview information accessible and usable during the data analysis and thesis writing process. Moreover, the researcher conducted all semi-structured interviews and expert discussions according to the case study research protocol; thus, the information and evidence gathered through interviews are consistent with the design procedures and questions outlined in the case study protocol. Overall, the researcher has maintained a chain of evidence throughout the study, contributing to its construct validity and overall quality.

4.12.2 Internal Validity

According to Yin (2018) internal validity 'seeks *to establish a causal relationship whereby certain conditions are believed to lead to other conditions, as distinguished from spurious relationships.* The author further argues that internal validity is necessary for explanatory and causal studies only but not relevant for descriptive or exploratory studies. Internal validity should be applied during the data analysis phase of case studies (Yin, 2018). The internal validity of this research was achieved in multiple ways. Initially, it was achieved by systematically developing the research questions and conceptual framework and identifying the appropriate research philosophy, approach, research strategy, choice, time horizon and technique to ensure their compatibility with each other and verifying them during the data analysis process. Furthermore, using multiple data analysis techniques such as Thematic Analysis and Cognitive Mapping and then triangulating findings for the theory development and multiple validation events with experts also contributed to the overall internal validity of this case study research. All these measures contributed to having a clear direction and data analysis methodology and validation process for the research, enhancing the internal validity.

4.12.3 External Validity

According to Yin (2018) the external validity test will *'show whether and how a case study finding can be generalized'.* It addresses whether the findings of a study can be generalized beyond the immediate context of the study. The most effective way to achieve external validity is to carefully review the initial research questions and ensure they are of the 'how' and 'why' types. As Yin (2018) points out, reaching an analytical generalisation may be more challenging if there is no pressing 'how' or 'why' research question in a specific case study. According to the author, this situation can be prevented by incorporating 'how' and 'why' type questions into the study design and collecting additional data to support it, which can be extremely helpful.

Therefore, the form of the initial research question can directly influence the strategies to achieve external validity. During the research design phase, this research developed questions with 'how' and 'why' types, identifying appropriate theoretical prepositions and laying the groundwork for addressing external validity.

In addition, the researcher used a multiple case study design with the replication logic to address the criteria for external validity. The study was conducted with three selected cases which are governed under the same governance systems and procedures as laid out by the central government of Sri Lanka. In this way, the research findings can be generalized and replicated in all other districts of the country by cross-case generalization, thus improving the external validity of the research. Furthermore, since cross-case findings were compared and validated with the findings of expert interviews and literature during the data analysis process, the external validity of the research was further enhanced.

4.12.4 Reliability

Reliability '*demonstrates that operations of a study such as its data collection procedure can be repeated with the same results' (Yin, 2018).* In reliability tests, the findings and conclusions of the investigation should be similar if another researcher uses the same methodology used by the earlier researcher for a particular case study. A case study's reliability is determined by reducing errors and biases in the study to optimize its results.

To achieve reliability in this case study, as Yin (2018) suggested, the complete procedure adopted and the methodology used by the researcher for this case study were well documented. Two main tactics were applied in this research to meet the reliability criteria. They are using a *'case study protocol'* to deal with documentation problems and developing a 'case study database'. This research used a case study protocol and database to ensure reliability during the data collection phase. To increase the reliability of this study, all materials used in the data collection phase and each step taken throughout the process were well documented. The researcher also maintained a case study database, which organized and documented all the data collected as part of the case study. During the case study, all transcripts of the interviews were stored using the Nvivo20 software program.

Moreover, all interviews were audio recorded, and all transcripts were reviewed to ensure no apparent errors during transcription, increasing the research's reliability (Gibbs, 2018). Definitional drift in coding is another issue that affects the research's reliability. Gibbs (2018) suggested applying consistent checks about the codes to avoid developing inconsistencies

during the data entry and analysis. According to the author, this can also be achieved by writing memos about the codes, and it will help the researcher to remember the kind of thinking behind when the code was created in the first place and rereading these memos later part of the coding will improve the consistency. Accordingly, the researcher continuously checked and verified codes in this research and added related memos to ensure consistency across the data coding. Features of Nvivo20 software were used to attach memos for each code so that the researcher and other researchers in the future can refer to them when needed.

Several tactics have been used in this study to meet the requirements of four tests and the overall quality of the case study research, as discussed and proposed by Creswell and Poth (2016), Gibbs (2018), and Yin (2018). Table 4-10 summarizes the different tactics applied in this research.

Table 4-10: Tactics applied for enhancing the quality of the case study research.

Test	**Tactics used in the multiple case study research**	**Phases of the research in which the tactics applied**
Construct validity	Evidence derived from multiple sources	Data collection phase
	Maintain a chain of evidence	Data collection phase
Internal validity	Development of research question	Establishing the research problem phase
	Development of the conceptual framework following the research question	Developing the research design phase
	The establishment of appropriate techniques for data analysis	Research methodological design and the data analysis phase
External validity	Development of research questions with 'how' and 'why' questions	Establishing the research problem phase
	Applying replication logic	Research design phase
	Literature reviews	Data analysis phase
Reliability	Follow the case study protocol	Data collection phase

	Create a database of case study	Data collection phase
	Verify all interview transcripts for apparent errors	Data analysis phase
	Check all codes against the data	Data analysis phase
	Defining each code with memos and definitions	Data analysis phase

4.13 Summary and Link to the Next Chapter

Research is a well-coordinated and organized effort to generate and disseminate new knowledge with academic rigour. The research methodology applied in this doctoral research was discussed in this chapter. The research aimed to develop a framework to mainstream CCA and DRR into the food security sector at the district level. The chapter discusses and justifies the overall research methodology, the establishment of the research problem and detailed research strategy and related techniques to achieve the objectives. The chapter outlines all key methodology components following the 'research onion' model (M. N. K. Saunders et al., 2019) covering research philosophy, approach to theory development, methodological choice, research strategy, time horizon and research techniques. The overall design and methodology were justified by referring to the most recent research mythology literature throughout the chapter. Interpretivism is the philosophical assumptions and theoretical underpinning of this research. The focus of this research is to develop a framework to mainstream CCA and DRR into the food security sector, which is a complex issue. The researcher argues and justifies that such complex development issues cannot be theorized by definite laws, principles and strategies applied in natural sciences. Thus, case studies were selected as the preferred research strategy, and the rationale for selecting multiple case study strategies was presented and discussed in detail. The researcher proposes a 'holistic multiple case study design' in which the unit of analysis is the 'mainstreaming of CCA and DRR into food security sector planning'. Subsequently, three case studies were conducted by selecting three districts of Sri Lanka that are highly vulnerable and exposed to climate change, disaster risks and food insecurity. Document reviews and semi-structured interviews were conducted to gather data and evidence for the case study. Additionally, experts from the field of study were interviewed two times using semi-structured interviews and group discussions. The first group of semi-structured interviews with experts were conducted to get their opinion, views, and expert knowledge in the field of study. The second series of discussions were held to validate the framework being

developed as part of the research. Expert interviews also supported the researcher in reducing biases in data sources and increasing the validity and reliability of the research findings by triangulating data and evidence from multiple sources and techniques. Data and evidence collected through semi-structured interviews were analyzed using two main techniques: Thematic Analysis and Cognitive Mapping. To conclude the chapter, the researcher discusses the measures taken to ensure the research findings are acceptable and of high quality.

The following chapter presents the data analysis for the research.

CHAPTER 5 : DATA ANALYSIS

5.1 Introduction

Chapter 4 outlines the research, detailing the research philosophy, approach to theory development, methodical choices, research strategy, time horizon, and data collection and analysis techniques. This chapter presents the data analysis covering semi-structured interviews of experts and three cases. The chapter is structured as follows:

- Firstly, the chapter provides background information about the experts who participated in semi-structured interviews and the procedure used to analyse data collected from them. It follows the findings from the analysis of expert interviews covering four main areas, namely, the importance of mainstreaming CCA and DRR into the food security sector, effective methods and approaches in mainstreaming CCA and DRR into the food security sector; frameworks for mainstreaming CCA and DRR into food security sector; and recommendations for reforming and restructuring the planning processes for effective mainstreaming of CCA and DRR into food security sector planning in Sri Lanka. (Section A of the chapter)
- Secondly, the chapter provides background information on three case studies and the case study analysis procedures, followed by case study findings. Accordingly, it covers the importance of mainstreaming climate change adaptation and disaster risk reduction into the food security sector, effective methods and approaches, existing frameworks, and recommendations for reforming and restructuring planning processes in the respective case districts. (Section B of the Chapter)
- Thirdly, the chapter presents key findings of the cross-case analysis, summarising the analysis of expert interviews and cross-case analysis. (Section C of the chapter)

SECTION A

5.2 Background information and procedure adopted for analysing national experts' interviews.

Section 4.10 provides background and the method used to collect and analyse data and evidence using semi-structured expert interviews. As explained in Section 4.10.1.2, fifteen (15), semi-structured interviews were completed with well-known subject experts in the CCA, DRR, Food Security (FS), and Sustainable Development (SD) fields. Thematic analysis was used to identify key concepts and themes described in Section 4.10.2.1. As described in Section 4.10.2.2, cognitive mapping was another qualitative data analysis tool used to map approaches for mainstreaming CCA and DRR into food security sector planning processes. The NVivo20 software (Mac version) was used to manage, organise, and analyse qualitative data from semi-structured interviews, as described in Section 4.10.2.3. The following section presents a detailed analysis of the experts' interviews.

5.3 Analysis of Experts' Interviews

5.3.1 Importance of mainstreaming climate change adaptation and disaster risk reduction into the food security sector

It is critical to assess the importance and need of mainstreaming CCA and DRR into the food security sector in Sri Lanka. Such an assessment provides the overall context and current status of the studied issues, as discussed in the following Sections.

5.3.1.1 Current Status of Food Security in Sri Lanka

As discussed in the literature review chapter (Chapter 2), food security has four main dimensions: access, availability, utilisation, and stability (see the section 2.2.1). Access to safe and healthy food is a basic human right, an essential human need, and a primary yardstick of human health, which includes the main components of food availability, access, use, and stability (Dayananda, 2022). Experts provided opinions and knowledge regarding the current food security dimensions in Sri Lanka. Key findings are summarised below.

5.3.1.1.1 Food Availability Status in Sri Lanka

Food availability is primarily dependent on food production in Sri Lanka. Most experts believe Sri Lankans are focusing on food availability through subsistence agriculture. The expert N13

said, "*I can say that approximately 80% of food security has been ensured from a quantity point of view."* However, expert N15 had different views and expressed, "*I believe that both quantity and quality have not been met in Sri Lanka."* The same issue was concurred by N01 and N09, who said that *"there are issues concerning the stability of the agriculture and food security sectors in Sri Lanka."* According to experts, food availability is insecure across the country, and climate change and disasters have exacerbated it and this reaffirm the literature findings (see section 2.3.4.2).

5.3.1.1.2 Food Access Status in Sri Lanka

According to the FAO, "food access" means people have "access to adequate resources (entitlements) for getting the right foods for a healthy diet" (FAO, 2006). The majority of the experts expressed that there are serious issues concerning food access in line with the literature findings (see section 2.3.4.2). The expert N01 stated that *"in rural communities, not even 50% of the community has access to nutritious foods due to a system issue,"* indicating resource access issues. The expert N05 supplemented the same argument, stating that *"when we go to micro-level data, food security issues are there; it is about affordability and accessibility."* Insufficient income and poverty are the leading causes of access issues. The national expert N13 explained this by saying, "*in the dry zone, there is food insecurity, which is related to poverty*." The national expert N05 expressed similar sentiments concerning the urban poor, saying, *"my personal opinion and experience are that the urban poor is highly vulnerable. Very low savings and a lack of financial stability in the poor urban community cause access issues to regular foods." "If you take access and accessibility, it is a main issue for rural and urban,"* said national expert N12. The national N13 concurred on the same concerns. Food access in Sri Lanka is also affected by cultural nuances and gender. Contributing to this argument, the national expert N07 stated that *"our females will not eat until the men are happy. So, the societal and cultural nuances have a big role in the food security sector."*

Disasters and inflation affect purchasing power and food access, according to some national experts. National expert N09 stated, "*If you look at the inflation in Sri Lanka, it has increased at least two folds within two years due to COVID-19 and other economic shocks",* indicating high prices will create food access issues. The same point was made by national expert N02, who stated that *"due to climate change, floods, and droughts, food prices are rising, causing access issues for the poor."* National expert N04 emphasised disruption to supply chains and distribution networks due to disasters affecting food access. It was evident during the Covid-

19 pandemic. He explained these issues, saying, *"during 2015, 2017, and 2018 disasters and the recent pandemic, there seemed to be substantial disruptions to domestic distribution and access to market points."*

The national expert N03 highlighted that people on the edge of food security might be food insecure due to disaster, reflecting that *"Sri Lankans manage their meal requirements, but they are on edge. Whenever they face a shock, they will face affordability and access issues."* The national expert N01 highlighted and concurred on the same issue, saying that *"people do not have access to three meals in rural areas during droughts and floods"*. They either lack access to markets during the disasters or encounter direct food losses, leading to income and livelihood losses.

5.3.1.1.3 Food Utilization Status in Sri Lanka

Indicating the grave concerns about food utilisation, the national expert N05 expressed, *"I'm not sure whether Sri Lankans are very concerned about the composition of their food and its nutritional value."* The national expert N06 highlighted that *"some rural middle-income people don't like and prefer the quality food at the village level. They like urban foods, although they do not meet the quality standard,"* indicating issues related to knowledge and education on food security. The national N07, N12, and N15 had the same sentiments concerning knowledge about food utilisation. The experts also highlighted the lack of government support and extension programs for awareness raising and knowledge dissemination. In contributing to this issue, the national expert N06 underscored that *"the government is not promoting quality foods, and there is no policy on that."* Like in other dimensions, reliable data and evidence are also lacking concerning food utilisation. The national expert N04 expressed his concerns that *"there are fluctuating figures of malnutrition under the five-year-old age group. Some put it as high as 25%."*. The national expert N05 also concurred on data reliability issues concerning food utilisation. Lack of good health and nutritional indicators are also affecting the current status of the food utilisation outlook. The national expert N08 reflected this, saying that *"because of food insecurity, we see malnutrition. Why can't we address this issue?"* The National Expert N10 expressed some concerns regarding the progress of the recent investment to increase the quality, saying that *"when it comes to quality, so much emphasis has been given on nutrition value, safety aspects, the glycemic index, etc., and a lot of investments have been made to enhance the nutrition value of the food globally. But in Sri Lanka, people are working towards that"*.

National experts highlighted that food utilisation is a significant challenge in Sri Lanka. According to them, it gets further acerbated by the impacts of climate change and disasters.

5.3.1.1.4 Food Stability Status in Sri Lanka

According to FAO (2006), *"to be food secure, a population, household or individual must always have access to adequate food. They should not risk losing access to food because of sudden shocks (e.g., economic climate crisis) or cyclical events (seasonal food insecurity). Therefore, the concept of stability can refer to both the availability and access to food" (refer to section 2.3.4.1.* According to national experts, the consistency of food availability and affordability throughout the year in Sri Lanka is a major concern, reaffirming literature findings (see section 2.3.4.2 and 2.7). The national expert N05 reflected on this issue, saying, "*it is about consistency to have foods throughout the year. There are issues around equity, especially in the bottom layers of social strata, those who cannot afford food consistently'*, indicating the lowest strata of society are facing food stability issues. Geographical inequity issues were highlighted by the expert N06 saying that *"in most cases, the problems are in the rural poor; they don't have access to food throughout the year".* This issue was also concurred with by national expert N12.

According to experts, food stability also depends on disaster impacts and climate change. The national expert N14 highlighted this issue, explaining that *"the agriculture sector is also frequently affected by disasters and climate change. That has an impact on food security."* The same issue was highlighted by expert N09, saying that *"the most alarming part of food security is the availability across the year, which is hindered due to the variations in production."* According to the experts, due to the current foreign exchange and dollar issues, the government has taken certain policy decisions to restrict international trade, adversely affecting food stability in the country.

Climate change has a negative influence on global food security, growing poverty, hunger, and malnutrition, all of which disproportionately affect emerging countries and poor and marginalised groups. Climate shocks and changes in weather patterns have a higher impact on agriculture in Sri Lanka than in other countries.The country endured its worst drought conditions in late 2016, with paddy production dropping by 40% in early 2017. Following that, torrential rains in May 2017 harmed food crop productivity even more (Gunaratne et al., 2021c). According to the authors, Climate change threatens domestic food production and food security in Sri Lanka. The country placed 66th out of 113 countries in the Global Food Security

Index 2019, with an overall score of 60.8 percent - a 1.2 percent increase from 2018. The ongoing global food crisis, rising trade deficit, domestic food price inflation, and deterioration of foreign exchange have all had a negative influence on Sri Lanka's micro and macro food security (Senanayake et al., 2015). According to the authors, there have been many food security programs in the past and present that have improved domestic food production and ensured macrolevel food self-sufficiency. However, an increase in domestic agricultural production alone does not generate high economic growth, which could be used to combat the adverse effects caused by a decline in trade, an increase in domestic food prices, deteriorating foreign exchange reserves, and a global food crisis. With the current economic uncertainties, Sri Lanka has been severely affected by food insecurity, which has caused a serious hardship for its people (SyndiGate Media Inc, 2022). Various factors, including a failed regime, have caused severe economic shocks in Sri Lanka. Due to the current economic crisis, Sri Lankans have been skipping meals at least once or twice a day (Maharashtra, 2022). Sri Lanka is experiencing a rising problem with the waste of food. Every single day, the nation throws out approximately 3963 tonnes of food (Aloysius & Ananda, 2023b). According to the authors, despite the fact that a significant quantity of food is thrown away in Sri Lanka, nearly one-third of the population is unable to purchase a diet rich in nutrients, and approximately 22 percent of the entire population does not have access to adequate food to maintain a healthy life. Since the beginning of the 20th century, food security has been one of the most pressing issues in Sri Lanka. For Sri Lanka, there was also the extra strain of knowing that it was dependent on food supplies from overseas, which may be undercut by global trends (Daily Mirror, 2014).

In summary, the food security status in Sri Lanka is very complex, with many interdependencies between food availability, access, utilisation, and stability. Food security is also connected with development, equity issues, geographical and demographic variations, international and local trade, health, and education, which make matters even more complicated. Moreover, food security issues are compounded by climate change and disaster impacts. Thus, as depicted in Figure 5-1, following the procedure outlined in Section 4.10.2.2, the researcher developed a cognitive map to demonstrate interdependencies and a complex nexus between food security, development, climate change, and disaster-related issues.

Figure 5-1: Thematic map of food security status in Sri Lanka.

5.3.1.2 Observed Direct Impacts of Climate Change in Sri Lanka

Sri Lanka is exposed to climate change and its impacts. While climate change modelling research is relatively new to the country, experts in the sector have initiated dialogues in various technical and policy forums. In this study, national experts' opinions and knowledge were gathered through semi-structured interviews to assess the observed climate change impact in the country. The below section presents some of the observed climate change impacts according to the experts, which are also affirmed through literature (see section 2.3.4.2).

5.3.1.2.1 Precipitation Changes

Most experts expressed their views and shared their knowledge that climate change is already felt in the country leading to observable precipitation changes. The national expert N01 contributed to this discussion, elaborating that *"there is a feeling impact, and it is common sense. We can get past examples, such as continuous floods reported in 2015, 2016, 2017, and 2018. After a few months of floods in 2017, there was a severe drought in all 25 districts"*. He went on to say that rainfall severity has increased and drought severity has changed. The national expert N02 concurred with the same observations saying that *"it is especially felt in the water management sector. It is either too much or too little water"*. The national expert N03 elaborated on this issue, providing specific data on the studies conducted under their programmes, saying that "*rainfall studies done in Colombo have shown a 20% increase in short-interval rainfall intensities. We have found that rainfall intensity changes are much more significant in the northern part compared to the southern part of the country"*. The national expert N04 also supplemented the same observations by referring to other data sources. He explained that *"in Sri Lanka, it is clear that the wet zone is getting wetter, and the dry zone is getting drier. The southwest monsoon will be higher, and the northwest monsoon will be lower"*. Several experts pointed out that it is not just about the total amount of rainfall but also its distribution. The national expert N12 explained that further, saying that *"there are erratic rainfall patterns across the country"*.

Experts concluded that due to climate change, Sri Lanka is experiencing precipitation changes across the country.

5.3.1.2.2 Temperature Changes

As discussed in section 2.3.2 of the literature review chapter, the temperature change is one of the observable changes from climate change. The researcher inquired about this phenomenon

with the experts. They also agreed that due to climate change, Sri Lanka is experiencing temperature changes. Supporting this view, the national expert N04 explained, "*there is also some troubling evidence, and it says that there is a separate process of ocean warming around Sri Lanka."* The national expert N05 also highlighted that *"there is a trend of increased temperatures, especially in the central part of the country and in the wet zone".* The N06 also agreed, confirming that "temperature changes are also happening". The N07 gave further evidence on these issues confirming that *"in different areas, different changes occur; both the maximum and minimum temperatures are increasing".* The national expert in N08 concurred with this idea saying that *"extreme heat is also experienced in Sri Lanka. Heatwaves and extreme heat have become a topic discussed on television*".

In conclusion, many experts believe that temperature changes from climate change are already felt and evident in certain parts of the country.

5.3.1.2.3 Sea-Level Rise

Sea level rise is another common phenomenon of climate change. Some experts also opinioned that sea level rise has been observed in certain parts of the country, specifically in southern coastal areas. National expert N07 expressed his view on this issue, saying, *"sea level rise is not very pronounced, but there are signs that coral is bleaching and certain areas are getting high waves. Sea level issues are not just the rise but also current dynamics."* The national expert N01 also concurred that sea level rise has already been observed in certain areas of the country, saying that *"coastal hazards and erosion have increased. Some areas have been permanently inundated in the south."*

In conclusion, some experts expressed their concerns about sea level rise, saying that it is already felt in the country's coastal lagoons and lowlands.

5.3.1.2.4 Evapotranspiration Changes

The national expert N05 discussed evapotranspiration changes due to climate change. He explained that *"climate change is happening at three levels, in my view. That includes increasing or decreasing precipitation, increasing temperatures, and increasing or decreasing evapotranspiration. During dry spells, evapotranspiration is also higher."* The expert summarised that evapotranspiration changes could have a significant issue as they may influence the production of the agriculture sector.

Figure 5-2 summarises the mind map of the observed impacts of climate change in Sri Lanka.

Figure 5-2: Cognitive map of observed climate change impacts in Sri Lanka.

Climate change is occurring at an increasing rate all throughout the world. According to an IPCC special study on climate change and land, the measured average world temperature increased by 1.58 degrees Celsius between 2006 and 2015 when compared to 1850-1900. (Abeysekara et al., 2023). According to the authors, climate change tends to have a greater negative impact on developing countries than on developed countries. The fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) indicates that South Asian temperatures are projected to rise by more than 2 °C by the middle of the twenty-first century, hot days will become more common, and rainfall is likely to become more erratic with an increase in extreme rainfall events (Esham et al., 2018b). In the Sri Lankan context, local farm households have clearly observed significant climate variations during the course of their farming (Suresh et al., 2021). According to the authors, there has been a significant rise in temperature, which has had a severe influence on agricultural output. They further claim that farmers in Sri Lanka have faced highly variable weather conditions, which have hampered a wide range of farming operations. The observed and anticipated climate changes in Sri Lanka demonstrate a significant departure from expected rainfall and temperature trends. Rainfall has a large interannual fluctuation (1970-2020) (Ratnayake et al., 2023). Furthermore, authors argue that certain temperature shifts toward higher values, as well as positive anomalies in

rainfall, which alter seasonality and the risk of more extreme occurrences in the future, particularly during the Maha cultivation season. In the recent past, there has been a startling acceleration in the rate of climate change that has been seen in Sri Lanka (Khaniya et al., 2021).

While discussing the direct impact of climate change, such as precipitation changes, temperature changes, and sea-level rise, experts also explained the nexus between climate change and hazards leading to disasters. Therefore, the following section analyses how climate change induces various hazards in Sri Lanka.

5.3.1.3 Climate Change and Disaster Nexus in Sri Lanka

As discussed in Chapter 2, researchers have established clear nexus between climate change, extreme events and food security. Therefore, this Section presents themes and patterns that emerged between climate change and hazards based on the analysis of semi-structured interviews with national experts.

5.3.1.3.1 Climate-Induced Disasters in Sri Lanka

According to national experts, multiple hazards are induced by climate change which is also affirmed through literature (see section ; and 2.7). The nexus between climate change and hydro-met hazards are discussed below.

Floods:

National experts say floods are the most common and frequently felt climate-induced hazard. The national expert N01 comprehended this issue, saying, *"within a short period, huge rainfall occurs, leading to floods."* The national expert N03 explained how human interventions and climate change lead to floods, saying that *"we have seen and observed significant changes in land use. Some areas have been cleared, while other areas have been paved. When high-intensity rainfall is received in a shorter period, the runoff will be increased, and a higher amount of water will be accumulated in the rivers. It may cause flash floods and riverine floods."* The national expert N06 commented on the same issue, saying that *"one of the reasons is the forest and catchment area clearance. It increases the siltation. Therefore, the capacity of the reservoirs had reduced. During the last 30 years, the number of disasters has increased."* The national expert N15 also concurred the similar issues. The national experts N04, N07, and N11 explained how climate change could impact different types of floods, such as flash floods, saying that *"we consider flash floods to occur due to climate change. Even in dry zones, we are*

experiencing flash floods. We have identified high-intensity rainfall received in shorter duration as one of the root causes for causing flash floods".

The national experts N14, N13, N10, N09, N08, N05, and N02 also expressed their views, confirming that they have observed a clear nexus between floods and climate change in Sri Lanka.

Drought:

Drought is another frequent hazard, specifically in the intermediate, dry and semi-arid zones of Sri Lanka. The national experts also established clear linkages between climate change and droughts. The national expert N01 affirmed that *"two main hazards are floods and droughts which get impacted due to climate change".* The national expert N03 also concurred with the same view, saying that *"during dry periods, droughts occur as land use is not capable of retaining enough water in the ground."* The national expert N06 concurred on the same issue. The national expert N04 explained the inter-monsoonal dynamics and climate change, saying, "*we are also experiencing inter-monsoonal drought spells, which reduce the harvest and sterilise some of the crops and their panicle production."*

National experts N05, N07, N08, N10, N12, N13, N14, and N15 also concurred and expressed the same sentiments and facts to affirm that climate change has induced droughts across vulnerable districts.

Dam Spills and Releases

The national expert N01 highlighted potential secondary hazards due to climate change, saying that *"dams release excess water during the high-intensity rainfalls, and then it impacts the downstream including many hectors of cropping lands and loss their production".*

High Winds and Cyclones

Climate change is also affecting wind speed. The national expert N01 highlighted facts about high winds and their impacts, saying that *"high winds patterns have changed".* A similar issue was concurred by the national expert N07, elaborating that *"wind speed is another issue. We have a lot of possible losses, but the question is how much is attributable to climate change."* The National Expert N08 expressed his concerns about the impending risks due to climate change, saying that *"there are big cyclones that are just passing by and going to countries like Bangladesh and India, which are like near-missing events."* The National Expert N14 also concurred on the same issue, highlighting that *"cyclone intensity has increased as well."*

Pests and Diseases

Experts also expressed their opinions, informing the researcher about the nexus between climate change and pests and diseases in the agriculture sector. The national experts N01 explained the issues saying that *"there are insect attacks and unidentified diseases in the agriculture sector. These are either direct or secondary impacts due to climate change. Some pests and diseases have changed and are not responding to chemical pesticides".* The national experts N02, N04, and N09 also explained similar issues due to increased pests in the food sector.

Vector Born Diseases

The national expert N07 highlighted that *"there are other sets of disasters that are emerging and are related to climate change, for example, dengue. Those have increased partly because of the influence of temperature changes.".* The national expert N08 also expressed similar concerns saying that *"there were massive outbreaks of dengue disease in 2017. There are new diseases we have not recognised as a cause for concern, such as typhus fever. We have also found unknown vectors which spread urban Malaria. There seems to be a link between vector-borne diseases and floods."* The national expert N11 also expressed similar views.

Wild Animal Attacks

Some national experts have also highlighted issues related to wild animal attacks closely related to climate change. The national expert N02 explained that *"human-elephant conflict had increased over the years due to food and water scarcity"*, indicating it as a possible secondary impact of climate change. The national expert N03 also concurred on the same issue. The National expert N07 also gave further explanation on this issue, saying that *"wild animal attacks have also gone up, due to land use planning issue which has a link with climate change".*

In summary, national experts highlighted that multiple hydrological and biological hazards in Sri Lanka are induced by climate change. This is also supplemented by literature and research findings. Sri Lanka is already seeing increasingly frequent extreme weather events; for example, in the last four years, the country has seen five significant floods and four droughts (Esham et al., 2018b). The IPCC also predicts that climate change will worsen in the twenty-first century, with more frequent heat waves, higher wind speeds from tropical storms, and

increased drought severity. The large-scale changes in temperature, precipitation, and other climatic variables show that all extreme occurrences such as droughts, floods, heat waves, and cold spells are exacerbated due to climate change-induced temperature rises (Weerasekara et al., 2021). The authors argue that extreme weather occurrences have become more common in Sri Lanka as a result of the rise in climate change-related weather anomalies. Sri Lanka is the second most affected country by extreme weather events in the previous 20 years, according to the Global Climate Risk Index. From 2010 to 2018, Sri Lanka had a cycle of hydro-meteorological disasters. Droughts and floods occurred within the same area within a few months of each other, impacting the same vulnerable people and substantially reducing their capacity to cope.

As outlined in the Special Report on Managing Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) of the Intergovernmental Panel on Climate Change (IPCC), vulnerability needs to be better considered in light of its dynamic nature and changing spatial and temporal patterns (Birkmann et al., 2015). Climate change may result in more extreme weather patterns such as heat waves, heavy rainfall events, and droughts, as well as increased incidences or intensities of these events (Stocker et al., 2014). Over the years, there has been a general rise in temperature and precipitation patterns, increasing sea levels, and an upsurge in weather-related natural disasters like floods and droughts in Sri Lanka (Ruklani et al., 2021). Therefore, the following Section will discuss climate change's impacts on hazard parameters such as duration, frequency, intensity, and seasonality.

5.3.1.3.2 Climate-Induced Hazards Intensity Changes

Supplementing the literature findings (see the section 2.3.4.2), according to national experts, intensity changes are the most commonly impacted hazard parameter due to climate change. They have expressed their concerns and shared expert knowledge, informing the researcher that the intensity of rainfall, floods, droughts, cyclones, pests and diseases, vector-borne diseases, and landslides has increased over the last several years. The national expert N01 highlighted this: "*Rainfall severity has increased; drought severity has changed. Insect attacks and diseases in the agriculture sector have increased due to climate change".* The national experts N03, N11, and N15 also concurred on the same issue and provided further details, saying that *"it means we get high-intensity rainfall in a shorter time, affecting rainfall distribution. Overall, the total annual rainfall remains the same. However, the intensity has changed, affecting agriculture".* The N05 expressed his opinion with much higher certainty,

saying, "*definitely, there is an increase in the intensity and frequency of climatic hazards and extreme weather events."* National experts N06 and N07 also affirmed the same issue. Regarding high winds and cyclonic events, experts N07 and N14 expressed their views about increased high winds and cyclone intensity.

In summary, several national experts have indicated that intensity changes of major hazards in Sri Lanka are attributable to climate change. The IPCC also emphasises that, while climate change is not the only cause of all disasters, it is the cause of an increase in the frequency and severity of the majority of disaster events (Weerasekara et al., 2021). It is predicted that climate change will result in an increase in the severity and frequency of hazards (Bergholt & Lujala, 2012). Rising ambient temperatures cause higher heat stress, and intense precipitation irregularities such as droughts and floods become more common and severe (Marambe, Punyawardena, et al., 2015).

5.3.1.3.3 Climate-Induced Hazards Frequency Changes

According to national experts, the frequency of several hazards in Sri Lanka has increased. They have pointed out that the frequency of droughts had significantly increased compared to other hazard events. The national expert N09 explained these changes, saying that "*dry spells, floods, and flooding leading to secondary hazards and landslides have increased." "These hazards are quite frequently happening now".* The national expert, N14, also concurred and explained the frequency changes, saying, "*Definitely, we can see a big difference." We are facing frequent disasters. "Frequent droughts or frequent floods are common."* He concluded by saying that *"so the frequency of disasters has increased, but also the onset of rainfall gets delayed".*

The national experts N02, N04, N05, N06, N012, N13, and N15 also expressed their opinions, indicating that droughts and floods have increased significantly due to climate change. In recent decades, climate change has increased the frequency and intensity of extreme weather events, and this trend is expected to continue (Field, 2012). Multiple extreme weather events are now occurring in rapid succession in the same region, resulting in compound disasters that make disaster risk reduction difficult (McGreevy & Adrien, 2023).

5.3.1.3.4 Climate-Induced Hazards Duration Changes

The duration of hazards is an important parameter determining the damage and loss level. The national experts also strongly expressed that durational changes are evident in Sri Lanka. Supporting this argument, the national expert N01 stated that the *"duration of hazards has*

changed, and its effects on food security". The national expert N07 also concurred on this issue, saying that "*the length of dry spells is increasing."* When it comes to floods, the national expert N11 stated that *"we have identified that high-intensity rainfall received in a shorter duration", indicating* that such events could leave to flash floods. National expert N12 said that "we also experience prolonged droughts now."

In summary, experts have expressed that the duration of droughts and floods has been altered due to the impacts of climate change. Climate change has increased the frequency, duration, and intensity of droughts across significant portions of the Americas, Africa, and Asia, according to researchers (Chiang et al., 2021). Evidence from climate change implies a general decrease in both annual rainfall and rainy days. There is also evidence that the rainy season is becoming shorter, owing to the fact that rainfall is starting later. The frequency and duration of dry periods have increased over years (Makondo & Thomas, 2020).

5.3.1.3.5 Climate-Induced Hazards Seasonal Changes

Seasonal changes affect agriculture, livestock, and the food security sector to a greater extent. Many experts interviewed expressed that they have the data and experience to conclude that seasonal changes are obvious in Sri Lanka due to climate change. The national expert N01 stated, "*before 20 years, there were well-developed patterns and seasons, and the onset of rains was very regular. Now there are no such patterns. Seasons have shifted."* The N04 also had similar sentiments: "*most grassroots people think that monsoon rains are erratic. So they face difficulties in the planting season."* The national expert N06 also highlighted the issue: "*irregular rainfall patterns are occurring because of climate change. Therefore, it is difficult for people to plan and schedule their harvesting and cropping seasons."* The national experts N07, N09, N13, and N14 also expressed their experience, indicating that the seasonality of monsoon rains, droughts, and floods has changed, and they attributed these changes to climate change.

There is a likelihood that climate change will have an adverse effect on the seasonality and generation process of floods, which has direct implications for flood risk assessment (Vormoor et al., 2015). Temperature and precipitation increases will impact water use and crop productivity. Cropping seasons, varieties, and agricultural methods are all predicted to suffer as a result of climate change. As global temperatures are rising, it is evident that precipitation patterns are shifting due to climate change (Yoon & Choi, 2020).

Thematic analysis and cognitive mapping of national experts' views, opinions, and inputs confirmed that major hydrometeorological, biological, and selected geological (landslide) hazards are induced by climate change altering intensity, frequency, seasonality, and duration. Figure 5-3 demonstrates the cognitive map for the climate change and disaster nexus in Sri Lanka.

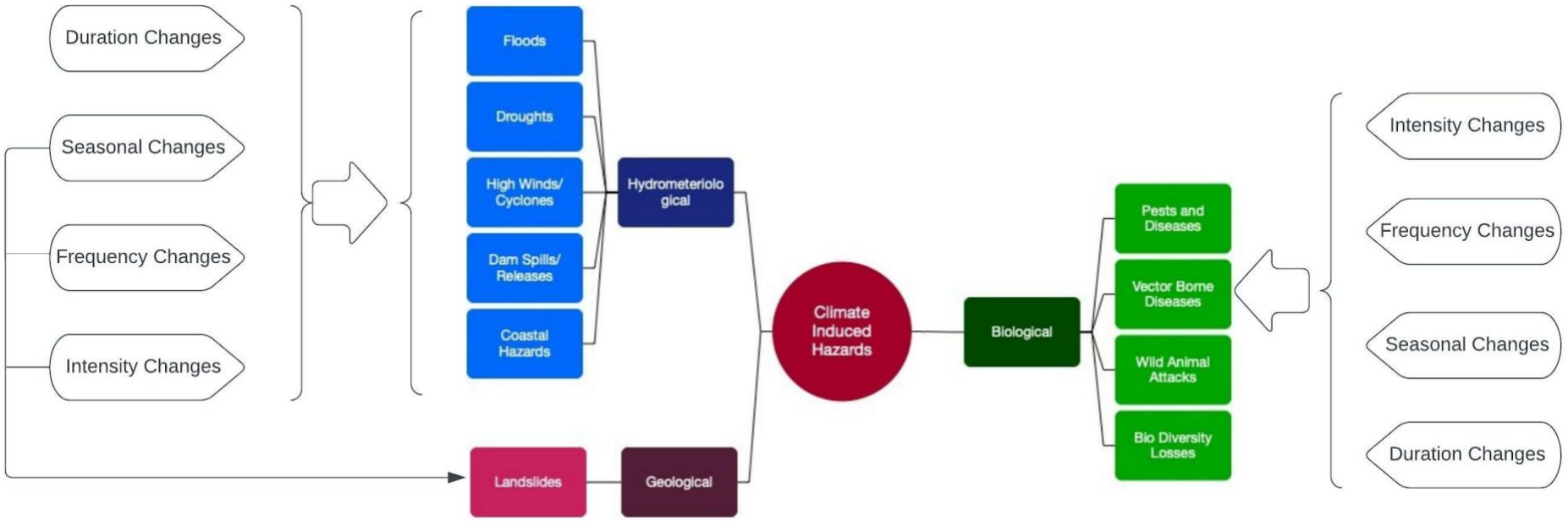


Figure 5-3: Cognitive map for climate change and disaster nexus in Sri Lanka.

5.3.1.4 Vulnerability of the Food Security Sector to Climate Change and Disasters in Sri Lanka

Having discussed the current food security status in the country and established the nexus between climate change and disasters, the following section presents "how" and "why" disasters and climate change affect the food security sector. This analysis is supplemented through the publish literature (see the section 2.3.4.1; and 2.3.4.2)

5.3.1.4.1 Climate Change and Disaster Impacts on Food Security

As discussed in Section Current Status of Food Security in Sri Lanka and depicted in Figure 5-1, food security has four main dimensions: food availability, access, stability and utilisation. This section analyses climate change, and disasters affect those dimensions. The food security sector is divided into three main sub-sectors in Sri Lanka: agriculture, livestock, and fisheries. Experts summarised the overall impacts of each sub-sector as discussed below.

Impacts on Agriculture sub-sector

Agriculture is one of the most critical subsectors of food security. The current status of food security relies heavily on both subsistence and commercial agriculture. According to the national expert N05, *"climate change contributes to increasing or decreasing precipitation, temperatures, and evapotranspiration. These are the primary impact causing issues in the food security sector. Secondary effects are on the productivity and production of the sectors. It also affects the manufacturing of raw materials; quality of materials; quality of produce".* The national expert N09 brought in an example to explain how climate-induced disasters affect the agriculture sector. He explained, saying that *"in 2016, there was an intensive dry period and drought in Sri Lanka. Rice production in the Maha season decreased to 2.9 million metric tonnes. Sri Lanka usually produces 3 to 3.5 million metric tons"*, indicating how dry spells and drought reduced the production in that particular year. National expert N06 highlighted the direct damage from climate-induced disasters on the agriculture sector, saying, "*there is a huge increase in the damage as agriculture production has been affected".* He also brought up the impacts of climate change due to seasonal changes, saying that *"it is very difficult for people to plan their harvesting and cropping seasons,"* indicating that seasonal changes could also lead to overlaps between harvesting season and erratic disaster events, causing production losses. The national expert N01 concurred on the same issue.

The national expert N07 discussed how climate change, dry spells, and droughts impact the saying that *"as the length of dry spells increases, agriculture water requirements are changing as well".* The national expert N11 concurred on the same issue.

The national expert N04 highlighted how erratic disasters, seasonal changes, and pests and diseases affect the agriculture sector, saying that *"recently we had a situation where farmers were not able to harvest for three to four seasons, and then we had huge floods. Production was down; farmers have been impacted."* He also discussed how production losses are attributable to pests and diseases, saying that *"over the past several years, we have seen an increase of pests to food crops, such as armyworms".* He further discussed how seasonal changes impact the production, saying, "*we are also experiencing mid-season drought spells, which reduce the harvest, sterile some of the crops and their panicle production".* The national experts N08, N11, N12, and N14 discussed similar issues explaining how climate change and climate-induced disasters affect the agriculture sector in Sri Lanka.

Sri Lanka is seen as a vulnerable, small island nation that faces major threats from climate change. Climate change will have the greatest impact on agriculture and food security, water and coastal resources, biodiversity changes, and human health in Sri Lanka (Kottawa-Arachchi et al., 2017). According to the past research findings, most farmers believe that climate change will have a negative influence on their agricultural produce in Sri Lanka (Suresh et al., 2021). Sri Lanka is extremely vulnerable to the effects of climate change, which will have a negative impact on agriculture, aquatic ecosystems, health, coastal areas, infrastructure, industry, and wildlife (Ruklani et al., 2021). Reduced yield of most agricultural crops in Sri Lanka would result in higher consumer prices for various agricultural commodities, with a resultant fall in overall household consumption over the next few decades. Food insecurity will be exacerbated by the expected fall in crop yield and rises in food prices (Abeysekara et al., 2023).

Impacts on Livestock Sub-sector

According to the experts, livestock is not a prominent subsector in Sri Lanka compared to the agriculture sector. However, experts presented their observations regarding how climate change and disasters impact the livestock sector. The national expert N04 explained how disasters could impact the livestock sector, saying that "the *livestock extension network has deteriorated during the COVID-19 pandemic. The dairy sector has been significantly affected due to the disease's spread, as there were no extension workers during the pandemic",* indicating the secondary impacts of disasters on the production and productivity of the livestock sector. The national expert N11 contributed to the discussion, saying that *"there is an*

impact from climate change on food security, which includes agriculture, livestock and fisheries", indicating direct damage to them from flash floods. The national expert N12 also concurred the issue saying, "*if you look at farm level production, it is highly vulnerable,"* indicating that the vulnerable livestock sector can have potentially severe damages and losses from climate-induced disasters.

Climate change is projected to increase the issues encountered by dairy farmers in Sri Lanka's village tank cascade systems. A majority of dairy farmers perceived climate change effects such as lack of pasture, milk productivity loss, and animal growth retardation (Ranasinghe et al., 2023). The influence of climate change, variability, and weather extremes on agricultural production, food security, and livelihoods is causing significant worry in Sri Lanka (Esham et al., 2018b). Climate change's effects on livestock could be measured in two ways: effects on animals and effects on livestock systems. Individual influences induced by changing disease occurrences, changing trends in reproduction and breeding, and variable levels of adaptability of the animals are obvious in the consequences on cattle. These are direct and obvious effects. However, there are complex and indirect effects on livestock systems, which play an important role in the sustainability of the livestock industry in developing nations, particularly in Asia and Africa (Silva & Kurukulasuriya, 2009).

Impacts on Fishery Sub-sector

The fisheries sub-sector is the main protein source for Sri Lankans. The sector comprises inland aquaculture and marine fishery. National experts provided vital details on the impact of disasters and climate change on the fishery. However, it is not prominent or felt with evidence and data in Sri Lanka as in the agriculture subsector. The national expert N01 highlighted a direct link between climate-induced disasters and inland fisheries, saying that *"when a dam releases excess water due to severe rainfall in a short period, fingerlings escape the reservoirs, hugely impacting the production, fish harvest, and protein intake".* The national expert N11 also highlighted how flash floods could impact the fishery sector, indicating possible harvest and fingerling losses in inland aquaculture. The national expert N01 also explained how generic early warning impacts the marine fishery harvest, saying that *"DMC issues warnings almost every other day on high winds, and that has impacted the fishery sector as fishermen do not go to the sea."*

The national expert N11 brought in some inputs related to the marine fishery sector, which could be affected by climate change, saying that *"there is a separate process of ocean warming*

around Sri Lanka. That impact the fishery sector." The national expert N12 also confirmed that the fishery sector gets impacted by climate change and climate-induced disasters due to direct production losses.

Rural coastal fisheries systems in tropical island nations are rapidly changing. Most coastal fishermen in Sri Lanka are experiencing changes as a result of climate change, increased frequency and intensity of natural disasters, increased frequency of human-elephant confrontations, and increasingly extreme weather events (Galappaththi et al., 2020). Climate change is having a substantial impact on worldwide fish production, as well as the livelihoods, nutrition, and food security of small-scale fishers (Galappaththi et al., 2021). Climate change affects livelihoods in fisheries and aquaculture communities, and hence adaptation and mitigation efforts must be human-centered. Measures to alleviate poverty and ensure food security for people in fishing and aquaculture communities are equally important for climate change adaptation and should be incorporated into the development and implementation of national adaptation strategies (Kalikoski et al., 2019).

In summary, based on the analysis of inputs, experience, and opinions from the national experts, all three subsectors: agriculture, livestock and fishery have a range of impacts from climate change and climate-induced disasters in Sri Lanka. Thus, the next Section presents the analysis of specific impacts on four dimensions of food security: availability, access, stability, utilisation, and context of Sri Lanka.

5.3.1.4.2 Climate Change and Disaster Impacts on Food Availability in Sri Lanka

Climate change and climate-induced disasters directly or indirectly affect production, distribution, and trade. Experts say food availability in Sri Lanka depends on production, distribution, and trade. The national expert N01 noted that inundations in some coastal areas of Sri Lanka had reduced production due to the loss of arable land. *"Some areas have been permanently inundated due to sea-level rise in the down south,"* he noted. Highlighting the impacts of floods and droughts, national expert N04 expressed as *"farmers were not able to harvest for 3 to 4 seasons, and then had huge floods."* National expert N06 said that *"there is a huge increase in damage as agriculture production has been affected,"* indicating such losses will eventually reduce local food availability.

Food availability depends on disaster losses and coping capacity, according to national expert N09. He noted, "*2016 drought was severe. Production dropped by 50%. The government could*

not afford to supply rice at that time", indicating food availability was an issue. The inter-monsoon season is crucial for field crop production. According to national expert N04, inter-monsoon droughts affect agricultural production. According to national expert N06, *"temperature differences due to climate change also affect production."* National experts N01, N05, N07, and N13 explained the nexus between climate change, disasters, and food availability, highlighting production and productivity losses. National expert N09 highlighted the impacts of disasters on the supply chain and international trade. He explained this issue, saying that "*the Covid-19 pandemic is a lesson for all of us. What will happen if the supply chain is disconnected? This is a real issue we must address as part of our food security."* The national expert N10 also highlighted how local trade and supply chains could be disturbed by disasters, which will lead to food insecurity.

The national experts N03, N14, and N15 also contributed to this analysis, highlighting how climate change and climate-induced disasters directly or indirectly affect food availability in the country.

Agriculture is heavily reliant on the climate and natural resources; hence, climate change has a significant impact on agriculture in Sri Lanka (Gunaratne et al., 2021a). According to the FAO (2016), climate change has long-term consequences for agriculture and food security. Population growth and changes in feeding patterns will cause a 60% rise in global food demand by 2050 compared to 2006 levels, while climate change will continue to have an impact on global food systems (FAO, 2016). Climate shocks and changes in weather patterns have a deeper impact on agriculture in Sri Lanka than in other countries. The country endured its worst drought conditions in late 2016, with paddy production dropping by 40% in early 2017. Following that, torrential rains in May 2017 harmed food crop productivity even more. Furthermore, 229,560 households experienced food insecurity, with rain-fed farmers and agricultural labourers bearing the brunt of the burden (Coslet et al., 2017).

5.3.1.4.3 Climate Change and Disaster Impacts on Food Access in Sri Lanka

Food access is primarily affected by price changes, the loss of livelihoods, and changes in the purchasing power of the affected communities due to climate change and disasters. The national expert N02 explained the issue, saying that *"due to climate change, floods, and droughts, food prices are increasing, resulting in access issues for poor people,"* indicating that the loss of production and supply issues increase the prices of food, making it harder for

ultra-poor people to access and meet their food needs and preferences. The national expert N03 also highlighted the price escalation issues, citing examples from the fishery industry, saying that *"abrupt weather patterns can cause availability and access issues, impacting the price,"* indicating that poor people cannot access their protein source during bad weather and disaster disruptions.

The national expert N02 also highlighted how a lack of regulatory policies could lead to price hikes during disaster periods saying that *"there are no policies or regulatory mechanisms to control prices and production-related issues",* indicating that such issues will eventually increase the prices during disasters. Experts N03, N05, N12, N13 and N15 also concurred on the same issue.

The national expert N03 highlighted how a fragile economy and poverty could increase food access issues in Sri Lanka. He explained that *"they are on the edge of poverty and highly vulnerable to various hazards, and whenever they face a shock, they will face affordability issues, and they may not have access to food leading to food insecurity."*

Direct disaster impacts on markets and related infrastructure also create access issues, especially in isolated areas. National expert N03 explained access issues saying that "*when their lands experience disasters like floods and droughts, they can no longer access the market. They cannot get supplies from their farmland as disasters already affected them."*

Food security in Sri Lanka demands actions beyond climate-resilient food production systems to take an integrated approach that can increase the climatic stability of the entire food system, including food access while addressing nutritional challenges arising from climate change impacts (Najim et al., 2022). Climate change-induced agricultural productivity reductions are projected to have a severe negative influence on food production and prices in South Asian countries, including in Sri Lanka. The findings also show that countries in this region are likely to experience food security issues, given that it is home to over half of the world's poor and agriculture contributes significantly to the region's GDP and employment generation (Bandara & Cai, 2014). Climate change is expected to have a negative impact on agriculture globally in the near future, with South Asian countries and small islands expected to be among the most vulnerable. Reduced yield of most agricultural crops would result in higher consumer prices for various agricultural commodities, with a resultant fall in overall household consumption

over the next few decades. Food insecurity will be exacerbated by the expected fall in crop yield and rises in food prices. As a result, climate change will have a negative influence on the overall GDP as well as the majority of the macroeconomic and microeconomic variables in the Sri Lankan economy (Abeysekara et al., 2023).

5.3.1.4.4 Climate Change and Disaster Impacts on Food Stability in Sri Lanka

Food stability is impacted by variations in production, a lack of buffer stocks, and disturbances to international trade due to disasters. The expert N04 explained the issue: *"If you look at the overall situation, more than 75% are rural, and most people depend on local food production." Failure of those tends to go for imports, which also creates access issues due to a lack of distribution during severe floods and landslides*. The national expert N09 explained the issue, saying, "*Sri Lanka will face a challenging position in food security if we don't focus on prepositioning, addressing supplies, and adapting to external shocks."*

According to climate change forecasts, rice yields might plummet by 40%, affecting the majority of farmers, and poverty levels could rise from 17% to 33% (Cordell et al., 2021).

5.3.1.4.5 Climate Change and Disaster Impacts on Food Utilization in Sri Lanka

Specific disaster impacts on food utilisation are not that high compared to other countries. The national expert N09 explained this situation: "*I have very positive findings of utilisation compared to Africa and other regions. If you look at the rates of diarrhoea and cholera, those are much lower in Sri Lanka, even after disasters such as floods, because our health system is quite strong. Because of that, our food utilisation is much better, especially after disasters".* However, the expert has raised his concerns about overall utilisation issues concerning nutritious food and said that they may get worse if disasters strike, saying that *"based on the data, 33% of the Sri Lankan population cannot afford to have a minimum nutritious diet in 2018."* It is not a direct impact per se but rather a compounding factor on the existing issues in food utilisation.

The national expert N07 raised concerns about pests and diseases induced by climate change, which can have some impacts on food utilisation. The national expert N09 concurred on this issue, saying, "*compared to the old days, most of the farmers are saying that without agrochemicals, they can't control or even think about agriculture."* According to the national expert N14, there could be a link between climate change and the overuse of agrochemicals, which can affect food utilisation and safety. He explained this issue by saying that *"the first thing is the overuse of agrochemicals. We realise that in some areas, a considerable amount*

of Arsenic is present in rice. Sometimes we are reluctant to eat freshwater fish because it is highly contaminated with heavy metals due to the overuse of agrochemicals." The national expert N15 concurred on this issue, explaining that *"although it says our education and literacy levels are high, our food literacy level is quite low."*

Globally, the most serious food safety challenges involved bacterial infections, pesticide residues, and mycotoxins, all of which were complicated by a lack of food safety expertise and knowledge (Uyttendaele et al., 2016).

In summary, climate change and climate-induced disasters affect all three subsectors of food security: agriculture, fisheries, and livestock, and all four dimensions of food security: food availability, access, stability, and utilisation. Figure 5-4 shows a cognitive map of disaster and climate change effects on subsectors and dimensions of food security in Sri Lanka.

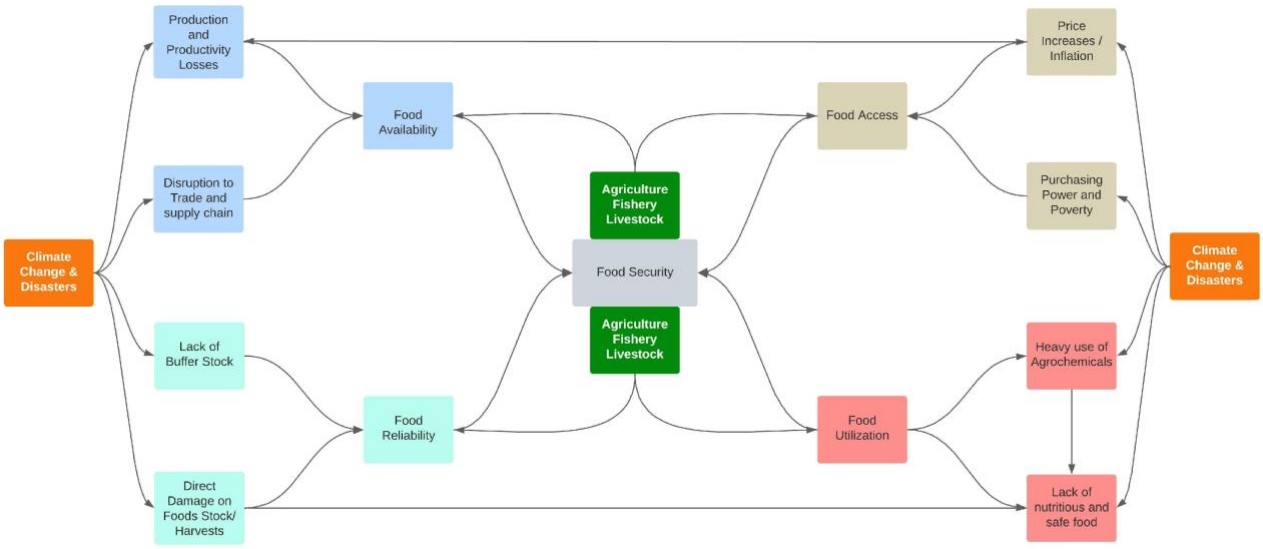


Figure 5-4: Disaster and climate change impacts on food security dimensions

5.3.1.4.6 Inherent Vulnerability of Food Security Sector to Climate Change and Disasters

According to national experts, the food security sector is highly sensitive to climate change and disasters due to its heavy dependence on water, temperature, and other atmospheric conditions. National expert N05 explained it further: "*It is a very susceptible and fragile sector for climate change and disasters."* The national expert N08 also concurred on the inherent vulnerability of the sector, saying that *"whether you have rain or don't have rain, there are impacts on the agriculture sector,"* indicating that food security is highly vulnerable to water

stresses. The national experts N11, N13, and N14 concurred on the high inherent vulnerability and compounding impacts, saying that *"when food security is impacted, that means all other sectors will be impacted too."*

The national experts N01, N09, and N12 also contributed to the discussion on the inherent vulnerability of the sector.

Temperature variations and other climatic factors have a substantial impact on agriculture all over the world. Farmers are having the worst perceptions of climate change and its effects on crops and livelihoods (Hussain & Hussain, 2019). Changes in precipitation and water resources will have a considerable impact on crop productivity, crop water requirements, and farm family income and welfare. The magnitude of yield variations is determined by crop type, CO2 fertilization assumptions, climate predictions, and adaptability (Karimi et al., 2018). Crops are susceptible to temperature variations. The consistency of previous research findings shows that crops are particularly sensitive to climate change (Mendelsohn, 2014).

The experts, specifically N09, also highlighted that, in addition to the inherent vulnerability of the sector, there are system-level vulnerabilities; therefore, the next section presents the analysis of the system-level vulnerability of the food security sector.

5.3.1.4.7 System Level Vulnerability of the Food Security Sector to Climate Change and Disasters

The national experts identified multiple systemic vulnerabilities of the food security sector to climate change and disasters in Sri Lanka. They range from practices, data, extension issues, early warning-related issues, governance issues, policy issues, research, etc. Therefore, this section presents the analysis of system-level vulnerabilities.

Abandoning of Good Practices

According to national expert N15, some good practices that were part of traditional irrigation systems had been abandoned with the development. He explained that in the traditional cascade irrigation system, there were water distribution and drainage systems such as *"Mada Horuwwa"* and *"Kunu Ela,"* which were designed to address siltation issues and maintain their capacity against climate shocks. However, the expert explained that those systems are no longer used in modern development, saying that *"there were many errors and mistakes in the Mahaweli development programmes. There were many good water management principles. Those good practices have been removed from the system, and now we experience siltation and*

climate change problems in many reservoirs and tanks." As a result, now the country is facing floods during excess rainfall and droughts during dry spells.

Climate-Induced Migration

Some experts brought evidence about possible climate-induced migration, which has made the sector further vulnerable to climate-induced food insecurity in the future. The national expert N07 explained the issue, saying that *"land-use planning has a component of climate change. People usually go to places where land has access to water, and they establish their farmlands and settlements. There is a small, micro-scale climate-induced migration"*. The national expert N12 also concurred on the same issue and explained it, saying, "*we also did a small study on climate migration. We found that many people are going away from rice farming. Climate change has increased the gravity of the problem, so farmers are abandoning rice cultivation, which will be a big problem for food security,"* indicating that climate-induced migration can significantly impact food security in the future.

Data and Data Reliability Issues

The availability of reliable data is one of the most critical issues discussed by the experts. Due to a lack of data related to the food security sector, policymakers and practitioners cannot make informed decisions, which makes the food security sector highly vulnerable. There is a clear distinction between climate variability and climate change. The national expert N07 highlighted these issues, saying, "*we have seen this in every four-year cycle. When climate change runs on top of those cycles, the food security sector is very vulnerable to climate variability. But you couldn't say whether it was vulnerable to climate change. That's the part we are struggling to factor out,"* she said, indicating that they cannot take action without knowing the real issues and their magnitude. The N08 also shared his opinion, saying that *"there is a huge issue with data sharing"* indicating that they cannot make informed decisions without data and data sharing mechanisms.

The national expert N09 also highlighted the lack of baseline data in the agriculture department, one of the main subsectors of food security. He further explained that *"when it comes to the agriculture sector, this is one of the least mainstreamed sectors regarding disaster management and climate change adaptation. Numbers are not there; there are no protocols; people arbitrarily provide numbers."* The national expert N10 connected the lack of data availability and the early warning system. He explained how important it is to have reliable data for weather forecasts, saying that *"the best part is that in Maha season, when the*

Department of Agriculture issues the advisory that the onset of rain will be delayed by three weeks, people listen to that. People rely on the system, but unfortunately, we don't have a reliable data set to give a good forecast".

The national experts N04 and N012 also highlighted the sector's vulnerability due to a lack of data and data-sharing protocols among the key stakeholders.

Early Warning and Forecast Issues

Experts also discussed how the lack of an early warning system and reliable forecasts make the food security sector highly vulnerable to climate change and disasters. The national expert N01 explained this issue: "*Due to tropical weather conditions, we have a short period to forecast, and there were issues related to the reliability of our forecasts. People did not believe or trust our forecasts,* indicating that a lack of reliable weather forecasts makes the food security sector highly vulnerable".

The national expert N09 also connected these issues with the capacity and human resources required to make reliable forecasts. He explained this issue, saying, *"I know that the division of agro-meteorology in the Department of Agriculture is the primary unit, and it has very few members and is becoming very unpopular slowly. But the mandate of that entity is to support farmers. But I don't think they fulfil their mandate."* The national expert N15 concurred on the same issue, saying that *"compared to other sectors, there are multiple issues in the food security sector. Farmers are not trusting and acting based on the early warnings and advisories from the technical agencies. Hence, they always go with their conventional cultivation patterns*." The national expert N04 so highlighted the lack of mid-term forecasting, which is essential for agriculture. He explained, *"The farming community did not abide by the fact that they had a negative perception towards the forecast and prediction by the meteorology and agriculture departments."* All these issues related to the lack of reliable early warning systems and forecasting issues make the food security sector highly vulnerable to climate change and disasters.

Extension Issues

Many experts expressed concerns about the country's extension system during the interview. The national expert N15 explained the current situation: "*One of the reasons is that we don't have a proper education and extension system and awareness programmes. That leads to the situation where farmers may not get the correct information or perceive this information as not right. People always go to myths and traditional solutions."* The national expert N09 also

raised several issues related to the extension system in the country, saying that *"when it comes to the livestock sector, if they want to see a veterinary doctor, they must plan 4-3 days. They will lose two or three days of their production,"* indicating an insufficient extension system to serve farmers. He also brought up issues related to the perception of the extension systems, explaining that *"they think that farmers are reporting to the government." Secondly, they always believed that if they lost contact, they would not benefit. Farmers living and cultivating in the dry zone do not receive appropriate agriculture extension services, advisories, and technology.* The national experts N01, N02, N04, and N06 also contributed to this analysis, expressing their views that the current extension systems are weak, making the sector highly vulnerable to disasters and climate change.

Fragile supply Chain

Food security also depends on the changes in supply related to food products and their distribution. The experts believe that the current supply chain in the country is very fragile, which makes it highly vulnerable to disasters and climate change. The national expert N04 stated this issue: "*Some of these value chains are very small and fragile. Once they are broken, overall access to the market will be reduced"*. The national expert N15 explained the issue, saying that *"COVID-19 showed how fragile the global supply change is. It has also given the lessons that local farmers need to think about their resilience and ensure food security through the home garden."* The national expert N12 also discussed and explained the lack of appropriate supply chains makes the food security sector highly vulnerable to climate change and disasters.

Fragmented Coordination in the Sector

Interagency cooperation is essential for food security because many agencies are involved. The current food security coordination system is very fragmented, with insufficient inter- and intra-coordination mechanisms within subsectors and related stakeholder agencies. The national expert N08 explained the current issue, saying that *"the main issue is the fragmented nature and coordination issues of the sector."* The national expert N12 highlighted the same issues with specific examples saying that *"there is an issue where food security, climate change and disasters go as separate themes in Sri Lanka. They do not go as an integrated subject".* The national experts N09 and N10 also highlighted similar issues in the coordination system, explaining that it makes the food security sector more vulnerable to climate change and climate-induced disasters.

Governance Issues

According to national experts, there are multiple governance issues in the food security sector. The national expert N01 highlighted the issues with some specific examples, saying that *"there are institutional issues for water management. It is very weak and has been politicised by appointing unqualified extension workers"*. The national expert N04 connected governance issues to food price inflation, saying that *"there is a price mafia that controls the prices of foods,"* indicating that there is no governance system for price controls and related regulatory measures. The N14 also explained how the governance structure and interventions make the food security sector highly vulnerable to climate change and disaster risk reduction. He explained, *"Political mechanisms prefer to distribute money for relief than mainstreaming CCA and DRR because that will increase their vote base",* indicating such negative political interventions make the food security sector further vulnerable to climate change and disasters.

Inadequate institutional and Human Resources

Experts have also highlighted the lack of institutional and human resources within respective organisations. The national expert N04 explained the situation, saying that *"some of the mandated agencies are not very functional and operational in this aspect, both in terms of institutional capacity and human resources," indicating* a lack of service delivery. Regarding climate change and disaster advisories, the national expert N09 highlighted the issues, saying that *"the division of agro-meteorology in the Department of Agriculture is the primary unit, and it has very few staff members."* The national expert N11 also supplemented the issues, saying, "*We don't have a sound technical team at the climate change secretariat to implement the policy directives and mandate of the secretariat."* The national expert N13 also highlighted the lack of technical capacity in the agriculture department. He explained, *"Climate and disaster risk reduction should be integrated into our production planning process." But I don't have much idea about how to do that."* The national expert N14 also highlighted the issue of lack of technical expertise with relevant government officers at the local level. Such capacity gaps will increase system-level vulnerabilities in the food security sector.

Infrastructure and Land Use Issues

According to experts, food security infrastructure and land use are vulnerable to climate change and disasters, making the sector more vulnerable. *"Traditional land use, which was capable of absorbing excess water and releasing it slowly to the rivers and lakes, has been disturbed,"* said national expert N03. Because of this, flash and riverine floods occur during high-intensity

rainfall. He added that droughts might occur during dry periods because land use cannot retain enough water. N14 experts also noted food security infrastructure maintenance issues. *"Lack of tank system maintenance also creates food security problems,"* he added. *"There is a lot of encroachment on the catchment areas, so it will also reduce water catchment areas, which will increase climate change impacts and reduce the food production capacity,"* he concluded.

Lack of Appropriate Use of Technology and Innovations

Experts identified food security issues due to inadequate technology, applications, and innovations. According to national expert N02, *"farmers use an excessive amount of water for controlling weeds than the required amount,"* making the sector more vulnerable to climate change and disasters. The expert N06 brought service delivery issues. *"The Agriculture Department does not introduce drought-resistant crops and new varieties,"* indicating a lack of new advisories, practices, or crop varieties. *"I do not see we are using appropriate technology,"* added national expert N09. The expert also noted that farmers do not use appropriate technology. *"There is not enough emphasis on climate-smart agriculture and new technology,"* said national expert N12, adding that such lethargic processes make the food security sector more vulnerable to climate change and disasters.

Lack of Assessing and Measuring Mechanisms

Experts noted that the sector is more vulnerable due to a lack of measurement and assessment mechanisms for food security. "*There are no measuring mechanisms for food security and nutrition,"* said national expert N09. *"Census and Statistics Department has never used the food security module as part of their census and assessments,"* he added. According to the expert, the country lacks measurement tools because the food security generic module does not include an indicator for climate change adaptation or related issues.

Lack of Production Planning and Buffer Stock

National experts say food security depends on production, buffer stock, and production planning. The system is vulnerable to climate change and disasters without these key elements. *"Sri Lanka will be facing a very difficult position in food security due to climate change if we do not focus on prepositioning, addressing supplies, and adapting to external shocks,"* said national expert N09, providing specific examples. *"There are no production plans in Sri Lanka,"* he added. The expert concluded, "*Are we considering climate change conditions and contingencies? Those are not there yet".*

Lack of Risk Transfer Mechanisms and Insurance

National experts say the food security sector lacks insurance and risk transfer mechanisms. National expert N04 added, *"Failures of what we have in risk insurance and delays of payments are due to not having a fair face of assessing losses and damages"*, which make the food security sector more vulnerable to climate change and disasters. National expert N11 stated, "*There are some systems, but those are not functioning well."* As premiums may be high, the insurance industry is not ready to accept the risks according to them. The national expert N09 also noted that farmers depend on informal lending due to the lack of risk financing mechanisms, making the sector more vulnerable to climate change and disasters.

Negative or Lack of Coping Mechanisms

Farmers' and other stakeholders' negative coping mechanisms make food security more vulnerable to climate change and disasters. *"People know the impact of the agriculture sector,"* explained the national expert N06. He says the action plans lack disaster management and climate change mitigation actions. *"In most cases in paddy cultivation, 80% of water is used for weed control,"* the expert said. *"Farmers are not interested in diversifying their farmlands,"* the expert N12 elaborated on the issue. According to experts, political interference and abandoning traditional practices also lead to negative coping mechanisms. *"Farmer and community-based organisations are becoming branches of the main political parties,"* explained the expert N12. *"It seems that people are not concerned about climate change, no matter how much we say, because it has not gone into their minds yet,"* expressed expert N15. *"They still believe they go ahead with conventional farming and cultivation,"* which increases the vulnerability of the food security sector. National experts N03 and N09 also affirmed that negative coping mechanisms increase the food security sector's vulnerability.

Policy Issues

Several national experts noted that a lack of food security policies makes the sector more vulnerable to climate change and disasters. *"There were many policy issues that affected agriculture production, but climate change has amplified those issues,"* explained the national expert N01. *"I do not think there is any government plan that focuses on food security, even at the policy, strategy, and programme level,"* clarified the national expert N06. He further explained that the current agriculture policy does not address food security. *"There are huge policy gaps in production planning,"* said national expert N09. Sri Lanka has no food security

policy or Food Security Act. National expert N12 explained the issue saying that *"when the government changed, the policy gets changed ",* and such inconsistencies create higher sectoral vulnerability.

Research and Applications Issues

According to national experts, inadequate research may make the sector more vulnerable to climate change and disasters. Expert N11 explained the issue, saying that *"there is not enough research to substantiate impacts in those sectors,"* making informed decisions difficult. *"During 2015, 2017, and 2018 and the recent pandemic, there seemed to be substantial disruptions to the food supply,"* said national expert N04. *"But no one has assessed the real food security impact."* The national experts N01, N06, N07, and N15 also discussed research gaps that increase sector vulnerability.

Subsistence Farmers and Recognition

The national experts also highlighted the social vulnerability associated with the recognition of farmers. They highlighted this issue as *"no recognition for farmers in society." Recognition comes with the monetary power or the acceptance in the society"*. N15 also attributed to this issue, informing the researcher that *"during the colonisation, farmers have discredited as not intelligent and put into the corners. Some of the societal changes that came with the colonisation did not positively contribute",* indicating such issues also make the food security sector socially vulnerable to climate change and disasters.

While climate change is a global issue, the negative consequences are felt more acutely in impoverished countries due to their reliance on natural resources and limited ability to cope with climate unpredictability and extremes (De Silva & Kawasaki, 2018). A fundamental challenge in scaling up food security globally is to better harness current capacity and research aimed at making evidence-based decisions (Uyttendaele et al., 2016). The main food safety challenges involved a lack of food safety awareness as well as adequate government legislation and enforcement. The authors further argue that it is necessary to improve training in order to elaborate on control measures such as good hygiene practices, the implementation of certified food safety management systems, and the establishment of acceptable criteria. The world is rapidly changing. Problems emerge, and the information flow is rapid. Leaders in food security must be aware of food safety and must develop an attitude of continuous learning, critical thinking, and be provided with the right tools (the "know how"). Accelerated globalization of

food trade, climate change, population expansion, price increases, pandemics, and environmental burdens including climate change will all have substantial but unpredictable effects on food security, perhaps leading to starvation in the short term. According to evidence, the food rescue system in Sri Lanka is characterised by intermittent redistribution, and food donors and rescuers are primarily motivated by humanitarian concerns (Aloysius & Ananda, 2023a). The findings also point to lacking institutions in the surplus food rescue system, such as facilitator organizations and back-end organizations. Inadequate food logistics and establishing formal relationships were recognised as important problems in food rescue activities by food redistributors. Inadequate allocation of resources, poor monitoring and evaluation mechanisms, reliance on food security evaluation, and a lack of climate focus in programmes and evaluations are some of the significant hurdles for mainstreaming (Lam et al., 2021). Food security is challenged by a number of climate-related problems. These problems include decreasing agricultural production, food loss along supply chains, poor rural people's weak livelihood resilience, and the occurrence of high levels of undernourishment and child malnutrition (Esham et al., 2018b).

As discussed above, the food security sector has multiple system-level vulnerabilities to disasters and climate change. These are interrelated and have a compounding impact on the overall vulnerability of the food sector, as stated in Figure 5-5.

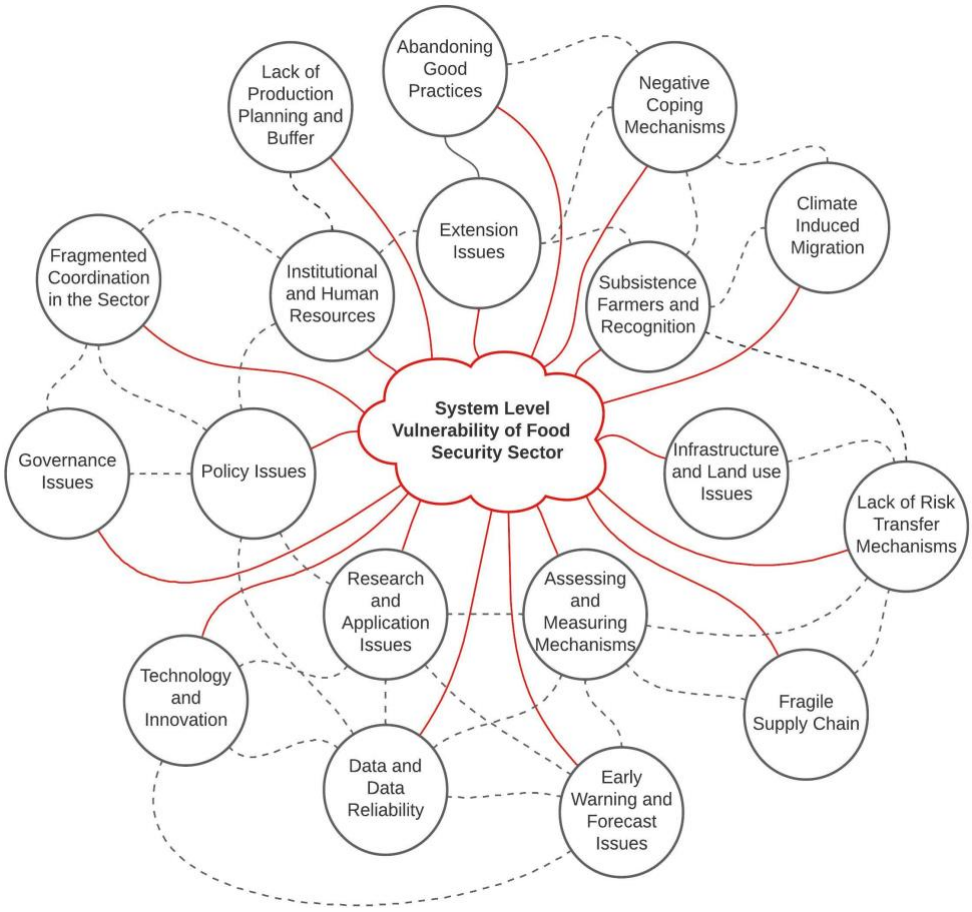


Figure 5-5: System level vulnerability of the food security sector in Sri Lanka.

5.3.2 Integration of CCA and DRR into the Food Security Sector

Climate and disaster risks are closely related to the food security sector's performance. Thus, CCA and DRR should be integrated into the food security sector planning processes. Therefore, this section will provide an analysis based on expert opinions, summarising key points regarding the need for mainstreaming measures, tools and instruments, mechanisms for measuring effectiveness, existing frameworks and limitations, and bottlenecks for mainstreaming.

5.3.2.1 The Need for Mainstreaming

Climate change adaptation and disaster risk reduction have not been mainstreamed into various planning documents. There may be some standalone projects focusing on disaster risk reduction. The food security sector and its subsectors, such as agriculture, livestock, and fisheries, are exposed and highly vulnerable to climate change and disasters. Thus, such issues should be integrated into the food security sector planning to achieve SDG-2 "zero hunger" by

2030. Reaffirming the literature findings (see the section 2.9.4), the national expert N05 emphasised the importance of mainstreaming: "*I believe and advocate that disasters and climate change should be integrated into sectoral plans across all the sectors in Sri Lanka. If we are not considering disasters and climate change, sector-wise or strata-wise, we are missing a lot."* The national expert N06 outrightly highlighted the need saying that *"there is no point in developing plans without climate change and DRR because they can't implement or even if they implemented those, it would get impacted due to climate change and disasters".*
Many United Nations agencies and their global frameworks recognize the need of mainstreaming climate action into food security and broader development policies, strategies and programs at the national and local levels (Lam et al., 2021).

The national experts N14, N13, N12, N07, N04, and N03 also emphasised the importance of mainstreaming climate change adaptation and disaster risk reduction into the food security sector, considering its exposure and associated high level of vulnerability.

5.3.2.2 Mainstreaming Measures

Reaffirming various mainstreaming options stated in literature (see the section 2.9.1; 2.9.3 and 2.9.4), experts discussed a range of measures that can be applied to mainstream climate change adaptation and disaster risk reduction in food security sector planning at different levels. Some of the key measures suggested by the experts are explained in the below section.

5.3.2.2.1 Advocacy and Enhance Understanding

Sri Lanka has accepted and recognised disasters and climate change as development issues. Disasters and climate change have been mentioned at different levels and in documents. Thus, the knowledge curve about the issues has been enhanced. The national expert N05 highlighted the importance of advocacy in pursuing the agenda further, saying that *"these are like when you have no options kind of interventions. Disasters are not optional; it is imperative. It's a must. The 'must' component has not come yet, and we need to push for it".* In the Sri Lankan context, political leadership and political will are needed for positive and progressive change. Advocacy can play a key role in doing so. The national expert N06 highlighted this explaining that *"for any programs and policies, the political leaders and officials should be made aware of the risks. Political advocacy is needed. People are more interested in the subject when there is a political interest and will".*

5.3.2.2.2 Area-based Strategic Planning.

According to national experts, the area-based strategic environment assessment framework can provide the necessary ingredients for mainstreaming climate change adaptation and disaster risk reduction into the food security sector. In doing so, all the issues related to that particular area can be assessed, and appropriate goals, targets, outputs, and actions can be set for the given geographical areas, such as a province, a river basin, or a municipality. National experts N1, N07, N12, and N15 highlighted the importance of area-based strategic planning for mainstreaming CCA and DRR into the food security sector. The national expert emphasised this: "*I think the individual and institutional territories should be broken down." They should consider mobilising other stakeholders, including the general public and multiple stakeholders. "They should look at these issues very broadly."*

5.3.2.2.3 Comprehensive and Consolidated Planning

Comprehensive and consolidated planning is called for developing integrated plans and mobilising all the key stakeholders. In the consolidated and comprehensive planning, key sectors need to be mobilised for a common development goal and co-design plans, which are climate and disaster inclusive. The national expert N03 highlighted the need for and importance of consolidated planning, saying that *"it is good if they can look at the needs and specific areas to develop comprehensive sectoral plans and then bring these sectoral plans into an integrated plan at the national level."* Multi-sectoral approaches are necessary to address this issue. Food security is integral to agriculture, irrigation, water, transportation connectivity, and other special programmes, such as cash assistance programmes that can be provided during a disaster or shock; thus, comprehensive and consolidated planning is needed to ensure CCA and DRR mainstreaming into various sectors. The national experts N04 N05, N07, N08, N09, N10, N11, N12, and N13 also highlighted the ways and means of mainstreaming CCA and DRR into the food security sector through consolidated planning processes.

5.3.2.2.4 Decentralization

Centralisation hinders mainstreaming CCA and DRR. Thus, experts advised decentralisation to allow mainstreaming of CCA and DRR into the food security sector. Decentralisation helps identify local vulnerabilities and risks and mainstream them into sectoral and overall development planning. Bottom-up mainstreaming is easier because climate risks and disasters are local. National expert N09 advised that *"there should be a huge change at the central level*

for decentralising agriculture and streamlining CCA and DRR in other sectors. I would suggest that we go through a bottom-up approach," national expert N12 said of decentralisation while suggesting a system and platform where all these stakeholders and institutions, including the private sector and civil society groups, can engage and strengthen the mainstreaming processes. According to national expert N15, small-scale farmers' contributions are critical to food security in Sri Lanka, so decentralisation must consider how best to involve farmers in the mainstreaming processes.

5.3.2.2.5 Enhance Technology, Data, and Applications.

Technology and data are essential for mainstreaming. Risk assessment, impact evaluation, climate forecasts, and forecast-based production and investment planning require data and technology. Data and data-sharing mechanisms are the biggest obstacles to mainstreaming CCA and DRR. The national expert N01 stated, "*we need to improve forecasts and go for forecast-based agriculture, and it will contribute to substantial progress in the food security sector."* National expert N02 stressed the need for introducing new agricultural technology like drip irrigation to maximise the potential of the dry zone. Data, technology, and their applications were discussed by national expert N03 highlighting the need for mainstreaming CCA and DRR into the food security sector. National experts N04, N06, N07, N08, N09, N10, N11, N12, and N15 also discussed the need for data and technology to make risk-informed food security decisions.

5.3.2.2.6 Financing and Resource Allocation

The success of mainstreaming also depends on the availability of resources and budget for implementing plans and related programs. Resources could be allocated through consolidated funds of the government or development banks such as the World Bank and the Asian Development Bank. The national expert N09 suggested potential options for the farmers, saying that *"systems should be built gradually in a way that farmers are recognised in the society, and farmers can reach out to any organisation and connect for food availability loan, bank credits etc."* The national experts N02 and N06 also highlighted that mainstreaming could be achieved through allocating resources. The national expert N03 explained the financing options saying that *"if there is a long-term plan for the agriculture sector, then banks, like ADB and World Bank, do not need to develop their investment plans. They can support the existing government plans"*.

5.3.2.2.7 Governance and Enforcement

Enforcement and related governance procedures are needed to mainstream CCA and DRR into the food security sector. When development projects are designed, respective enforcement agencies should review and endorse their implementation, ensuring they are climate and disaster-inclusive. The national expert N06 suggested that *"the Ministry of Defence as the parent ministry of DMC can always talk to other ministries and sectoral agencies to give them targets for mainstreaming DRR into their sectoral plans,"* indicating that such governance and enforcement mechanisms are crucial for effective mainstreaming.

5.3.2.2.8 Policies and Legal Provisions

Mainstreaming can be ensured with appropriate policies and legal provisions, making it compulsory for the respective agencies to mainstream CCA and DRR. Without such policy and legal requirements, mainstreaming becomes optional, leaving departments and sectors to only focus on their primary mandates without addressing cross-cutting issues such as climate change and disaster risks. The national expert N01 explained this need by saying that *"there should be legislative frameworks for mainstreaming."* Experts say it should be mandatory and backed with appropriate legal provisions. The national expert N02 explained how sectoral agencies should look at the mainstreaming in their respective sectors, saying, *"If it is the irrigation department, they must think that this is part of their planning process rather than an external agency advocating for mainstreaming CCA and DRR into the sector".* The success of mainstreaming depends on the legal and policy provisions. The national expert N11 highlighted the importance of legal provisions: "*If there is a legal mandate, we will be able to push and pull this to the highest level for implementing our mandate with multiple stakeholders."*

5.3.2.2.9 Policy Coherence

As part of post-2015 development agendas, SDGs, the Paris Agreement and SFDRR were adopted, recognising 2030 as a key milestone for achieving sustainable progress of all the targets at the country and sub-national levels. Policy coherence is a prerequisite for mainstreaming CCA and DRR into the food security sector. The national expert N05 emphasised the importance of policy coherence, highlighting that *"we have sustainable development goals, which are a strategic framework for mainstream interventions. There are a few coordination challenges. The SDGs and the Paris Agreement work separately, and so does the Sendai Framework."*

The national experts N03, N10, N11, N14, and N15 also highlighted the need for policy coherence to effectively mainstream CCA and DRR into the food security sector.

5.3.2.2.10 Research and application in implementing policies and related programs

Mainstreaming climate change, disaster risks, and food security requires new knowledge, research, technology, and applications. National expert N01 stressed that *"my suggestion is to enhance technology, research, and institutional development,"* underscoring the need. *"We need more research to see whether cultivation can be done in different geographical locations, even during the offseason,"* said national expert N02. *"Five years ago, we developed the first-ever drought-tolerant rice variety and three drought-escaping varieties,"* said national expert N10.

Experts N04, N05, N06, N07, and N15 also provided examples of how research, knowledge generation, and their applications can support mainstreaming CCA and DRR food security sectors.

5.3.2.2.11 Revival of Historical Good Practices

Sri Lanka's strong agriculture, water management, and engineering practices date back thousands of years. Some good historical practices were designed to withstand droughts, floods, and climate change. The green revolution and modern agriculture have abandoned good historical practices affecting community resilience. Farmer roles like *"Wel Vithane"* and "*Raja Kari"* and water management practises like *"Mada Horruwwa," "Kunu Ela,"* and *"Bedma System"* are examples of such systems. These traditional but trusted systems are slowly disappearing from agriculture, making it more vulnerable to climate change and disaster risks. *"Good practices include water management, harvest storage principles, etc. We need to preserve these principles as a buffer against climate change,"* explained the national expert N15. Such principles are socially accepted. The expert asserted, "*we should look at our historical best practices, tested and tried over 1,000 years, to ensure food security. We should investigate how those old systems can be revived and retrain farmers about them as a mainstreaming option",* concluded the expert.

5.3.2.2.12 Strategic Communication and Extension

Mainstreaming requires good communication and extension between farmers and service providers. Communication and extension of climate forecasts, early warning and adaptation measures, and new technologies should be readily available to enable timely and effective

mainstreaming. *"If there are dry spells and climate shocks, we should be able to promptly communicate with the farmers,"* said national expert N09. Easy-to-use methods should exist. New advisory tools are needed. Last-mile farmers should be connected. There should be national-to-local connectivity. Thus, communication and extension help policymakers, technocrats, and end users like farmer groups to share knowledge.

5.3.2.2.13 Strengthening Institutions, Mandates and Support Structures

Institutions and mandates should be strengthened to help mainstream CCA and DRR into food security with required policies and legislation. Food security is a multi-stakeholder effort, so success depends on each agency's contributions. The current institutional structure, mandates, and support systems must adapt to emerging trends and compounded issues caused by external shocks like climate change and disaster risks. *"climate change and disaster risk reduction sectors should be trying to work together to understand the common issues,"* said national expert N05. Expert N08 emphasised the need for operational-level committees and working groups to drive the mainstreaming process saying '*there should be a cell-based plan implementation mechanism. Multi-stakeholder cells can address food security issues".* National experts N02, N03, N04, N06, N09, N11, N12, N14, and N15 also advocated strengthening institutions, mandates, and support systems to mainstream CCA and DRR into the food security sector.

5.3.2.2.14 Training and Capacity Building

Capacity-building accelerates mainstreaming. Capacity should be increased for risk identification, climate forecasts, early warning systems, climate and disaster resilience farming practices, and climate and disaster resilience planning tools, among others. "*We need to focus on capacity-building,"* confirmed the national expert N05. "*We should enhance the knowledge and make them aware of the importance of risk-informed decision making,"* highlighted national expert N06. He explained, "*We can help them assess risks, mainstream them into programme design, and allocate resources to risk-based mitigation measures."* Mainstreaming DRR and CCA into planning without such an approach is difficult. National experts N04, N05, N11, and N14 also showed how training and capacity building could help mainstream CCA and DRR into food security.

Sri Lankan stakeholders anticipate that the government and responsible authorities will provide comprehensive guidance in response to current and future food safety challenges and will

allocate adequate resources at particular levels for enhancing systems that ensure food safety throughout the entire food and feed chain in the nation (Dayananda, 2022). The author further argues that implementing broader strategies, such as enhancing existing food controls, supporting scientific and evidence-based risk assessment in the establishment and review of food control measures, enforcing national standards for food contaminants and inspection, adopting an enhanced national food safety plan to boost international food trade, and strengthening food security monitoring and surveillance programmes are required. He also proposes encouraging stakeholders to actively participate in risk assessment and communication, as well as developing an integrated agricultural system to address Sri Lanka's food safety and security challenges in the long run. Food rescue operations can be made more efficient and effective by establishing intermediary organizations such as food banks to provide the necessary food logistics, enforcing food safety parameters and basic minimum standards for food redistribution, and organizing regular community awareness programmes on food redistribution (Aloysius & Ananda, 2023a). The authors further argue that food rescue must be incorporated into existing policy as a way to reduce food waste and improve food security. Scaling up to food security in Sri Lanka involves considerable policy reforms and structural adjustments in governance, administrative institutions, and wider society, given the island nation's many issues in food security, poverty, climate change, and the continuation of development gaps (Gunaratne et al., 2021c). Achieving food security involves moving beyond the development of climate resilient food production systems to a comprehensive approach capable of ensuring the climate resilience of the entire food system while addressing nutritional problems caused by climate change impacts. As a result, there is an urgent need to work toward a climate-smart agriculture system that addresses all aspects of food security (Esham et al., 2018b). Climate-smart agriculture (CSA) is a strategy for reforming and reorienting agricultural systems to promote food security in the face of emerging climate-change challenges. It encourages farmers, researchers, the private sector, civil society, and policymakers to take coordinated actions toward climate-resilient mechanisms through four main priorities: (1) building evidence; (2) boosting local institutional effectiveness; (3) facilitating coherence between climate and agricultural policies; and (4) integrating climate and agricultural financing (Lipper et al., 2014).

5.3.2.3 Frameworks for Mainstreaming CCA and DRR into Food Security Sector

When designing a comprehensive planning framework for mainstreaming CCA and DRR into the food security sector, existing policies, strategies, plans, and programmes will be crucial entry points to build upon and sustain (see section 2.9.6; and 2.10). Therefore, this section analyses the existing planning and strategic frameworks, their limitations and bottlenecks, processes for end-user engagement, appropriate planning boundaries and units, and the planning cycle based on the experts' opinions gathered from semi-structured interviews.

5.3.2.3.1 Entry points for Designing Planning Framework for Mainstreaming CCA and DRR into Food Security Sector

A range of national policies, strategies, plans, and programmes can be used as reference documents and entry points for designing a planning framework for mainstreaming CCA and DRR into the food security sector in Sri Lanka (see section 2.9.4 and 2.10). With the establishment of the Sustainable Development Council as per the Sri Lanka Sustainable Development Act No. 19 of 2017, several policy documents and strategies have been developed in the recent past. Some of the key instruments are discussed and analysed below.

Sustainable Development Act No. 19 of 2017 provides overall legal provisions for having an integrated approach for the food security sector and designing programs for achieving 'zero hunger', SDG-2. One of the key objectives of the act is to '*promote the mainstreaming and maintain the equipoise of environmental, economic and social factors in the making of all decisions by government'* and formulate appropriate strategies. The Sustainable Development Council of Sri Lanka has been empowered to make appropriate policies, strategies, and guidelines, facilitate and monitor progress reviews, develop standards and indicators, undertake research and audits and coordinate with respective agencies to implement SDGs. The national expert N04 highlighted the importance and relevance of the act, saying that *"this might be revolved around SDG 02, Sustainable Development Act and the national policy for sustainable development."*

Sri Lanka has established its own national goals in accordance with the level of ambition at the international level while also taking into account national circumstances and interests. Additionally, Sri Lanka have incorporated the seventeen Sustainable Development Goals into its national planning procedures, policies, and strategies in the pertinent ongoing processes in the economic, social, and environmental fields in line with the Sustainable Development Act (Blackhall Publishing, 2019).

National Policy Framework-Vistas of Prosperity and Splendour is the development framework of the current government presented during the past presidential election. While it is largely a political manifesto, later becoming a government policy, it detailed ten related policies. Those are *"an efficient country free from corruption, a safe and a secure country for all, a productive citizen and a happy family, people-centric economy, a technology-based society, new approach in the national spatial system, sustainable environmental policy, a righteous disciplined and law-abiding society and dialogue with the village"*. Although it is not directly related to food security, related disciplines such as the people-centric economy and sustainable environmental policy are linked with climate change and disaster resilience. Therefore those provisions can be used for mainstreaming CCA and DRR into food security sector planning processes. *The Vistas for Development provide an overall outlook on how they want to develop the country over the next few years."* The national expert N04 explained this policy, saying, *"I think what is important right now is the "vistas of prosperity and splendour. This is President Gotabhaya's development plan"*.

The government's National Policy Framework (NPF) consists of ten core policies aiming at reaching four outcomes: a productive citizenry, a contented family, a disciplined and just society, and a rich nation. Ten major policies that take into account include socioeconomic, economic, environmental, and political factors (Ministry of Finance, 2020).

Draft National Policy and Strategy on Sustainable Development presented in August 2020 by the Sustainable Development Council of Sri Lanka, which has identified Policy Goal 2: *'Hunger is eliminated while ensuring food and nutrition security for all in a sustainable manner'.* It broadly covers overall strategies for food security, including adaptation to climate change, early warning and climate forecasts and an overall increase of production and productivity with timebound policy targets and specific strategies to achieve them. As a strategy, it does not provide specific details, implementation arrangements, and means of achieving and mainstreaming CCA and DRR into sectoral planning processes at different levels.

The National Policy and Strategy outlines policy objectives and strategies for accomplishing those objectives, which are founded on seven guiding principles. The guiding principles represent the government's key intents and provide an overall framework for policy in

accordance with the basic principles of the 2030 Sustainable Development Agenda (Sustinainable Development Council, 2020).

The National Agriculture Policy (NAP) of Sri Lanka was launched in 2021 with the vision for *'sustainable food security to achieve national prosperity'*. The main focus areas of the policy include food and food crops and sustainable food security with improved food quality. The main thrust areas include *"crop production and productivity improvement, self-sufficient and independence in basic food and feed requirement, planned resource use, market competitiveness, climate resilience, minimising all risks and uncertainties, mainstreaming gender and youth in agriculture and maintaining centre-periphery relations"*. While the main focus of the policy is agriculture production and productivity improvements, the policy has identified climate change, risks and uncertainties as thrust areas for interventions paving the ways forward for mainstreaming CCA and DRR into food security sector planning processes. However, the policy has not identified specific details, intervention mechanisms and mainstreaming options. The national expert N12 stated the relevance of agriculture policy for food security, saying that *"when we take food security, it is more related to agriculture policy than other policies"*. The national expert N13 also discussed agriculture policy, saying that *"there is a draft agriculture policy. There are many subsidy policies for food security"*, indicating that such policies could be important entry points for mainstreaming CCA and DRR into food security sector planning.

The national agriculture policy aims to increase domestoc agricultural production in order to ensure the nation's food and nutrition security. It also aim to boost agricultural productivity and assure sustainable growth and maximise benefits and limit detrimental effects of globalisation Agriculture and food security. One of the key thrust areas in the NAP include 'climate resilience' which highlights needs for adaptation to climate change and extreme events (Ministry of Agriculture, 2021).

The national climate change policy of Sri Lanka was launched with the vision for *"a future where climate change will have no adverse consequences on Sri Lanka" (Climate Change Secretariat of Sri Lanka, 2016b).* Its goal is to *"adapt and mitigate climate change impacts within sustainable development".* Sustainable development has been emphasised in multiple sections of the policy. The policy addresses the need for assessing overall vulnerability, including disaster risks and the need for recognise and addressing climate change vulnerability in the national development agenda. Food production and food security are also covered in the

policy under the adaptation section to take measures to address the impacts on the crop, animal production and fisheries due to climate change.

This policy's purpose is to solve climate change challenges locally while also engaging in the global context. It seeks to promote adaptation and mitigation activities within the context of long-term development. Its primary goals are to sensitise and educate communities on the country's vulnerability to climate change on a regular basis; take adaptive measures to avoid/minimize the adverse effects of climate change on people, livelihoods, and ecosystems; mitigate greenhouse gas emissions inline with the path of sustainable development; promote sustainable consumption and production, and increase knowledge in society on the multifaceted issues related to climate change. It also aim to strengthen the country's capacity to deal with the effects of climate change in an effective and efficient manner and highlights the fact that climate change challenges must be mainstreamed and included into the national development process (Ministry of Environment, 2016).

The National Adaption Plan for Climate Change in Sri Lanka was launched in 2016 with the timeframe 2016-2025 (Ministry of Mahaweli Development & Environment, 2016). Food security has been identified as a priority sector with sub-sectors of agriculture, livestock, and fisheries. Several priority areas have been identified in the plan, such as rice, other field crops (OFC), horticultural crops, sugarcane, livestock, fisheries, agriculture, and land degradation. National expert N10 explained the development process of the national plan, saying, "*In 2016, the national climate change adaptation plan was launched from 2016 to 2025, and now we are developing provincial adaptation plans".* It has identified potential linkages with other plans, key stakeholders, timeframes, specific adaptation options, and responsible agencies for the implementation. However, it lacks a framework and implementation arrangements at national, sub-national, and district levels.

According to the National Adaptation Plan (NAP), the following sectors are particularly sensitive to the negative effects of climate change: agriculture, fisheries, water, human health, coastal and marine ecosystems, biodiversity, infrastructure, and human settlements. The Plan offers all stakeholders the chance to formulate policies, improve cooperation, institutional setup, mobilise resources, develop and transfer technologies, raise awareness, and build ability to promote resilience of vulnerable populations (Grantham Research Institute, 2016).

The National Disaster Management Plan of Sri Lanka has been developed to reduce disaster impacts on communities, infrastructure, lifeline facilities, shelter, agriculture, and development

activities of Sri Lanka (Disaster Management Center, 2022). It covers multi-hazards and all major phases of disaster management, including mitigation, preparedness, emergency operations, and post-disaster recovery activities. The plan has also outlined sub-national plans at the district, divisional, and community levels and coordination mechanisms with other departments and sectoral agencies. The plan lacks implementation arrangements, related frameworks, and cross-cutting issues such as climate change, food security and nexus with SDGs. This national Disaster Management Plan was developed to have a unified, broadly accepted framework for risk reduction that will be adhered by all citizens in Sri Lanka to counter potential disaster impacts in the nation. The plan is applicable at all levels of the national structure and organizations, from the national government down to the local, provincial, and community levels (Preventionweb, 2023).

5.3.2.3.2 Appropriate Planning Unit for Food Security Sector

The national experts also expressed their opinions and provided inputs into the appropriate planning level for effectively mainstreaming CCA and DRR into the food security sector. Sri Lanka follows administrative structures from national, provincial, district, divisional, and Grama Niladhari levels for planning and rarely goes to the eco-system level. While there are advantages and disadvantages at all levels, most experts agree that divisional-level planning is the most practical and appropriate scale for mainstreaming CCA and DRR into food security sector planning. However, it is worth noting that the divisional level follows different boundaries, such as Divisional Secretariat Divisions, local government / Pradesheya Saba Divisions, sectoral divisions such as health, agrarian, irrigation divisions etc., and they should be mobilised to a common framework at the divisional level. The national expert N04 plained that *"the divisional level should be the focus for bottom-up planning. Divisional development cells will be a good unit. And they can go down to GN units under their jurisdictions".* The national expert N06 also explained that plan implementation would be more practical at the divisional levels, saying, "*For the implementation of the plan, I think it has to go to the divisional secretariat level.* The experts N08, N09, and N13 also supported the idea that divisional-level planning would be ideal and practical for mainstreaming CCA and DRR into food security sector planning. The national expert N14 explained it further: "*To make a sizable contribution, the mainstreaming should happen at the division level. Sometimes, if you go to micro-level mainstreaming, that is practically impossible because of the resource constraints."* National expert N15 also suggested the divisional level, as administrative, governance and resources are distributed at that level which can be maximised for mainstreaming. Experts also

expressed the value of bottom-up planning and mainstreaming approaches to maximise resource efficiency.

The food sovereignty movements advocate for a localist approach to food security that also provides larger social, economic, and environmental benefits. In such approach people are empowered to create their own culturally and environmentally suitable food systems for ensuring food security (Leventon & Laudan, 2017). All levels of government must act fast to build a food system capable of feeding a rapidly rising population while maintaining sustainability in the core (Carrad et al., 2023). Differing perceptions of responsibilities, capacities, and motives, as well as divergent understandings of how the system operates across players, sectors, and levels of governance, are common. This leads to policy and practice mismatch, as well as inefficient flows of resources and knowledge throughout the network of climate adaptation players (Helfgott et al., 2023). Authors argue that these disconnects are built in profound misconceptions of different actors' grounded realities, an experiential process of mutual discovery is required to foster shared knowledge and mutual respect. Thus they propose the process of multi-level integrated planning and implementation (MIPI) that brings together a variety of actors at the local, district, state, and federal levels.

5.3.2.3.3 Appropriate planning cycle for mainstreaming CCA and DRR into Food Security Sector

The national experts have also expressed their opinions about the suitable planning cycle for mainstreaming CCA and DRR into the food security sector. The expert suggested long-term, medium-term, short-term, and seasonal planning for the food security sector. The national expert N12 said, *"If we take the food security sector, I believe there should be plans for the short term, medium term, and long term. If you take early warning and downscale climate forecasting, those things must be short-term interventions, at least every three months, every six months, or annually"*. While having five-year development plans, some experts advocated for seasonal plans, specifically those focusing on agricultural production. National experts N15, N14, N11, N09, N06, and N05 also supported long-term, medium-term, and seasonal planning for the food security sector, considering the vulnerabilities and risks triggered by climate change and disasters.

Individuals and societies are impacted by climate fluctuation and change. Seasonal climate forecasting within agricultural systems can improve readiness and result in improved social, economic, and environmental results (Meinke & Stone, 2005). Food security should be viewed as an integral aspect of the development planning. This is especially true for emerging nations,

which encounter high levels of conflict, culminating in complex circumstances. These countries must adopt well-planned short-, medium-, and long-term strategies with linked actions to increase their food security (Samuel Zziwa, 2003).

5.3.3 Reforming and restructuring planning for effectively mainstreaming CCA and DRR into the food security sector.

While there are some initiatives and pilot work for mainstreaming the CCA and DRR food security sectors, it is evident that current planning structures and processes are not enabling and conducive to effective mainstreaming. Therefore, expert opinions and inputs were sought during the research to identify specific recommendations and enabling environments for facilitating such a reform process, as discussed in the below section.

5.3.3.1 Policies and Legal Provisions

There should be legislative frameworks and enabling policies for supporting the mainstreaming of CCA and DRR in the food security sector. The national expert N01 highlighted this need, explaining that *"there should be provisions in the constitution stating how it should happen, including measures to ensure it does not change based on the regime changes, approval mechanisms, etc."* The national expert N03 also highlighted that relevant guidelines and policy directives should come from the national level so that all stakeholders know the process and mandates. The national expert N04 explained that policies and legal provisions are prerequisites for effective mainstreaming at local levels, saying *that "if there is a legal mandate, we will be able to push and pull this to the highest level with multiple stakeholders."* The national experts N12 and N09 also highlighted the need for policies and legal mandates to facilitate the process at multiple levels.

5.3.3.2 Leadership and Initiatives

The current planning structures and processes are bound by the existing bureaucratic systems, procedures, regulations, and circulars. Institutional and personal leadership are needed to facilitate mainstreaming and reforming the planning process beyond their typical mandates, traditional norms and working cultures. The national expert N13 highlighted this, explaining that *"we need somebody to initiate. It has to be initiated by the ministry".* The national expert N08 also highlighted the need for creativity for planning and mainstreaming.

5.3.3.3 Mainstreaming Culture

The mainstreaming culture should be part and parcel of the organisation's culture and policies. They should not wait for the specialised agencies to come and inform them about the need for mainstreaming; rather, when they develop their policies, strategies, plans and programs, the respective agencies should consider holistic views and mainstream DRR and CCA into their processes by default. The national expert N02 explained this: "*For example, if it is a small and medium enterprise development plan, we should not try to mainstream climate change and DRR; rather, it has to be part of SME development. We should create this culture,"* indicating that all agencies should have such thinking and working culture within their institutions.

5.3.3.4 Stakeholder Coordination and Cooperation Mechanisms

Multi-stakeholder coordination and cooperation are needed for mainstreaming DRR and CCA into the food security sector, as multiple agencies are mandated to work on dimensions of the food security sector. Such mechanisms will facilitate inter-agency coordination, collaboration, knowledge exchange, and data sharing. The National Expert N08 explained this by saying that *"mutual trust and genuine interests among the sectors are very important. There should be a multi-stakeholder collaboration space where multi-agency staff can work on common thematic issues such as food security".* The national expert N13 also suggested a similar need saying that *"we have not mobilised all these agencies and talked together yet. I think we should establish a platform for supporting the discussion".*

5.3.3.5 Guidelines and Tools

Integrated planning needs guidelines and tools to mainstream CCA and DRR into the food security sector. It will standardise mainstreaming across sectors and help agencies integrate it into food security sector planning. "*There are some tools and guidelines, but I suggest someone revisit those and redesign the approach,"* highlighted national expert N03. National expert N14 stressed the importance of tools and guidelines for DRR and CCA mainstreaming into food security. "*We have enough regulations and institutional mechanisms, but we do not have tools,"* he said. Integrated planning and implementation require additional tools. Artificial intelligence and computer-aided software will help integrate complex and big data, including climate and disaster risks, forecasts, and other data. The national expert N07 suggested using computer programmes to "visualise" data and scenarios. He further explained it, saying, "*We could add climate change and forecasting data. It improves accountability by connecting sectors, monitoring, and responding".*

5.3.3.6 Financing Mechanisms

Planning, mainstreaming CCA and DRR into the food security sector and reforming existing planning mechanisms require additional resources, especially financial resources. While there are resources in annual budgets for implementing plans, no specific budget is allocated for planning itself, which is a major gap in the Sri Lankan planning process. The national experts N09 and N13 discussed the issue and highlighted the need for financial resources to enable mainstreaming processes in the food security sector.

5.3.3.7 Lessons Learned and Documentation

Mainstreaming CCA and DRR into the food security sector is a longer-term process. Thus, reforming the existing planning processes is also time- and resource-consuming. Experience, good practice, and lessons learned can significantly enable such processes in the food security sector. The national expert N02 highlighted this need: "*There should be a mechanism and support to document lessons learned and apply lessons from the past to develop the sectors."* The national expert N03 also suggested looking at how a critical review of past practices would help mainstream and reform current processes. The expert explained this further, saying, "*We should also see why mainstreaming failed so that we can effectively mainstream CCA and DRR into the sectoral plans in the future.".*

5.3.3.8 Political Will

Political will is critical and essential to Sri Lanka's governance system, policy formulation, planning, and programme implementation. The national expert N05 explained this by saying that *"our societies and country are very political; if we can bring all the political parties into one pitch on the issues of CCA, DRR, and food security, then it will be possible for us to think about the integrated planning process in the short, medium, and long term."* The national expert N08 also highlighted the need for endorsement from the executive president for mainstreaming and reform processes. The national expert N15 highlighted the importance of aligning the mainstream agenda with the interests of the political wings. He explained this by saying, *"only the political system can make this change. We should build their knowledge base on this. They usually like to get credits and recognition. So, we need to get the benefit of that attitude"*. The national experts N12, N10, N09, and N06 also discussed and contributed to this analysis, confirming that political will is an important enabler for mainstreaming CCA and

DRR into food security sector planning, reforming and restructuring the current planning processes.

In Sri Lanka, increased stakeholder participation in policy formation resulted in reasonably effective policy implementation. However, the ountry must create its own fund to carry out its Intended Nationally Determined Contributions (INDCs) and the implementation of the National Adaptation Plan (Hewawasam & Matsui, 2019). Sri Lanka offers a supportive policy environment for adapting to climate change and building resilience. However, given the inherent complexity in climate change adaptation ecosystem, the country is in a difficult situation, particularly due to the complexities introduced by the institutional coordination mechanisms among the sectors. Significant capacity constraints exist in sectoral agencies in implementing their mandates to execute climate change policies and plans in Sri Lanka (Marambe, Silva, et al., 2015). Within the current climate change discourse, the need for a systematic relationship between disaster risk reduction and climate change adaptation to achieve sustainable development and human security is being discussed. Within the current climate change discourse, the need for a systematic relationship between disaster risk reduction and climate change adaptation to achieve sustainable development and human security is being discussed. However, significant discrepancies exist between DRR and CCA that have significantly hindered or hampered their use in practice which has led to spatial and temporal mismatches, the knowledge mismatches, and norm mismatches (Birkmann & von Teichman, 2010c). The mainstreaming of innovative solutions into government operations need improvements in public financial management institutions to integrate climate risks and adaptation strategies into budgets and macro-frameworks, as well as the management of public investment, assets, and liabilities (Bellon & Massetti, 2022). Several climate change adaptation initiatives are underway at the national and subnational levels in South Asia, but they are fragmented and incoherent due to a lack of a vision that integrates technological, institutional, financial, capacity, information, and policy demands (Ahmed et al., 2019). Authors further argue the significance of cross-sectoral coordination, stakeholder integration, democratic decision-making, establishing synergies with local government institutions and expanded capacities to harness funds from bilateral and multilateral funding organizations.

SECTION B

5.4 Case Studies

5.4.1 Case study background information and analysis procedures

Three districts frequently affected by disasters and exposed to climate change were selected as case studies for this research. Key Informants Interviews through semi-structured interviews and document reviews were conducted to gather data and evidence about food security, climate change, disasters, and related issues. Case study data were analysed as described in section 4.10.2. Thematic and cognitive maps were used to identify key themes and concepts using qualitative analysis techniques. The Nvivo20 software was used for the qualitative data analysis. Each case study is described in the following section.

5.4.2 Data Analysis of the Case Study 01: Anuradhapura District

5.4.2.1 Description of the Case Study 01: Anuradhapura

Anuradhapura district comprises 22 divisional secretariat divisions and 694 Grama Niladhari Divisions. 311,065 families have been registered in the district as per the election registry for 2020 (Department of Census & Statistics, 2022). One or more hospitals or health centres are in each divisional secretariat division operated by the government or the private sector. About twenty per cent of the Grama Niladhari Divisions have access to a government or private school that offers classes up to an advanced level (GCE A/L). In 60% of the Grama Niladhari Divisions, government or private schools offer classes for ordinary level (GCE O/L) or lower grades. It is estimated that 484 Grama Niladhari Divisions (69.7%) have access to piped water from national water supply systems or community-based organizations. (Department of Census & Statistics, 2022). A majority of GN divisions experienced droughts (80%), over 65% of GN divisions faced damages caused by wild elephants, 47% of GN divisions experienced damages caused by other wild animals, and 39% of GN divisions faced storms or hurricanes (Department of Census & Statistics, 2022), as depicted in Figure 5-6.

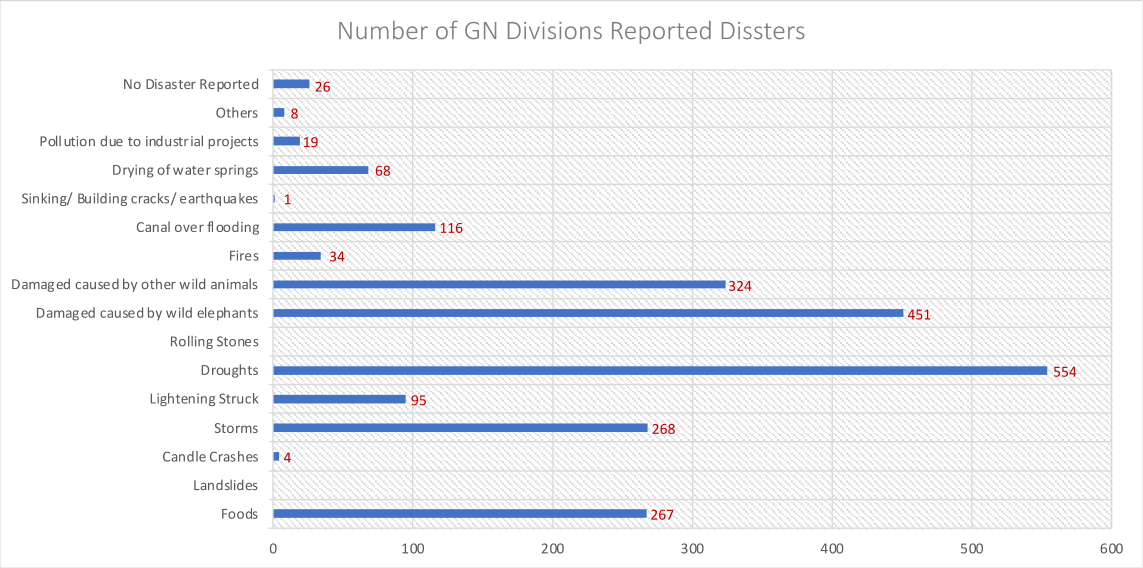


Figure 5-6: Number of GN divisions reported disasters in Anuradhapura district over the past 10 years.

(Department of Census & Statistics, 2022)

Regarding economic activities, the latest data says that most Grama Niladhari Divisions (637 GN divisions, 91.8%) are engaged in crop production, 45% in livestock production, 31% in non-agricultural economic activities, and 11% in fisheries. More than 71,002 families benefited from the "*Samurdhi"* social safety net programme, while 27,367 individuals received public social welfare assistance ("*Pin Padi"*) in 2020 (Department of Census & Statistics, 2022), as depicted in Figure 5-7.

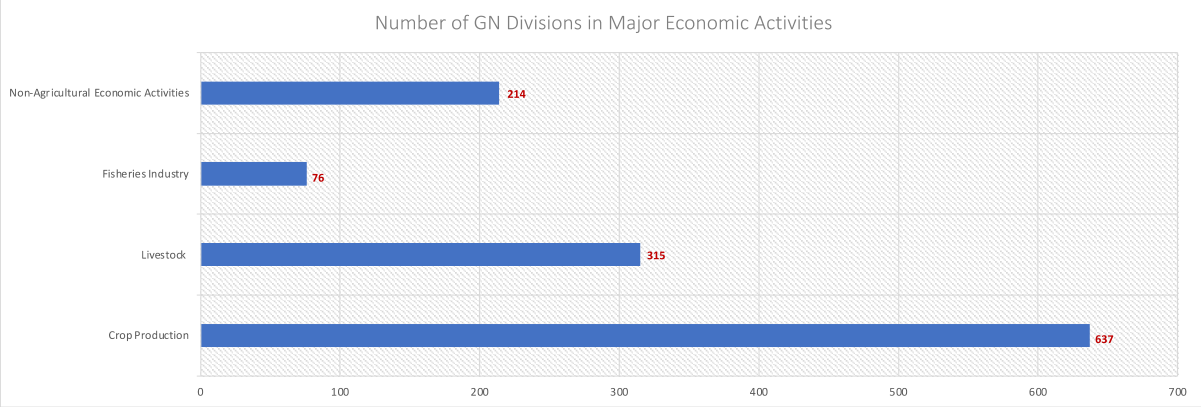


Figure 5-7: Major economic activities in Anuradhapura districts by GN divisions.

(Department of Census & Statistics, 2022).

5.4.2.2 Institutional Setup for Foods Security and DRM in Anuradhapura District

The central government of Sri Lanka governs the Anuradhapura district under the leadership of the district secretary, traditionally known as the Government Agent. The district consists of representatives at the level of directors or below from line ministries or departments such as agriculture, irrigation, agrarian services, animal health and livestock, disaster management, meteorology, health services, wildlife, etc. The district regularly holds coordinating committee meetings called "district coordinating committee" (DCC), mobilizing all key stakeholder agencies, parliamentarians and other elected representatives from local governments, farmer organizations and cooperative societies etc.

Cross-cutting issues such as disaster risk management, climate change adaptation, and the food security sector are coordinated by the district secretariat with technical assistance from respective line departments and agencies at the district level. District disaster management committees have been formed but are not functional unless there is a crisis or disaster. There is no dedicated institution for facilitating climate change adaptation and food security apart from agriculture production, coordinated by the Agriculture Department and the Agrarian Services Department. The district disaster management coordinating unit exists in the district. It reports to the district secretary at the district level while liaising and reporting to the DMC at the national level. Provisions in the disaster management act support disaster management-related coordination and implementation at the district level and below. Divisional disaster management committees and GN-level disaster management committees should be formed; however, those not very active and functional at the district level. Irrigation, Agriculture, Agrarian Services and other related agencies work with divisional offices and farmer organizations to plan and implement annual and seasonal programs based on the targets set by their national counterparts. Anuradhapura district is a major agriculture production district which dominates rice and other field crops. The district has major irrigation schemes, minor irrigation cascades and rainfed irrigation systems. Divisional Agriculture Committee (DAC) and District Coordination Committee (DCC) coordinate agriculture production-related issues and planning decisions with inputs from technical agencies, elected representatives, and farmer organizations. United Nations Agencies such as UNDP, international NGOs, local NGOs and community-based organizations operate and present in the district and support various projects and initiatives related to DRM and CCA. Still, at a smaller pilot scale, their impact is yet to be seen.

The following section presents specific details and analysis of the district based on the key informants' interviews (semi-structured interviews) in Case Study 1.

5.4.2.3 Analysis of the Key Informants' Interviews Data from Case Study 01

5.4.2.3.1 Food Security Status in Anuradhapura District

Key informant data were analysed to assess the food security dimensions of availability, access, utilization, and stability in the district. Data revealed that the district produces rice, millet, mung beans, cowpeas, green grains, maize, and vegetables, with high food diversity. Agriculture is one of the district's main livelihoods and income sources; therefore, experts believe that food availability is constrained due to a lack of disposable income. In this case, key informant A09 explained the issue: *"I can say that 50% of the people in the district have been secured with food. Many families live only from farming and derive their only income from those two seasons. Their food is essentially hand-to-mouth."* Several major irrigation schemes, minor irrigation cascade systems, and rain-fed agriculture contribute to food availability. The key informant A02 explained this by saying that *"agriculture is thriving in this basin compared to other basins. It's a rich basin. Irrigation tanks' density is much higher. Major irrigation schemes feed many areas. There are also minor irrigation cascades. Therefore, agriculture production is much higher."* The key informants believed and felt that rice might not be an issue for most people in the district as it is a major rice-producing district in the country.

However, several key informants raised concerns about food utilization, specifically a lack of quality food, agrochemical overdosage, and imbalanced carbohydrate-rich diets. The key informant A01 explained this situation by saying, *"there is an issue about nutrition value." They are using excessive amounts of agrochemicals. When we visit the field, we can also see that people might not have a nutritious, balanced diet, and we can see them as malnourished. The key informant A04 said."* In our district, food quantity is not a big concern." The national expert N10 warned that food diversity is dwindling in the district as farmers shift to monoculture (paddy) rather than fruits and vegetables, posing challenges to the district's ability to provide balanced and nutritious diets. She explained the issues, saying, *"in the recent past, farmers have gone into paddy cultivation (monoculture). Resilient and diverse food varieties have been diminishing in the district although such crops can produce harvest throughout the year."* Case Key informants A11, A09, A07, A06, A05, A04, and A03, explained that food utilisation is one of the main concerns in the district due to overdosage of agrochemicals and unbalanced diets due to the lack of food diversity.

The key informants highlighted the lack of access and infrastructure for markets that create access issues in most parts of the district, despite having two economic zones within or near the district, namely "Dambulla" and "Thambuththegama." Food access in the district is primarily affected due to sudden price changes as a result of monoculture, climate and weather events or disasters, or changes in government policy concerning the importation of food products. The key informant A08 explained the price changes, saying, *"the price in the market is fluctuating so much."* The key informant A03 also concurred on the same issue, explaining that *"sometimes vegetables don't have a good price. But on the other hand, if you go to another part of the country, prices would be extremely high,"* indicating issues related to the transport and distribution of food. Key informants A05, A06, A07, and A11 also discussed and explained the market issues, which create price fluctuation leading to food access issues across the district. Key informant A09 explained this further, saying that *"farmers get the income only in a particular season; therefore, during the offseason, they may not have access to food due to price changes and a lack of income."*

Food stability is also not assured, as the district is relatively weak in production planning. The district usually cultivates in one season, and interseason cropping is not widely practised. Disasters like drought and climate change also affect production, leading to instability. Post-harvesting losses also increase food instability in the district. The key informant A05 explained these issues, saying, *"the production planning is quite weak in the district, and we see an imbalance between what the district and the country need and what they are producing."* The key informant A06 explained this issue further by saying, *"usually, they cultivate only in one season, and then after that, they rest for the remaining time before they resume paddy cultivation in the next season."* Therefore, cropping intensity is relatively low since they are not using the lands for other field crops. Farmers are reluctant to engage in other field crops.

Paddy production in Anuradhapura District accounts for 12 percent of national production, maize production for 40 percent, soya production for 80 to 90 percent, while the farmers in the district contribute significantly to green gram, undhu, ginger, and cowpea production (Daily News, 2022). Authors further report that in the 2022 Yala season, the district had intended to produce paddy on 91,500 hectares of its irrigable lands, or roughly 131,000 hectares. However, this has now been cut to 68,000 hectares, while maize and soy production have been restricted to just 1,661 and 1,330 hectares, respectively. A district-wide programme for home gardening is active, nevertheless. 42 percent of Anuradhapura district households are food insecure, with insufficient calorie consumption due to access concerns. Gender, age, the marital status,

monthly income, debt, and family size were all important factors in predicting food security. (Jayarathne & Rupasena, 2019). According to recently conducted research, more than 75% of households were somewhat food insecure in Anuradhapura district, while more than 80% of farmers engaged climate change adaptation techniques (Sithumini et al., 2020). According to the authors, farmers who applied climate change adaptation measures are more food secure than those who did not.

5.4.2.3.2 Observed Climate Changes in Anuradhapura District

According to key informants, temperature changes have been evident in the district over the years. They also believe and feel that precipitation changes are common. Evapotranspiration changes are also reported. Contributing to this analysis, key informant A02 explained this, confirming that *"climate change impact is already there in the district. Temperature also increases in the district. If you compare with other districts, the temperature rises, and evapotranspiration is high".* In discussing the precipitation changes, key informant A05 explained the situation, saying that *"there were many dry periods in the district. Most of the farmers lost five consecutive seasons due to drought".* The key informant, A09, explained the climate change situation in the district with data, saying that *"we experienced a decreasing trend in water availability and rainfall, and it has already been found from research. I have reviewed decadal variances for the last 60 years. Looking at the 60s to 70s, you will find that rainfall is below average. From the 80s to the 90s, you can see that rainfall patterns have changed. If you look at the latest details from 2010 to 2020, observed rainfall is higher than the average rainfall, so I believe that rainfall patterns and changes are reported in the district,* indicating the impacts of climate change. Key informants A11, A10, A08, and N07 also provided their opinions and experiences about climate change, including concomitant temperature and precipitation changes.

5.4.2.3.3 Climate and Disaster Nexus in Anuradhapura District

Among the many disasters in the district, experts believe that drought is the most common disaster induced by climate change. Furthermore, the drought has had a direct impact on the district's food production and food security. The key informant A01 explained it further: *"since 2015, we have been experiencing droughts, and farmers have missed six seasons in some areas that we are working. Especially for a small-scale farmer, it has a significant impact. It has impacted both the quantity and quality of the food since the production has been disturbed for the continued six seasons."* The key informant A02 explained this issue by saying that *"climate*

change is already affecting the district, which includes prolonged drought and water scarcity." Key informants A03, A04, A06, and A11 also suggested that drought is the most common disaster in the district and is induced by climate change. According to key informants A01, A02, A03, A04, A06, A07, and A11, extreme flooding is another common climate-induced disaster in the district. While rainfall is lower during dry periods, severe and high-intense rainfall occurs during the rainy season, resulting in flash and riverine floods. The key informant A03 explained the flood situation: *"floods are common in the districts and contribute to production losses in the district."* The key informant A04 further contributed to the analysis, saying that *"two main flooding sources in the district are Malwathu Oya and Yan Oya"*, which cause regular riverine floods. Key informant A07 explained the gravity of the current situation, saying that "*high-intensity rainfall causes more frequent floods"*. It is very regular—at least once or twice per year. *"We experienced flash floods or inundation and have observed crop and production damages due to them."*

Wild animal attacks, especially from wild elephants, wild boars, peacocks, and monkeys, have become more frequent and severe in the district, according to key informants A01, A02, A03, and A06. Key informants explained these issues as secondary hazards due to droughts induced by climate change. The key informant A06 explained this situation: *"during the droughts, due to the food and water scarcity for animals, they come to the villages and attack the harvests, farmlands, and vegetables. Animal attacks will cause significant production and productivity losses in the district."* According to key informants, production losses from wild animal attacks affect food availability and reliability in the district.

Pests and diseases have also increased, according to key informants A02, A04, A06, and A07. The key informant A06 explained this issue by saying, *"we feel like there are more pests and diseases during the drought periods. A direct relationship between climate change and pests and diseases appears to exist."* The key informant A07 also concurred with this phenomenon, saying, *"when the temperature changes occur, we have also observed changes in the pest population."*

A recently conducted study revealed the possible adaptation measures for the food and water security corresponding to irrigation reservoir scale in Anuradhapura district. Researchers developed five scenarios for one of the irrigation schemes, Pahala Divul Wewa with a catchment area 5.12 km2, in Anuradhapura. The worst climate change forecast for Pahala Divul

wewa has been determined as a 22% rise in the South East monsoon and a 42% drop in the North East monsoon. Under such circumstances, cropping intensity would be reduced from 0.678 to 0.55 in this scenario, resulting in major consequences on food security (Dissanayake et al., 2021). Drought is one of the most common disasters affecting the district's food security sector. Drought is evidently caused by rising temperatures and decreased precipitation. according to the findings on analysing 114 years of drought data in the district (Kaleel & Nijamir, 2017).

5.4.2.3.4 Vulnerability of Food Security Sector to Climate Change and Disasters in Anuradhapura District

Food availability, access, reliability, and utilisation are impacted by climate change and climate-induced disasters in the district, according to key informants A03, A04, A06, A07, A09, A10, and A11. The key informant A3 explained the situation, saying that *"there is a huge impact from the droughts in the district and sometimes we have abandoned entire season due to water shortage. We have rainfed cultivations and Chena cultivations. If there is no rain, they just abandon the season"*. According to them, climate change and climate-induced disasters impact the harvest and harvesting period, ultimately impacting food availability and reliability. They also explained that disasters affect markets, distribution, and supply chains, increasing prices and leading to food access issues. Food inflation is prevalent in the district due to disasters, heavy rainfall, flooding, and extreme climate events. The key informant A06 explained how disasters impact people, saying, *"we experienced a lot of production losses during disasters. Sometimes we get unexpected rainfall during the offseason, and the harvest will be lost. Sometimes we also lose the harvest due to droughts impacting food security."* When their production gets lost, it also impacts credit repayments and overall income, leading to less purchasing power and food access issues, according to key informant A08. Key informant A09 explained the socio-economic vulnerability of the district, saying that *"Anuradhapura district has the lowest savings among people, so when the products get impacted by disasters, it poses a significant challenge for food access".*

It has been discovered that the Anuradhapura district is more vulnerable to the effects of climate change than other districts in the country as a whole because of its significant reliance on primary agriculture (Eriyagama et al., 2010). Droughts routinely impact agriculture production in the district, threatening national food security if the pattern continues (Kaleel & Nijamir, 2017).

In addition to the inherent vulnerability of the sector due to its heavy dependence on water and other atmospheric parameters, the food security sector also has systemic vulnerabilities that increase the food security risks in the district, according to key informants. Some of the key systemic vulnerabilities are analysed and explained below.

- ***Abandoning Good Practices*** is one of the key systemic vulnerabilities that key informant A01 explained. The district had better water management practises through the cascade system and traditional roles assigned to farmer organisations and lead farmers, but those practices have diminished over the years.
- ***Data and Data Reliability*** is another major systemic issue in the district. According to key informants A05, A08, and A09, data availability, reliability, usage, and evidence are lacking in the district for farmers to make informed decisions regarding production planning. The key informant A05 explained the issue: *"productivity might be reduced because of climate change, but I don't have the data to discuss that in detail."* Key informant A08 explained the data usage issue among farmers, saying that *"there is an attitude problem, and they don't see the value of data, rainfall, and forecasts,"* which makes the food security sector more vulnerable to climate change and climate-induced disasters. The possible reason was explained by N09, who said that "*people get this information only from the TV news and the newspapers, but the research findings are not coming into the general society,"* indicating a lack of data usage, research and outreach.
- ***Early Warning and Forecasting issues*** make the food security sector more vulnerable to disasters and climate change in the district, according to key informants A05 and A10. Key informant A05 explained further, saying that *"there is an issue, and we are not sure whether these advisories are reaching up to the village level or not, as we only discuss them at the seasonal meetings and inform the farmers through general awareness raising."* The key informant A10 explained a related issue by saying that *"farmers follow routine practices. They are not looking at seasonal forecasts, 10-day forecasts",* indicating farmers' lack of usage and applications, making the food security sector more vulnerable to climate change and climate-induced disasters.

- ***Extension issues*** are also closely linked with the lack of application of data, forecasting, and early warning by farmers, according to key informants A05 and A06. They explained the issue by saying, "*there is no real impact on the ground, and farmers are not using this information and adapting their practices yet."* Despite the government's efforts to encourage farmers to change their crops, *"farmers are a bit reluctant as they don't have much experience with those crops and they are not aware of the market access, demand, and availability,"* which makes the sector more vulnerable to climate change and climate-induced disasters, according to key informant A06.
- ***Fragile Supply Change*** associated with transport and distribution systems makes the sector more vulnerable to climate change and disasters, according to key informants A03 and A11. Key informant A03 explained this vulnerability by saying that *"there is a huge issue related to the transport of food and distribution,"* indicating it makes the sector more susceptible. Key informant A11 explained how the poor supply chain contributed to price anomalies of products exposed to weather extremes and disasters, resulting in wholesalers and retailers taking advantage. He explained this vulnerability by saying, *"if rain occurs during the harvesting period, farmers are unable to sell their products. So, rice millers and wholesale agents purchase products at a much lower price".* It will have an impact on people's incomes. They may not be able to access other food items and meet their food preferences with such low income. It is a complex issue impacting all dimensions of food security.
- ***Governance issues*** also make the food security sector more vulnerable to climate change and climate-induced disasters, according to key informant N05. Political interferences and the integrity of governance systems are significant barriers to the implementation of adaptation and risk mitigation measures. Key informant N05 further explained this by saying, *"sometimes, political interference and influences come, so we might end up spending money on the tanks, which the politicians like over the farmer organizations prioritise."* Such practices make the sector more vulnerable.
- ***Lack of Assessing and Measuring Mechanisms*** is another key issue in the district, according to key informant A09. He explained this issue further, saying that *"they have only one tool, which is workshop-based planning in various*

sectors." They go out for a day and will develop their annual plans, according to the key informant. There is no proper identification of needs or gap analysis. No *"monitoring and feedback system"* makes the food security sector vulnerable to climate change and climate-induced disasters.

- ***Lack of production planning*** is another key issue, according to key informant A05. This is linked to the lack of need analysis, the identification of niche products, the lack of diversification, and market issues. The key informant further explained the context of the issues, saying that *"there should be a plan for various seasons, various regions, and various crops. But there is no such crop planning based on the demand and needs in Sri Lanka."* Lack of production planning is a bigger issue linked to early warning systems, extension issues, policy issues, etc.

- ***The lack of risk transfer mechanisms*** is a key issue in the district because it makes the food security sector more vulnerable to climate change and climate-induced disasters, according to key informant A09. The key informant explained this vulnerability further: *"if farmers lose their harvest, they have to bear the cost. There are no risk financing solutions for agriculture, farming, and food security at the district level."* The absence of risk financing mechanisms has a greater impact on the district's food security than just the production or food availability dimensions.

- ***Negative coping mechanisms*** also contribute to the higher vulnerability of the food security sector, according to key informants A06 and A08. This includes farmers' reluctance to adapt to changing climates by practising new crop types beyond their traditional practices. Key informant A06 explained this vulnerability further: "*the agriculture department is also trying to introduce new crops, but farmers don't like to accept those new crops."* Farmers are hesitant because they have little experience with those crops. According to them, farmers who lose their products and sell them at lower prices face other socio-economic problems, including credit defaults, a lack of income, etc., leading to more significant food security issues. The key informant A08 explained the importance of leadership, saying that *"leadership is also a crucial aspect in climate change adaptation and*

food security, so there should be leadership qualities from the farmers to change our practices."

- ***Policy issues*** are another major systemic vulnerability of the food security sector, according to key informant A05. It also relates to governance issues in the district. According to the key informant, *"there is no policy for identifying, prioritizing, and implementing climate change adaptation and risk reduction options in the district; therefore, political interferences derailing the priority actions are very common".* Thus, it increases the overall vulnerability of the food security sector in the district.

- ***Research and application*** are other significant issues in the district, leading to a lack of evidence and data for adapting to climate change and disaster risks, according to key informant A09. Therefore, the government and related stakeholders have failed to convince farmers. They only get generic information from the news, leaving the adaptation to climate change slow and weak, increasing the vulnerability of the food security sector.

- ***Lack of risk knowledge and awareness*** also make the food security sector more vulnerable to disasters and climate change in the district, according to key informants A08 and A09. Risk knowledge is also closely associated with their traditional practices, early warning reach, and risk perception. *"Sometimes traditional knowledge is a barrier to climate change adaptation. Farmers do not like to change their practices that have been in place for generations. It leads to a situation where, even if they receive early warning and forecasting in advance, they do not change their practices",* leading to a more vulnerable sector. Key informant A08 explained this further, highlighting, *"I cannot emphasise the value and the importance of getting Agro-advisories and early warning enough, but unfortunately, some of our farmers are not listening to those."* According to key informant A09, the food security sector is one of the most neglected sectors in the district. The public and the farming community have a significant knowledge gap regarding this issue. Key informant A09 explained the gravity of the issue, saying that *"the most important group that they should know about these changes is the*

farming community, but the reality is that only a minimal number of farmers know about this phenomenon and these changes," which makes the food security sector more vulnerable to climate change and disasters.

- ***Lack of Recognition for Farmers and Farming*** is another systemic vulnerability of the food security sector, according to A08. In today's society, farmers do not have credibility, and people do not respect farming. A societal stigma says that children of farmers will not be able to go to a good school, and even if they do, there won't be any recognition. As a result, younger generations are becoming disinterested in farming. That will have a significant impact on food security. The key informant explained the issue by saying, *"in our society, people believe that farmers are poor, and that attitude has made the new generation not interested in agriculture."* According to the key informant, there is a trend that everyone is trying to move away from farming. He confirmed that this would have a devastating effect on the country's economy.

The district is extremely susceptible to the potentially damaging effects of climate change as a result of its lacklustre infrastructural and socioeconomic assets, as well as its limited copying capabilities and high level of exposure to a wide number of hazards (Eriyagama et al., 2010). A greater understanding of current adaptation measures and the causes of adaptation methods employed by paddy farmers are required in order to develop policies aimed at supporting effective adaptation strategies in the food security sector.

5.4.2.3.5 Limitation and Bottlenecks for Mainstreaming CCA and DRR into Food Security Sector Planning in Anuradhapura District

Food security sector planning is at a very primitive stage in the Anuradhapura district. Climate change and disaster risks are not considered while planning, which focuses on crop production based on the targets given by the respective national agencies to their counterparts at the district level. The following specific limitations and bottlenecks for mainstreaming CCA and DRR into the food security sector were identified by the key informants:

- **The disconnect between national policies and local-level needs** is a major limitation for mainstreaming CCA and DRR in the district. The district and local partners have a poor understanding and knowledge of national-level policies and

strategies. The key informant A01 explained this by saying, *"they don't have much understanding of the national-level policies, SDGs, programs, and policies."* There is a major disconnect between the national level and the district level. *"They don't know about resources available at the national level apart from what they are getting from their departments."* Key informant A09 also concurred with this limitation, saying that *"when we are talking at the district level, the translation of these international instruments, such as the SDG, SFDRR, and the Paris Agreement, is non-existent".* Such knowledge gaps hinder the mainstreaming of CCA and DRM into food security sector planning to a greater extent.

- **The Fragmented approach to mainstreaming** is another issue at the district level. There is a major disconnect between the provincial government and the district government. Therefore, they follow parallel processes than an integrated approach. The key informant A02 highlighted this issue: "*Chief Secretary and GA will not sit in the same meeting because they have bureaucracies and politics. The entire extension system of the country is fragmented*". Key Informant A03 also discussed the hindrance due to the fragmented approach saying that interventions happen in isolation than mainstreaming into overall development planning processes in the district. Key informants A05, A06, A07, A09 and A11 also discussed the current mainstreaming challenges due to the fragmentation in planning and implementation between the district government, the provincial government and other line agencies present at district and local levels.
- **Governance Issues** are another bottleneck for mainstreaming CCA and DRR into food security sector planning at the district level. It is also connected with the mandates, bureaucracy, and coordination issues between district and provincial governments. According to key informant A02, such governance issues also lead to fragmented extension at the local level. According to key informant A03, *"there is no responsible agency to support an integrated and comprehensive planning framework in the district and at the national level"*. Key informants A06, A07, A08, A09, and A11 also highlighted current governance issues as a major bottleneck for mainstreaming CCA and DRR in the district.
- **Lack of accountability and monitoring** is another big issue in mainstreaming CCA and DRR into the food security sector in the district. Key informant A03

highlighted the issue, explaining that *"one of the reasons is that there are no responsible agencies for food security, drought mitigation, and all other related system issues."* The key informant further explained, *"even if people feel like this is an important area, there is no agency to approach."* The key informant A05 discussed how the lack of a responsible agency, accountability, and monitoring leads to a lack of implementation, even if there are longer-term plans and measures for mainstreaming. Key informants A06 and A07 also concurred on similar issues for mainstreaming. Key informant A08 explained the lack of follow-up by government officers on various projects and initiatives, saying, *"there is no monitoring, and after the projects have been completed, there are no follow-ups or evaluations to see the impact."* Key informants A09 and A11 also discussed the lack of accountability and monitoring due to unclear roles and responsibilities among the staff and agencies.

- **Lack of data and evidence** is another main issue, according to key informant A03. A lack of needs and impacts assessments, resource mapping, and evidence for informed planning hampers the mainstreaming processes.
- **Lack of communication, awareness and understanding:** According to key informants A03 and A09, there seems to be a major issue in mainstreaming CCA and DRR into food security sector planning. Information and knowledge do not penetrate and transfer from the national to the district and local levels as they should. A03 explained the issue, saying, *"there is a huge lack of understanding and awareness on the issues."* Key informant A09 said, "*these things have not been sensitised at the district level. I don't believe these global instruments have been translated into local level actions,"* indicating a gap in knowledge transfer, communication, and awareness between the national and district levels.
- **Lack of leadership and initiatives** also affect the success of mainstreaming CCA and DRR. Mainstreaming requires officers and agencies to work beyond their regular mandates, allowing the mainstreaming of CCA and DRM into their sectoral work. Such an approach requires leadership and initiative. However, according to key informant A08, government officials do not display such leadership qualities and lack risk-taking initiatives. The key informant explained this issue by saying, *"government officers don't take risks. They don't even take 10% risk."* Key informant A10 suggested that a senior official, such as the district

secretary or government agent, should take the lead in mainstreaming CCA and DRR into the food security sector. The key informant elaborated on this further, explaining that *"if any person, such as the district secretary, can provide leadership and bring all agencies into a common forum with a common agenda, then mainstreaming is possible,"* indicating it is a critical issue at present.

- **Attitude and human factors** also affect the mainstreaming processes in the district, according to key informants A01, A02, A08, and A10. This is exacerbated by other related issues, such as lack of governance, policy, and institutional mandates, leading to a lack of interest and negative attitudes by the leadership of the institutions. Key informant A01 explained that "*there is no interest between the District Secretary and Chief Secretary to work together, and they have different political views."* A02 also explained the systemic issue, saying that the *"Chief Secretary and Government Agent/District Secretary will not sit in the same meeting because they have bureaucracies and politics."* Attitudes and the human factor are not restricted to government systems; similar problems have been reported with farmers and at the local level. Key informant A08 explained this further, saying, *"sometimes, farmers also think that when extension workers visit villages, it is a burden and their freedom will be lost."* The key informant A10 explained how a lack of attitude leads to a lack of mainstreaming, saying that *"there are attitude and mandate issues, and they don't like to work together. They go in different directions".* Personal attitudes and facilitation skills matter for mainstreaming CCA and DRR into the food security sectors.
- **Lack of mechanisms and mandated institutions** is a major issue in mainstreaming, according to the key informants A04, A06, A09, and A10. The lack of established mechanisms and mandates between the district government and provincial government is one of the key bottlenecks for the lack of progress in mainstreaming at the district level. Key informant 10 explained this by saying that *"every organisation is focusing on their mandate and individual targets"* instead of an integrated approach and mainstreaming CCA and DRM into food security sector planning processes.
- **Multi-stakeholder coordination issues** are critical issues affecting the mainstreaming of CCA and DRR into food security sector planning in the district. Key informant A02 explained that planning and implementation happen at the

individual agency level rather than through a coordinated approach, saying that *"they are working in silos."* Related to this, the key informant also explained the coordination issues between the agencies belonging to the central government (district government) and the provincial government. Such issues also penetrate extension workers at the field level, as they belong to and report to different district and provincial government agencies, resulting in a fragmented extension system. Key informants A05, A09, A10, and A11 supplemented this issue, affirming that multi-stakeholder coordination issues in the district hinder the mainstreaming of CCA and DRM into the food security sector.

- **The lack of policies and legislation** to facilitate mainstreaming work at the district level is another bottleneck. According to key informant A06, no constitutional and legal provisions exist for provincial and district governments to work within common development frameworks. The key informant A07 highlighted that the lack of overall thematic policies for mainstreaming different sectors into agriculture policy and related programmes is the main bottleneck for mainstreaming, thus leading to a lack of coordinated approaches. He further explained it by saying that "s*ince there is no overall policy, they are going for just individual plans and individual tasks,"* indicating that such an approach adversely affects the mainstream agendas in the district.
- **Lack of scale-ups and scale-outs of good practices in mainstreaming** is another main issue, according to key informant A11. Currently, there are a few foreign-funded pilot projects in the district on a very small scale; however, there are no consolidated plans for scaling them up to have a greater impact, saying that *"these projects are being implemented on a very small scale, not across the district, so the impact is not much apart from their pilot initiatives."* According to the key informant, there are no mechanisms for upscaling those programmes across the district. Therefore, mainstreaming is not feasible to upscale through such pilot project approaches.
- **The lack of tools and methodologies** also affects the success of mainstreaming in the district. Key informant A04 explained it, saying that *"planning is one of the main issues. There are no tools or systems for integrated planning"*. Without such tools, mainstreaming is ineffective, according to A09. He explained this by saying that *"they have only one tool, which is workshop-based planning in*

various sectors." There is no proper identification of needs or gap analysis. There is no monitoring and feedback system. Such ad hoc approaches will not enable mainstreaming of CCA and DRR into the food security sector, as it needs a systematic approach for mainstreaming.

- **Lack of land use planning and zoning** is another main issue, according to key informant A03. There is no proper use of zoning and its application in implementing various projects in the district.
- **The mismatch between administrative and eco-system boundaries** is another main issue affecting the mainstreaming process in the district. Key informant A02 explained this issue further, saying, *"if you take the flood, the root causes of the flood are not in the place where it impacts; they might be somewhere else, or they might be in some other division or district. Therefore, if we don't have a system to bring these administrative boundaries together and work with the natural resource boundaries, we will be unable to find a solution".* The key informant suggested that problem analysis should go beyond administrative boundaries to support mainstreaming.
- **Political interferences** are negatively affecting mainstreaming efforts in the district, according to key informant A09. Politicians are involved in prioritising and deciding what actions and interventions will be implemented in the district without referring to plans or planning processes. Key informant A09 explained the gravity of the issue, saying, *"most of the time, they call for a meeting or discuss it at the DCC. Money also comes in the form of allocations given to each parliamentarian. So, there is no interconnectedness between this planning process and what they do in the field. All this planning is ad hoc, and there is no strategic thinking."* Such ad hoc and politically motivated programmes can easily derail the district's mainstreaming processes. Key informant A08 also contributed to this discussion, saying that even staff appointments are based on political interference.
- **Lack of technical knowledge and know-how** is also affecting the mainstreaming progress at the district level. Key informant A08 explained how political interference has led to technical knowledge gaps among the staff. He explained this issue by saying, *"at the village level, most of the officers are appointed based on political influences and affiliations. I don't think they have*

the qualifications to do the job." Such knowledge gaps create bottlenecks for mainstreaming processes in the district.

Farmers in the Anuradhapura face obstacles when putting their plans into action, such as a lack of market access and knowledge, infrastructure and finance issues, a lack of technology and financial resources, a lack of public awareness, a shortage of qualified labour, a lack of education, and health issues (Alikhan, 2013).

Figure 5-8 summarises limitations and bottlenecks and their nexus for mainstreaming CCA and DRR into food security sector planning in the Anuradhapura district.

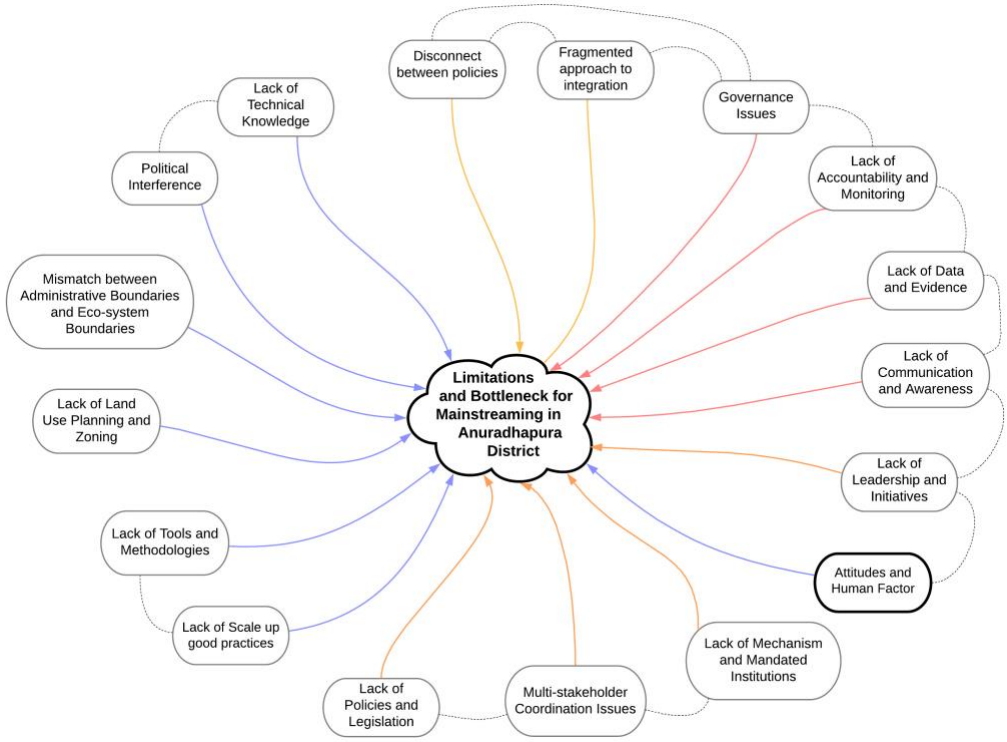


Figure 5-8: Limitations and bottlenecks for mainstreaming CCA and DRR into food security sector planning in Anuradhapura district.

5.4.2.3.6 End-user Engagement in food security sector planning in Anuradhapura District

As discussed below, multiple mechanisms and instruments for engaging the end-users in the Anuradhapura district exist. End-user engagement has multiple challenges and limitations, as discussed below.

- **Current Practices of engaging end-users in the food security sector planning:** One of the mechanisms to engage end-users and farmers is through the seasonal meeting *("Kanna Resweema"*), which takes place at the district level. Key line departments such as agriculture, agrarian services, irrigation, and other related departments and farmers meet to discuss the season and make key decisions.

Another mechanism is the DAC, where divisional stakeholders, officers, and farmers meet at the divisional secretariat to discuss key issues and solutions. Farmers, as end-users, participate in both forums and engage in the decision-making processes. Another initiative from the former president of Sri Lanka was to adopt the concept of ABC committees. "A" represents national-level committees, "B" represents district-level committees, and "C" represents village-level committees. The "C" committee should make recommendations and plans to the "B" committee, which should then make recommendations to the "A" committee. Village-level officers such as the *"Grama Niladhari,"* the village development officer, and the *"Kupanisa,"* the agriculture research assistant, comprised the village-level committee. Farmers also get involved in the "C" committee.

- However, this mechanism is not fully operational because the president was replaced last year. In addition, some pilot programmes apply "Participatory Rural Appraisals" (PRA) for end-user engagement. But these are very isolated efforts and have not upscaled across the district. Another common mechanism is using agricultural extension workers and service centres. They engage with farmers in the field, and farmers also visit the service centres. There are 43 service centres across the district, with 693 *"Kupanisas"* attached to them.
- Furthermore, irregular engagement with farmers may occur during community consultations whenever stakeholders develop new proposals. Rarely do the model villages concepts developed under various programmes interact with farmers and end-users. Farmers, researchers, and extension workers interact in climate-smart model villages to introduce new technologies, solutions, and mechanisms. Another common mechanism for engaging end-users is through mass media such as TV, radio programs, leaflets, etc. Those are one-way mechanisms from the service providers to the communities. There are also several types of local organisations to engage with end-users, such as entrepreneur associations, youth councils, and farmer organizations. Among them, farmer organisations are the most active, recognized, and popular in the district concerning agriculture and food security. They also have committees for water distribution and management. Figure 5-9 demonstrates mechanisms of end-user engagement in the Anuradhapura district.

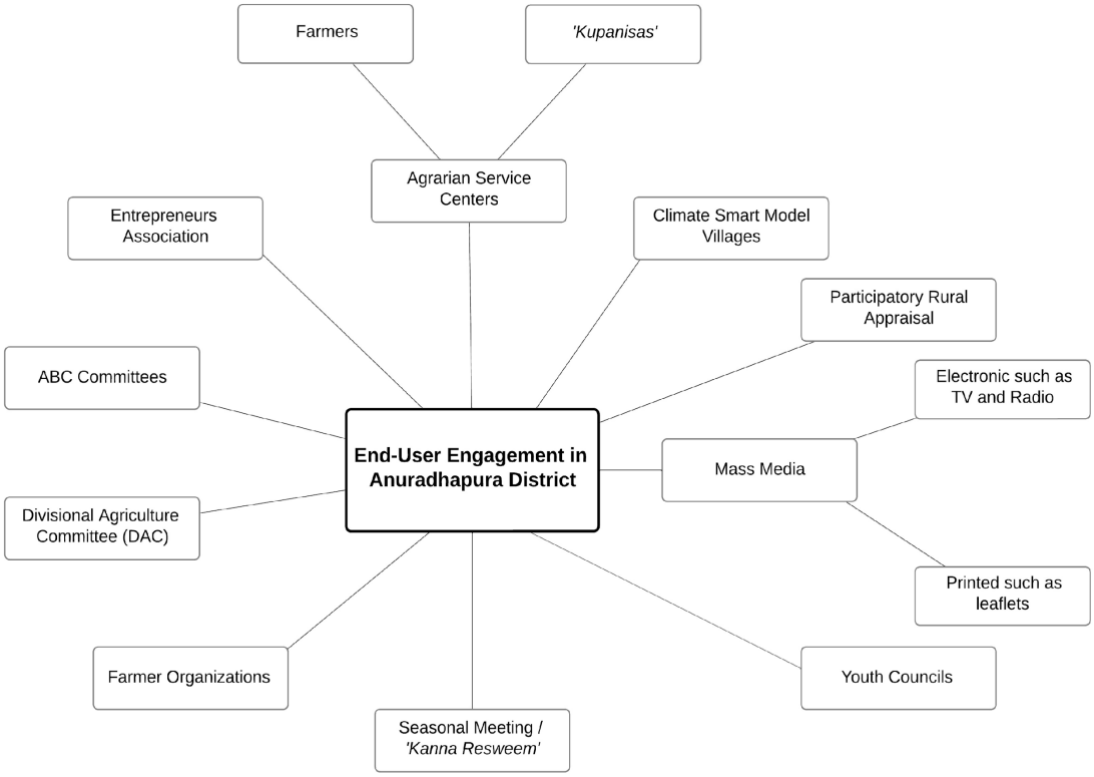


Figure 5-9: Mechanisms of end-user engagement in Anuradhapura district.

- **Current challenges and limitations of engaging end-users in the food security sector planning and mainstreaming:** Although numerous mechanisms exist for engaging end users, farmers' and communities' perspectives and recommendations are not adequately incorporated into planning and mainstreaming processes. The key informant A01 says, *"there might be challenges around whether we are bringing ideas from the end users from the ground level to the higher level. In most cases, officers are trying to do what they can and what they are interested in. There might be screening at the divisional and district levels."* Another challenge is that approaches such as participatory rural appraisal are time- and resource-intensive, so government entities and programmes may be unable to apply them. Key informant A01 highlighted this: *"I don't think the government can follow such a process. At the project level, we have our staff, which is costly."* Another issue is that the current extension system is fragmented, so bottom-up approaches are difficult to apply in engaging end-users in the planning processes. Another key challenge is the extension workers'

lack of technical knowledge and know-how. Although there are extension workers up to the village level, their technical knowledge of agriculture, food security, and planning processes is minimal. Another challenge is the attitude of government officials, who are not very supportive of community engagement. The key informant A04 explained this by saying, *"most of the time, government officials see community engagement as a barrier rather than a value addition."* Government offices and agencies like to find easy solutions. Another challenge is that community engagement is reported as completed with fake reports without real engagement at the local level. Key informant A09 explained this: *"there is a huge problem in Sri Lanka where false information is put in writing as it has been done. But if you check with the community to see whether they have such plans, they will say that they are not aware of them and are not involved".* Another challenge is that rainfed farmers are not organized, as no farmer organisations are associated with them. Therefore, there are no organised mechanisms to engage with them.

5.4.2.3.7 Appropriate planning unit and planning cycle for mainstreaming CCA and DRR into food security sector planning in Anuradhapura district

There are two parallel systems at the district level: provincial and central government systems. Key informants discussed the appropriate planning levels at the provincial, district, divisional, ecosystem, and Grama Niladhari (village) levels. Different key informants highlighted the pros and cons of different levels of planning, suggesting that it is important to have a well-coordinated system from provinces to districts to divisions to eco-systems and resource boundaries to farmer organisation levels. Several key informants highlighted that overall coordination could be done at the district level. However, the majority of them suggested that detailed planning, mainstreaming, and implementation can be done at a lower level, such as divisions, followed by cascades or scheme levels.

5.4.2.3.8 Recommendations for mainstreaming CCA and DRR into food security sector planning in Anuradhapura District

Climate change adaptation and disaster risk reduction have not been fully mainstreamed into the food security sector in the Anuradhapura district. As summarised below, key informants suggested multiple recommendations for mainstreaming CCA and DRR into the food security sector and integrated planning in the district.

- **Advocacy for change** is a key recommendation to facilitate mainstreaming and integrated planning processes in the district. Key informant A05 explained that attitudinal and positive change should occur at all levels to facilitate the process, saying, "*we must change our attitude and support positive change. We should encourage new ways of thinking and go beyond traditional modes of operation."* Key informant A06 also suggested that there should be a constitutional change through advocacy.
- **Communication and awareness creation** was another recommendation that key informant A05 made, specifically for farmers and local levels. New technology installed at the agrarian services centres, such as smart boards and disseminating information and communication materials through smartphones, etc., can create awareness among the extension workers, stakeholders, and farmers. The key informant further explained this issue: *"they don't like to change, and they don't like to use new technology or new ways of doing agriculture. We need to do a lot of awareness programmes for their attitudinal change."*
- **Data-driven solutions** were recommended by the key informant A05 as an important measure to advance mainstreaming. It includes technology transfer, dissemination of early warnings, and other related data for making informed decisions and facilitating the mainstreaming process at multiple levels.
- **The empowerment of local actors** is a critical area for supporting mainstreaming and integrated planning in the district, according to several key informants. Local actors are not fully aware of the mainstreaming needs, opportunities, and resources available to tap; therefore, they suggested empowering them to advance the mainstreaming of CCA and DRR into the food security sector. Explaining this further, key informant A01 said, *"if we can build the capacity of the provincial governments to access these external resources, then they will be able to access resources directly and implement priority programmes at the local government and provincial council levels."* Key informant A04 recommended to *"redefine the mandate of the institutions to support the integrated planning and mainstreaming processes."* According to key informant A06, government units such as district planning secretariats should be empowered to facilitate mainstreaming and integrated planning. The informant further explained that *"with a strengthened*

district planning secretariat, they will be able to facilitate and support the divisional level planning process." Key informant A07 recommended empowering officials at the local level to make decisions and set targets for the designated area, including technology transfer and the selection of economic activities, etc.

- **Financing and incentives** are critical requirements for mainstreaming and integrated planning. Key informant A01 recommended that the government tap into external resources such as the World Bank and get resources to implement the programmes at the local level. *"If they can tap into the SDGs and development banks, then they will be able to access additional resources for mainstreaming CCA and DRR into development planning processes,"* he explained.
- **Implementation, monitoring and evaluation mechanisms** are critical to facilitate the mainstreaming of CCA and DRR, according to key informants A03 and A09. Measuring effectiveness must be part and parcel of the master plan. According to key informant A03, institutional mandates and legal provisions are also required for establishing implementation, monitoring, and evaluation mechanisms. Key informant A09 also concurred on the need for a mandate and legal authority to establish implementation, monitoring, and evaluation mechanisms.
- **Knowledge generation and dissemination** is another important aspect for facilitating mainstreaming and integrated planning in the district, according to key informants A03 and A05. Key informant A03 explained the problem, stating that *"when we try to do everything without enough technical knowledge and partnerships, we will be setting ourselves up for failure"* and recommending that stakeholders increase their knowledge.
- **Leadership and supervision** are other critical recommendations for facilitating the mainstreaming of CCA and DRR in the district. According to key informant A02, *"leadership must look at these contemporary issues and be very visionary to identify long-term solutions."* There should be a sound policy framework to break down the silos and bring the high-priority areas forward. According to key informant A09, *"there are capable individuals, but there are no scaleups." We need to identify talented champions. We should give responsibility to those*

talented champions", indicating that the right leadership can transform and facilitate the planning and mainstreaming processes at the district level.

- **Multi-stakeholder coordination platforms** to facilitate mainstreaming and integrated planning were recommended by several key informants. Key informant A01 recommended strengthening the project steering committees chaired by the district and provincial governments, while key informant A03 recommended mobilising all responsible agencies under one umbrella. Key informants A05 and A06 also recommended strengthening the existing coordination mechanisms to support effective mainstreaming.
- **Policies and legal provisions** are required for effective mainstreaming at all levels, according to key informants A02, A07, and A09. Key informant A02 explained, *"if a particular policy covers mainstreaming, then we can go into specific action."* Key informant A07 recommended having *"legislation or parliament-level recommendations or a policy"* supporting the mainstreaming.
- **Scale-out good practices** are another important recommendation. According to key informants, emerging pilot projects in the district, specifically around climate-smart agriculture, can be scaled out across the district. Key informant A04 recommended it, saying that *"I would suggest that we take necessary measures to scale up and scale out the Climate Resilient Integrated Water Management project (CRIWM)."* Key informant A05 highlighted the potential for scaling up the extension work done by the agrarian services centres, while key informant A07 proposed scaling up the climate smart model village concepts for facilitating the mainstreaming processes at local levels. Key informant A08 recommended scaling up the *"Wew Gam Pubuduwa" (smaller and minor tank rehabilitation)* project.
- **Vision setting and strategic planning** were recommended by multiple key informants. Among them, key informant A01 recommended having a five-year strategic planning framework focusing on overall sustainable development in the district, while key informant A02 recommended a policy framework for longer-term planning. Key informant A03 recommended having a master plan for the district's development, while key informant A04 recommended restructuring and realigning administrative boundaries with natural resource boundaries so that plan implementation and problem identification would be easier. Key informants

> A06 and A11 recommended a planning system to mobilise and restructure district and provincial planning processes into a common system.

A recently conducted study also revealed that the impact of social networks, climate change awareness, climate change adaptation practices, and level of education all have significant (p0.05) implications on household food security (Sithumini et al., 2020). The negative effects of climate change were the most common motivator for farmers to change their farming practices in adapting to climate change impacts in the district (Wickramasinghe et al., 2021). According to the authors, most farmers employed supplemental reservoirs for water storage and irrigation as an adaptation method. 48 percent of farmers used early warning information. Among farmers' adaptive measures to climate change, increased utilization by insuring farm against risk was considered first and hence most significant. The second-ranked adaptation method was the use of supplemental reservoirs for water storage, the transition to shorter cycle crop types, and the planting of enhanced rice varieties. The last one was the change of harvesting periods. They further emphasize that the district's paddy farmers identified the following as the main policy and strategic interventions: developing and introducing new crop varieties to increase climatic tolerance; developing and/or strengthening early warning systems that provide daily weather predictions and seasonal forecasts; supporting the adoption of better irrigation and agriculturally related modern technologies; and disseminating local experience and knowledge. Due to monsoon delays, farmers utilize farm-level measures include altering the schedule of agriculture operations. To combat the seasonal variations in climatic factors, crop diversification and changing cropping intensity, which includes adjusting fertiliser and other inputs, different varieties, changing land use practices, moving the location of the crop, or changing the timing of activities are used. Additionally, farmers employ the *"Bethma"* system, which is regarded as a community-level approach (Alikhan, 2013). Auther further argue that information and resource sharing among key stakeholders including the farmer organizations, applying traditional and indigenous knowledge, establishing access to credits and financial tools, training and capacity budling to diversify income sources would positively contribute for mainstreaming climate change into the food security sector in the district.

5.4.3 Data Analysis of the Case Study 02: Polonnaruwa District

5.4.3.1 Description of the Case Study 02: Polonnaruwa District

Polonnaruwa district comprises seven divisional secretariat divisions and 294 GN divisions, with 141,451 families registered in the election registry in 2020 *(Department of Census & Statistics, 2022)*. Each divisional secretariat division has access to one or more government or private hospitals. 21% of GN divisions have a government or private school that offers classes up to GCE Advance Level, while 65% of GN divisions have a government or private school that offers classes up to GCE Ordinary Level or below. Piped water from a national water supply system or a community-based organisation is available in 62 GN divisions in the district (21 per cent). The majority of GN divisions report that wild elephants (66 per cent), droughts (62 per cent), storms and hurricanes (52 per cent), and floods (42 per cent) have caused damage within the last decade, as shown in Figure 5-10. Concerning social safety nets, 36,467 received "Samurdhi" programs, while 5,561 received elderly allowances ("Pin Padi") in 2020.

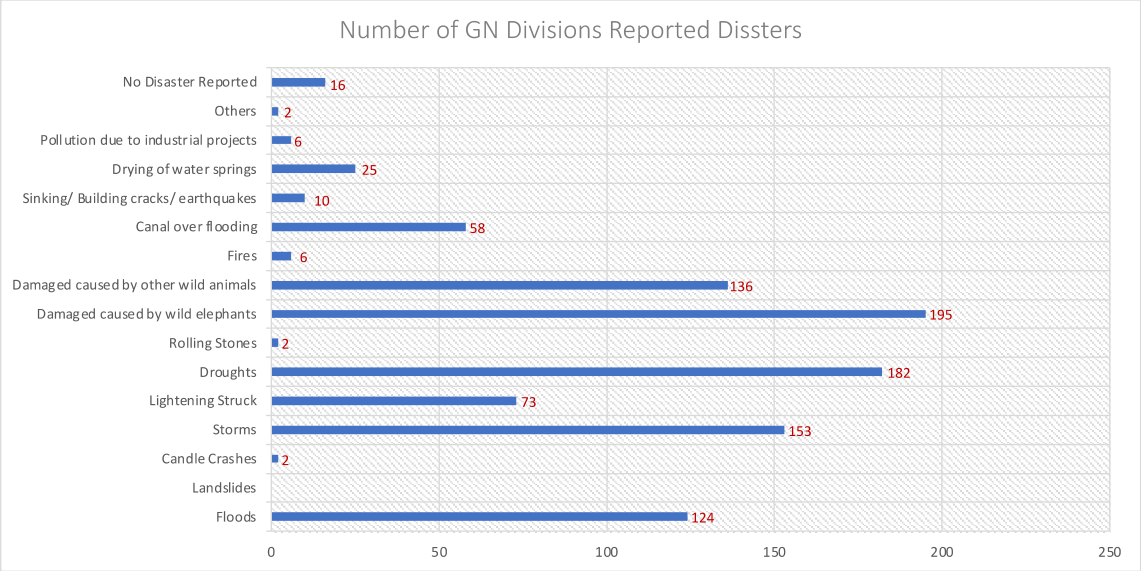


Figure 5-10: Number of GN divisions reported disasters in Polonnaruwa district over the past 10 years.

(Department of Census & Statistics, 2022)

According to the Department of Census and Statistics, most GN divisions are in crop production (237 GN divisions), 100 GN divisions are in livestock, and 45 GN divisions were in the fisheries industry in 2020. 109 GN divisions engaged in non-agricultural activities, as shown in Figure 5-11.

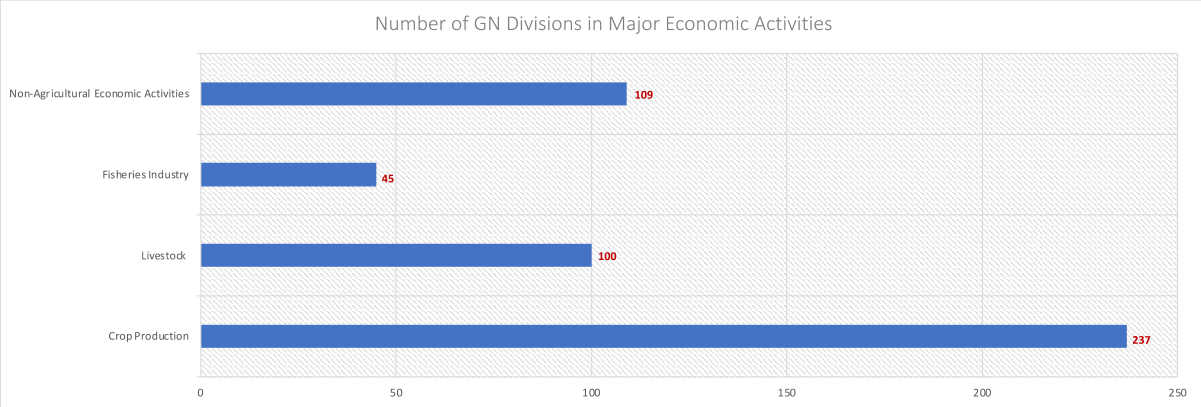


Figure 5-11: Major economic activities in Polonnaruwa district by GN divisions.

(Department of Census & Statistics, 2022).

5.4.3.2 Institutional Setup for Foods Security and DRM in Polonnaruwa District

The central government of Sri Lanka governs the Polonnaruwa district through the district secretary, also known as the government agent. The district government comprises representatives from line ministries and departments such as agriculture, irrigation, agrarian services, animal health and livestock, disaster management, meteorology, health services, wildlife, etc. The district regularly holds DCC meetings, mobilising all key stakeholder agencies, parliamentarians, and other elected representatives from local governments, farmer organisations, and cooperative societies.

The district secretariat coordinates cross-cutting issues, including disaster management, climate change adaptation, and food security, with technical assistance from respective line departments and agencies at the district level. The district disaster management committee has been established, but it is not operational unless there is a crisis or a disaster. A district disaster management coordinating unit reports to the district secretary while also liaising with and reporting to the DMC at the national level. The Disaster Management Act includes provisions that help with disaster management coordination and implementation at the district and sub-district levels. Apart from agriculture production, coordinated by the Agriculture Department and the Agrarian Services Department, there is no dedicated institution for facilitating CCA in the food security sector. Divisional and GN-level disaster management committees should be formed, but those should be more active and functional. Irrigation, agriculture, agrarian services, and other food security-related agencies collaborate with divisional offices and farmer organisations to plan and implement annual and seasonal programmes based on national targets. Major irrigation schemes irrigate rice and other field crops. DACs and the DCC coordinate agriculture production issues and planning decisions with input from technical

agencies, elected representatives, and farmer organisation representatives. United Nations agencies such as UNDP, international NGOs, local NGOs, and community-based organisations operate in the district to support various DRM and CCA projects and initiatives. Still, on a smaller pilot scale, their impact is yet to be seen.

Polonnaruwa is one of the districts in North Central Province (NCP) that suffers from droughts on a regular basis. Agriculture is the primary source of income for 73% of the people in the province, and they are regularly hit by drought. However, there is no agency primarily responsible for drought, and the government has no drought management policy or early warning system (Gunawardhana & Dharmasiri, 2015).

The following section provides specific details and analysis based on interviews with key informants (semi-structured interviews) in Case Study 2.

5.4.3.3 Analysis of the Key Informant's Interviews Data from Case Study 02

5.4.3.3.1 Food Security Status in Polonnaruwa District

Food security status was examined using data gathered from key informants, focusing on four dimensions of food security: food availability, access, utilization, and stability. Polonnaruwa district is the country's highest rice-producing district. Polonnaruwa district has four major irrigation schemes, which are "Kaudulla," "Minneriya," “Parakkrama Samudraya,” and “Girithale” tanks. In addition, irrigation water also comes from the “Maduraoya Reservoir” in the Ampara district and the “Moragaha Kanda Reservoir”. Thus, the district is considered a major rice-producing district in the country, given the feasibility of cultivating rice during two seasons of the year. There are several rice millers and wholesalers in the district as well. Therefore, staple food, like rice, is available and secure compared to other districts.

Key informant P05 explained the current food availability in the district: *"rice production in the district is much higher than in other districts. Regarding other field crops, it becomes the third or fourth in the district rank; therefore, food production is much higher."* Key informants P01, P02, P03, P04, P06, P07, and P08 also concurred with the same views, saying that the district is the highest rice-producing district in the country, so the quantity of staple foods is secured to a greater extent. However, key informant P08 highlighted that food diversity is low as most farmers engage only in paddy cultivation, saying that *“it is purely a paddy cultivating district. Therefore, other field crops are not cultivated much in the district. When you look at the food diversity, we are slightly below because we don't have diversity through other field crops."*

Concerning food access, key informants P01, P04, and P08 discussed the issues related to price fluctuations, market access issues, and income losses. Key informant 01 explained the issue, saying that *"sometimes vegetable prices are very high and cannot be offered by poor communities. It can range from 60% to 70% or even 100%."* According to the key informant, price fluctuation is due to rains, droughts, or other disasters leading to production losses. Key informant P01 had questions about food stability, saying, *"one of the main concerns is whether they can get such a quality diet throughout the year. We cannot believe it."* Farmers are engaged in two main seasons, so their production and income are seasonal. If disasters, climate change, and other external shocks trigger, food stability will be impacted, according to key informant P08.

Regarding food utilization, multiple key informants felt it was a serious concern in the district. Key informant P01 explained the lack of nutritional diets by saying, "*people sometimes might take the quantity, but they don't have the quality and nutrition value. They lack understanding and have no quality assurance programs."* Key informant P04 discussed the safety side of food, suggesting that "*there is an issue around the quality of food in the district. We have been using excessive chemical fertilisers for the production, and the food might not be healthy and safe."* Key informants P08, P06, P05, and P03 discussed the lack of food diversity in the district due to monoculture, which they believe impacts food utilisation.

Polonnaruwa district is one of the major farming districts in the dry zone of Sri Lanka. The livelihood of farmers mainly depends on crop cultivation. Farmers cultivate paddy as the main crop in both Yala and Maha seasons and face water shortages very often and couldn't fulfill agricultural practices mainly in Yala season, leading to food insecurity (Nilakshi & Rajendran, 2023). In the Polonnaruwa district, the average yield of paddy grown under major irrigation is frequently 6 to 8 percent greater than the national average. Additionally, compared to the Medirigiriya and Dimbulagala's average yields show a shows yield compared to rest of the district, contributing to food security within the district (Wijesooriya et al., 2021). The district of Polonnaruwa has consistently been less vulnerable and more food secure than other districts in the country, and it fared relatively better food security before the floods or other disasters (WFP, 2011a).

5.4.3.3.2 Observed Climate Changes in Polonnaruwa District

Multiple key informants expressed that the district has already observed and felt climate change. Among them, precipitation changes are the most commonly felt climate change impact, according to the key informants. Rainfall duration, intensity, and seasons have all changed,

resulting in climate extremes such as too much precipitation in a short period or lengthy drier periods with no regular onset of rainfalls. Key informant P04 explained this issue: *"we observed the rainfall changes in the district. In the past, we knew what would happen in December, but now it's challenging to predict. Sometimes rain gets delayed, and later excessive amounts of rain lead to floods also."* Key informants P01, P05, P07, and P08 also explained and expressed their concerns about precipitation changes in the district, and they believe it is due to the impacts of climate change. Key informant P07 explained the changes in precipitation in the district, saying that *"we feel like for the last 6–8 years, the situation has changed, and we don't get as many floods as we used to get. December-January rainfall has decreased during these years"*. Key informant P03 viewed that temperature changes are also being experienced in the district, saying*, "I feel like the temperature has been reducing for the last few years. When we were young, we felt like it was so hot. I feel like the environment is not as hot and dry as it used to be."* Therefore, key informants concluded that precipitation and temperature changes are common impacts of the climate change observed in the district.

The temperature difference between day and night in Polonnaruwa has increased dramatically (Yala: 0.066°C year−1, Maha: 0.0465°C year−1). There was a clear link between the occurrence of extreme rainfall occurrences and ENSO episodes (Sathischandra et al., 2014). Based on the data analyzed from 1979-2023, it is evident that the temperature and yearly precipitation trends are positive, and Polonnaruwa is becoming warmer and wetter as a result of climate change. It is also evident that temperature anomaly due to global warming and precipitation anomaly since 1979 due to climate change (Meteoblue, 2023).

5.4.3.3.3 Climate and Disaster Nexus in Polonnaruwa District

According to multiple key informants, drought is the most common climate-induced hazard in the district. Key informant P01 has expressed that drought has become an annual phenomenon in the district. He further explained, saying, *"we had continuous droughts in the district. Usually, we get a severe drought every three to four years. So, we feel climate change is happening, but it's slowly happening in our district."* Key informant P05 explained how the drought has changed, saying, *"we didn't experience this level of drought situation in the past years."* Key informants P02, P03, P07, and P08 also expressed their views, explaining that drought has become a regular phenomenon in the district due to climate change.

According to the key informants, the district recently experienced unusual flooding. Key informant P01 explained this situation: *"during the last few months of the season, there was a huge rain that we even thought would lead to floods."* Key informant P05 explained the

flooding situation in the district, explaining that "*there were floods in 2012, 2013, 2014, and 2015."* Key informants P02, P03, and P07 also concurred on the increased flooding situation in the district, and they believe it is due to the impacts of climate change.

Pests and diseases are also believed to be induced by climate change in the district when an extended dry period occurs. According to key informant P01, *"during the dry period, we also experienced pest attacks such as brown planthopper."* Key informant P03 explained it further: *"I feel like pests and diseases have increased. Attacks by 'Brown Leaf Hopper' and 'Rice Yellow Stem Borers' have increased. I don't know whether it is because of climate change, but it is more frequent and regular than in the past."* Key informants P04, P05, P07, and P08 concurred on the same issue, saying that pests and diseases have increased in the district during the last several years, indicating a possible nexus with climate change.

Wild animal attacks are common in the district and are induced by climate change. Key informant P01 explained this hazard, saying, *"there is a huge impact from monkeys, wild boars, and peacocks on production, and that has been a major issue because they directly damage production and harvest. On average, about 30% of the harvest and production get lost because of wild animal attacks"*. Key informant P05 explained the impact of the wild elephant attacks on food production, saying that *"wild elephant attacks severely affect the food security in the district. The number of wild elephants coming into the village keeps increasing, so the physical damage keeps increasing."* Key informants believe there is a direct link between climate change and wild animal attacks, as dryer periods and the lack of animal food induce their attacks on agricultural lands.

According to key informant P05, the district also faces tornadoes and high winds as major climate-induced hazards. Sometimes several villages get damaged by high winds and tornadoes. The key informant explained this, saying that "this is one of the main issues in the district."

According to recently conducted research, there is meteorological, hydrological, agricultural, and socioeconomic drought in the North Central Province, including Polonnaruwa distri, and 44 percent of rsponded in the research conclude drought as a result of a lack of rainfall within the projected time frame. 50% of people feel that the drought happened as a result of forest damage (Gunawardhana & Dharmasiri, 2015). In a recent study covering the Polonnaruwa district, the drought index assessed the 2016/2017 drought as a medium drought when compared to previous droughts based on rainfall deficits. This specific drought has been building up since the beginning of 2016, and it can be punctuated by floods in some regions, as happened in the south-west of the country for roughly a week which indicate possible climate

change nexus (Lokuhetti et al., 2017). Floods is another frequent disasters affecting number of villages in the district, and reported severe floods in the year, 2011, 2014 resulting hardships and widespread economic losses (IFRC, 2011) (UNOCHA, 2014) (News.lk, 2024).

As the district is exposed to climate change and climate-induced disasters, the following section discusses the vulnerability of the food security sector to them.

5.4.3.3.4 Vulnerability of Food Security Sector to Climate Change and Disasters in Polonnaruwa District

Food availability, access, and stability are affected due to climate change and climate-induced disasters. Food security predominantly depends on district agriculture production, livestock, and fisheries. Climate change and climate-induced disasters affect production in these subsectors. Key informant P02 explained this vulnerability by saying, "*food security in the district is purely dependent on agriculture and irrigation systems. Climate change is having a significant impact on the district. Our food security depends on rainfall. If there is a drought, it will impact food security in the district."* Key informant P01 explained the vulnerability of the access dimension, mainly due to the price fluctuation, saying that *"agriculture products and food prices are rapidly fluctuating in Sri Lanka. The main reason for price changes is climate change and disasters. Production gets changed despite our planned cultivation targets due to water stress, drought, floods, or climate change impacts."*

Drought in Polonnaruwa district has had an impact on agriculture, water resources, drinking water and food production, the environment, and household income, thereby affecting the food security of the people (Nianthi, 2018). However, Polonnaruwa district has emerged as least vulnerable agriculture district to climate change due presence of major and medium irrigation schemes (Niranjan et al., 2015). During the raining seasons, paddy fields get inundated, for example in the month of November, paddy fields get inundated several times exceeding 10% of paddy lands of the district (ReliefWeb, 2013).

In addition to the inherent vulnerability of the sector due to its heavy dependency on water and weather parameters, the food security sector has multiple systemic vulnerabilities identified by the key informants, as discussed below.

- **Data and data reliability issues** are the significant factors contributing to the systemic vulnerability of the sector. No data is available to assess impacts and risks, according to key informant P1. He further explained this issue: *"even we don't know which areas will be flooded or affected by droughts in our districts,*

so we don't have those details and risk profiles." Key informants also discussed the lack of data and information regarding climate forecasts and early warnings before five to six months, making the sector even more vulnerable to climate change and disasters.

- **Early warning and forecast issues** are other challenges in the district. Key informant P01 explained, saying, "I don't think our forecasting and early warning have been developed to the level it should have. So, climate change directly impacts the agriculture sector". Key informant P02 further explained the current situation saying that "even irrigation department and technical agencies are not looking at future climate scenarios or climate impact to decide the thresholds of reconstruction and renovations of tanks". Key informant P05 explained the uncertainty in the future without having future forecasts and information.
- **The fragile supply chain** is another key issue in the district that contributes to the overall vulnerability of the sector. According to key informant P05, there is no system to maintain excess production in the district. The key informant said, *"we don't have dry and cold storage in the district*. *Huge production loads get lost in wholesale markets such as Dambulla"*, indicating that a lack of supply chain and storage facilities makes the sector more vulnerable.
- **Inadequate institutional and human resources capacity** is another main issue in the district. According to key informant P01, there is no capacity within the current institutions and experts responsible for forecasting. He further emphasized, *"when we plan for cultivation, we don't know whether there will be floods or droughts, or whether we should move away from those areas to other areas, and so on". We don't have that information because we don't have a reliable forecast,"* indicating that the lack of capacity leads to a more vulnerable food security sector in the district.
- **Lack of production planning and buffer stock** is also a major systemic vulnerability of the district, according to key informant P01. Paddy Marketing Board (PMB) is primarily responsible for purchasing additional rice and stockpiling them as a buffer stock against shortages and price fluctuations. There are no such schemes and programmes for vegetables and other field crops. Key informant P01 explained the issue: *"there is no trust from people in the Paddy Marketing Board. There is a rice mafia in the private rice millers' industry in Sri*

Lanka. So, if we have a buffer stock, we can face such shortages due to disasters or the private sector mafia". Furthermore, a lack of production planning, buffer stocks, and storage facilities leads to higher post-harvest losses, making the sector further vulnerable.

- **The lack of social safety nets and compensation mechanisms** is another key vulnerability of the food security sector in the district. Key informant P05 explained this issue by saying that "*there is no mechanism for relief distribution and compensation when disasters affect the production and harvests,"* which make the food security sector further vulnerable.
- **Negative coping mechanisms** have made the food security sector further vulnerable to climate change and climate-induced disasters in the district. Key informant P01 explained this issue by saying, *"in the old days, most of the villages had around 90% of their food secured because they had the traditional coping mechanisms and systems in place. They had storage called 'Wee Bissa', where Paddy was stored for later use. They also had a dryer called 'Dum Messa', which is a smoke dryer rack above the cooking place to dry and store some foods such as jak fruit, breadfruits, etc. They also had traditional ways of storing potatoes and sweet potatoes for an extended period. Likewise, there were many traditional coping mechanisms to store and ensure food security in the rural setting."* The sector's vulnerability further increased when such good practices were no longer followed.
- **Risk knowledge, awareness, and perception** are other issues in the district that makes the food security sector further vulnerable. According to key informant P02, *"there is no understanding of climate change adaptation and disaster risk reduction. I don't think grass-roots people feel this issue yet, and the politicians do not feel this as well".*

Such systemic issues make the food security sector further vulnerable to climate change and climate-induced disasters in the district. The following section discusses limitations and bottlenecks for mainstreaming CCA and DRR into food security sector planning in the Polonnaruwa district.

5.4.3.3.5 Limitations and bottlenecks for mainstreaming CCA and DRR into food security sector planning in Polonnaruwa district

Food security sector planning is in its early stages in the Polonnaruwa district. Climate change and disaster risks are not considered, while planning mainly focuses on crop production based on the targets set by the respective national agencies. Key informants identified the following specific limitations and bottlenecks for mainstreaming CCA and DRR into the food security sector:

- **Attitude and the human factor** are the main bottlenecks for mainstreaming CCA and DRR into food security sector planning. Key informant P02 explained the negative attitude of the public servants, explaining that *"most of the offices just keep blaming the politicians and not doing anything. Our country has no motivations or performance-based salary systems, so they don't do their job."* Sometimes the existing institutional set-up also contributes to this issue. Provincial and district governments have parallel systems, which create attitude issues between them, making mainstreaming difficult. Key informant P05 explained this issue: *"different departments don't like to work with each other. They would like to focus on their mandate. They sometimes believe that they might get reduced allocations if they coordinated and worked with others*". Key informant P07 also concurred on the same barrier for mainstreaming CCA and DRR into the food security sector in the district.
- **The disconnect between early warnings and their applications at local levels** is another key limitation for advancing mainstreaming processes. According to key informant P04, the lack of long-term climate forecasts impedes the integration of CCA and DRR into food security sector planning processes.
- **The disconnect between the national and local needs** is another hindrance to mainstreaming CCA and DRR into the food security sector in the district. Key informant P05 explained that national-level guidelines for mainstreaming have not been conveyed to the respective line agencies at the district level. Key informant P06 also highlighted the lack of national-level programmes for mainstreaming, which hinders potential initiatives at the district and local levels. National frameworks such as the SDGs and their implementation at the district level are not connected and communicated well, according to key informant P07.

Key informant P08 explained the issue: "*we all are trying to deliver on the targets that we are getting from our line departments each year. Because of that focus, we cannot focus on integrated planning as we are more focused on our department targets, which come from the national level",* indicating the disconnect between national frameworks and local needs.

- **Fragmented approaches to mainstreaming** are other key barriers in the district. According to key informant P01, agriculture, irrigation, and other related departments in the food security sector do their planning in isolation. The key informant further explained, saying that "*our implementation arrangements are in silos, and institutions do their own thing, and whenever they face an issue, the government tries to intervene and implement patchwork and short-term solutions on a case-by-case basis rather than having an integrated planning process."* Key informant P02 also concurred on the current issue of fragmented planning. Key informants P04, P06, P07, and P08 also discussed fragmented approaches to planning as one of the main hindrances to mainstreaming CCA and DRR into the food security sector.
- **Governance issues** Specifically, the two parallel systems of provincial and district governments create significant challenges for mainstreaming DRR and CCA into the food security sector plan, according to key informants P03 and P05. Furthermore, key informant P05 explained that mandated institutions, such as the National Disaster Management Council, have not met in several years, resulting in a situation where policy directives are not reaching district and national agencies to facilitate mainstreaming processes.
- **Lack of accountability** is another key barrier to mainstreaming in the district. Although there are coordinating committees such as the DCC, there are no progress review mechanisms for mainstreaming and no accountability for such measures, according to key informant P01. Key informant P02 explained that mainstreaming is difficult without accountability and performance measurement frameworks. Key informants P05 and P07 also explained the issues related to the lack of accountability, which hinders the mainstreaming processes in the district.
- **Lack of data and evidence** is a key bottleneck for mainstreaming CCA and DRR into the food security sector in the district, according to key informant P01. He further explained this barrier: *"we are failing in our food security because we*

don't develop our plan based on the data, historical evidence, and the future forecast." Key informant P05 explained the absence of a theory of change and related evidence to demonstrate the progress, which also affects the mainstreaming processes in the district. Key informant P07 also expressed that poor data availability and reliability cause significant challenges for mainstreaming in the district.

- **Lack of financial solutions and resource use efficiency** impedes mainstreaming processes. There is competition among the agencies for resources; therefore, they do not coordinate and collaborate, thinking that mainstreaming will reduce the allocations coming to their respective sectors. They explained the issue by saying, *"they always try to get maximum allocations and make sure that they get their resources rather than getting resources for the overall development process, so they don't like to go for integrated planning and resource allocation."* Key informant P06 explained the issue of limited resources, and now they only focus on day-to-day maintenance rather than mainstreaming and longer-term planning based on climate forecasts.
- **Lack of leadership** is another key barrier to mainstreaming CCA and DRR into the food security sector in the district. Key informant P07 highlighted the issue: *"there is no vision, or either they are tired, so they are not interested in doing integrated planning. I believe that if these people can be re-energized, then we will be able to change,"* indicating that positive change and mainstreaming CCA and DRR into food security sector planning requires leadership.
- **The lack of mechanisms and mandated institutions** for mainstreaming is another issue in the district, according to key informant P04. The main reason for the lack of progress in mainstreaming is the lack of institutional mandate, legal provisions, and regulations. For agriculture, there are several organizations, such as the Mahaweli Development Authority, the Agriculture Department, the Agrarian Services Department, the Irrigation Department, the Provincial Agriculture Department, etc. Sometimes there is confusion about the responsible agency for this mandate and the subject area. Key informant P05 also highlighted the issues and confusion about roles and mandates for mainstreaming DRR and CCA into the sectors.

- **Lack of policies and legislation** also hinders the mainstreaming efforts in the district, according to key informants P01 and P06. The key informants highlighted this issue: *"the main reason for not having an integrated plan is the lack of policy at the national level. If there is a mainstreaming policy, then all institutions will be working according to that policy and supporting the implementation of that."* Key informant P06 highlighted the need for a national programme for mainstreaming so that all district-level organisations can be mobilised based on that.
- **Lack of scale-ups and scale-outs** is another challenge for the food security sector planning and incorporating CCA and DRR into it. Key informant P01 explained this issue by saying, *"there are only small-scale efforts when there are problems, but there are no integrated programmes and mechanisms to scale out good practices across the district".*
- **The lack of tools and methodologies** is also a hindrance to promoting mainstreaming efforts in the district. Key informant P01 highlighted the issue, saying that *"we don't see the national agencies, those who are directly and indirectly related to disaster management, climate change, and food security, taking enough actions to develop appropriate planning guidelines to be implemented at the local level."* Key informant P04 also explained the issues, saying that the district does not have the knowledge base, expertise, skills, and tools for mainstreaming DRR and CCA into the food security sector as these are emerging areas in the district.
- **Multi-stakeholder coordination issue** is another bottleneck for mainstreaming CCA and DRR in the district. Mainstreaming CCA and DRR into the food security sector requires collaboration and coordination between multiple sectors and actors in the district. However, according to key informant P01, *"implementation arrangements are in silos, and institutions do their own thing."* Key informants P03, P04, P05, and P08 also discussed the multi-stakeholder coordination issues that led to duplication of efforts and a lack of progress in mainstreaming CCA and DRR into the food security sector.
- **Political interference** is another hindrance to mainstreaming in the district. According to key informant P02, "fragmented planning processes are there in the district. It is purely due to political agendas in the country. The only target is to

win the next election. Therefore, they only focus on populous programs, which hinder mainstreaming processes". Key informant P03 also emphasised how political interference could derail the district's mainstreaming priorities, stating, "we don't have long-term plans, and we do base on what the minister says". Key informants P05, P06, and P07 also discussed how political agendas and interferences hinder the mainstreaming processes because priority activities cannot be implemented under such influences.

- **Lack of technical knowledge and know-how** is another key barrier to mainstreaming in the district. Key informant P03 explained the issue: *"we don't have integrated programmes and experts in the agriculture sector in Sri Lanka. One of the main reasons our agriculture is not moving forward is that we don't have enough experts in the sector,"* indicating that mainstreaming will be a daunting task for the district without such experts.

Droughts are common in the Polonnaruwa district, causing difficulty for 73 percent of the people who rely on agriculture for a living. However, there is no agency primarily responsible for drought, and the government has no drought management policy or early warning system (Gunawardhana & Dharmasiri, 2015). Brokers play a major role when paddy stocks are scarce in the Polonnaruwa district. The investigation discovered that value addition occurs exclusively at two places along the value chain: at the farmer and miller levels. Farmers' value addition at the farm gate was around 13% of the cost of production, which is the cost of drying paddy to standard grade (14 percent moisture). The lack of an effective method for drying paddy is a big issue for farmers. At the moment, one side of the carpeted road is dedicated to this function which demonstrate the lack of infrastructure and technology in the food security sector (Wijesooriya et al., 2021). Authors further highlights that in 2011, it was discovered that one community had three paddy collection centres. However, the number of collection centres at the village level has decreased in recent years, giving way to approximately 20 multifunctional purchasing and selling centres in one Divisional Secretariat for purchasing paddy, selling agro chemicals, fertilisers, seeds, and occasionally hardware items. In the North Central province, including in Polonnaruwa district, lack of reservoirs capacity and emptying, water shortage, lower reach of irrigated water and decreased paddy production leading to higher rice prices nationwide are some of the key structural vulnerabilities which lead to food insecurity far beyond the district (Harvard University, 2018). According to the authors, poor households are unduly reliant on domestically cultivated paddy for calory intake, and food insecurity is on the

rise as a result of periodic droughts and floods. Furthermore, the district's well-being lags well behind that of the country's capital, and conventional agricultural income is becoming increasingly fragile due to climate change.

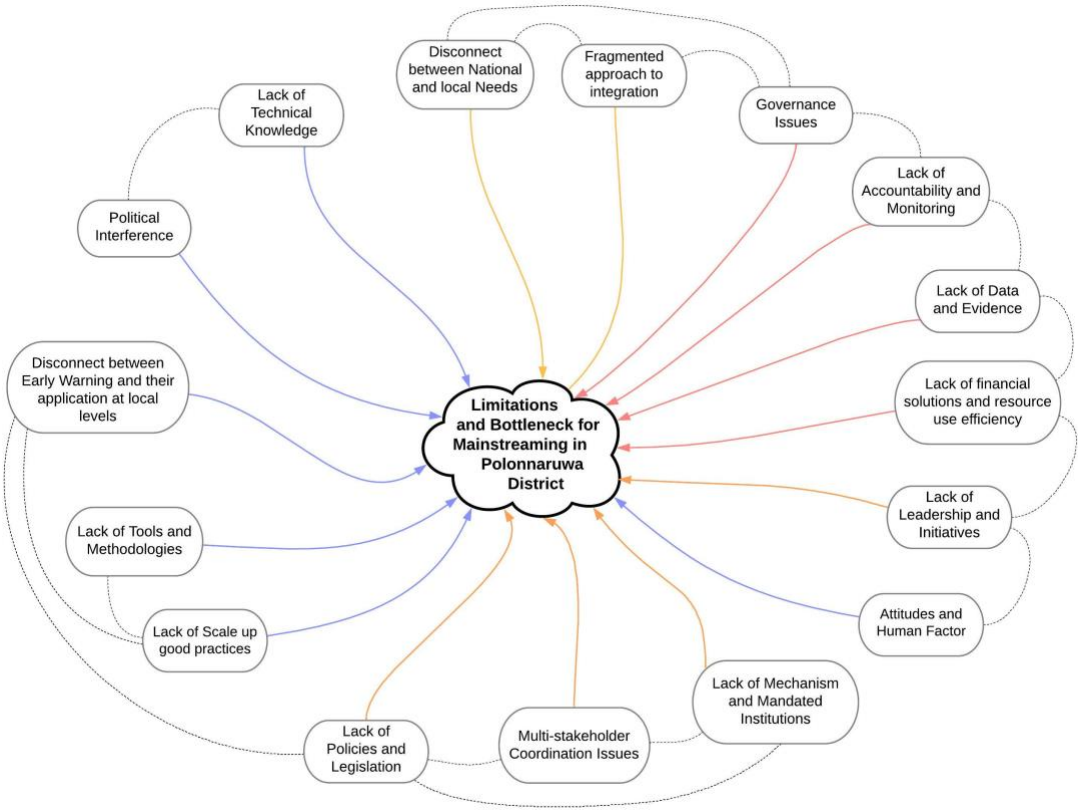


Figure 5-12: Limitation and bottlenecks for mainstreaming CCA and DRR into food security sector planning in Polonnaruwa district.

As demonstrated in Figure 5-12, having discussed key barriers and bottlenecks for mainstreaming CCA and DRR into the food security sector in the district, the next section discusses how end-users can be engaged based on the current practises and approaches.

5.4.3.3.6 End-user engagement for mainstreaming CCA and DRR into the food security sector in the Polonnaruwa district

The Polonnaruwa district has various mechanisms and instruments for engaging end-users. There are numerous challenges and limitations in applying them, as discussed below.

- **Current practices of engaging end-users in the food security sector:** According to key informants P02, P04, P05, P06, and P07, several mechanisms exist for engaging with end-users. One of the most crucial mechanisms is the

seasonal meeting (Kanna Resweema), which takes place at the district level and brings key departments, such as agriculture, agrarian, irrigation, and other related departments and farmer associations. They together discuss the overall planning process for the upcoming season and make key decisions. Another mechanism is the DAC, which meets at the divisional secretariat to discuss key issues and solutions with divisional stakeholders, officers, and farmers. Farmers participate in both forums and are involved in decision-making processes. Another common mechanism is the village-level committees and GN-level officials to engage and gather data for various district-level plans and instruments. In terms of agriculture and food security, farmer organisations are the most active, recognized, and popular form of end-user engagement in the district. Key informant P08 explained this further: "*we have one farm organisation per tank. If there is no tank in that village, we have a farmer organisation for the GN division. The farmer organisations are directly involved with the Agriculture Extension Workers (KUPANISA) at the GN level. We also have women's farmer organizations. So, we get information from committees, farmer organizations, and women-led farmer organizations".* Politicians also introduce ad-hoc mechanisms to engage end-users. For example, the former president introduced *"Gama Samaga Pilisadara"* (dialogue with villages), and suggestions and proposals were sought from the villages through engagement with the President and district stakeholders. However, this programme was short-lived as the President was removed last year. Figure 5-13 demonstrates mechanisms of end-user engagement in the Polonnaruwa district.

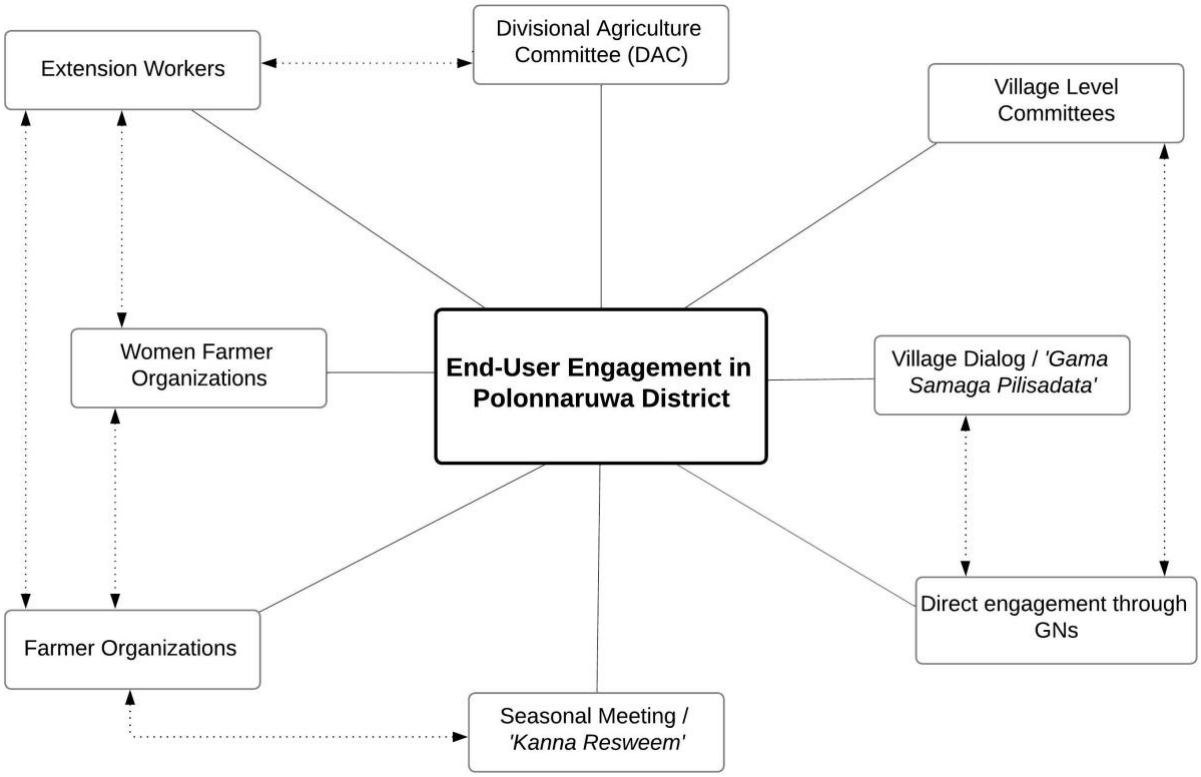


Figure 5-13: Mechanisms of end-user engagement in Polonnaruwa district.

- **Current challenges and limitations of engaging end-users in the food security sector in the Polonnaruwa district:** It is recognised that there are several mechanisms for engaging end-users; however, the views and recommendations of farmers and communities are not adequately considered in the planning, mainstreaming, and implementation processes. Explaining this further, the key informant P04 says that *"at the district level, for most of the plans, we get the input from the community level. But I cannot say how much inputs will be incorporated into the plan finally, but there is a mechanism to get their input."* According to the key informant P01, end-user engagement is as low as 10%. He further said that there are conflicts of interest among farmers as well. He further explained that *"when it comes to farmers, they are not as genuine and pleasant as we think. When you work with them, you will feel how selfish they are. They are more focused on the individual gains than the system-level gains."* Another challenge is that most GN-level officials and extension workers are women. There are practical challenges in engaging with end-users and farmers in the field, according to key informant P02. The key informant P02 further explained that the traditional effective engagement mechanisms, such as using temples, have

diminished over the years, making them even more difficult. He explained the issue, saying, *"in the past, we were able to do such engagement through the temples, and the temples had a lot of influence on the village and community members. But now, power has been reduced because monks and priests have also engaged in politics"* Key informant P03 explained the lack of recognition for farmers and their voices, saying, *"farmer voices are not recognised in our country, especially in the agriculture sector. Whenever they express their opinion, they are neglected in the planning or implementation."* The key informant expressed that although current systems and mechanisms for engaging the end-users exist, the district has practical implementation challenges, so engagement is very low.

Having discussed the current practises and mechanisms for engaging the end-users and related challenges, the following section discusses the appropriate planning unit for the district based on the opinions and suggestions of the key informants.

5.4.3.3.7 Appropriate planning unit and planning cycle for mainstreaming CCA and DRR into food security sector planning in Polonnaruwa district.

At the district level, there are two parallel systems: provincial governments and institutions of the central government. The appropriate planning levels were discussed by key informants, looking at the provincial, district, divisional, ecosystem, and farmer association levels. Key informants highlighted the benefits and drawbacks of various levels of planning, indicating the importance of having a well-coordinated system from the provincial to community levels. Most key informants stated that the appropriate and most practical planning unit should be at the divisional level. Key informant P01 recommended the planning unit, saying, *"the best would be to start at the divisional level and then come to the district and then go to the national level. This is how our administrative structure has been organised in this country. So, if we plan this way, that would be easy to implement"*. Key informant P04 concurred that the *"divisional level is the best for integrated planning and mainstreaming. We can target that division well for planning, and it's a good size geographically."* Key informants P05 and P08 also recommended divisional-level planning as the best suitable unit considering the level of stakeholder engagement, size, and available resources.

5.4.3.3.8 Recommendations for mainstreaming CCA and DRR to food security sector planning in Polonnaruwa district

Climate change adaptation and disaster risk reduction have not been fully mainstreamed into the food security sector in the Polonnaruwa district. Key informants made multiple recommendations for mainstreaming and integrated planning in the district. These are discussed below.

- **Advocacy for change** is one of the key recommendations given by key informant P02, who suggests that "if you have to change this from the bottom up, there should be a movement. So, I believe this grass-roots movement is impossible in countries like ours. Therefore, I believe it has to be a top-down approach," indicating that advocacy is vital in mainstreaming CCA and DRR into the food security sector.
- **Avoiding standard-alone planning processes** is another critical recommendation to facilitate the mainstreaming processes given by key informant P04. He explained this by saying, "*it has to be mainstreamed into a common plan. They believe DRR and CCA should be mainstreamed into the overall, sectoral, and national plans. It is inappropriate for Mahaweli, Irrigation and District Secretariat, Wildlife, and other individual agencies to prepare their plans. Sometimes these plans overlap. There is no mainstreaming".*
- **Communication and awareness creation** is another recommendation given by key informant P03, who suggested that there should be a proper agriculture extension system to bring all these stakeholders onto a common platform and bring the common messages to the farmers at the local level.
- **Creating and recognising champions** is another recommendation to promote mainstreaming CCA and DRR in the food security sector. According to key informant P01, *"leadership must also be linked with their career development, either through promotion or being properly rewarded for those who implemented integrated plans to achieve food security*." The key informant emphasised that individuals should be rewarded for their contributions to food security.
- **Data-driven solutions** were also recommended for strengthening the mainstreaming processes in the district. Key informant P07 highlighted this need: *"we should have access to data. We should have reliable data. We should be able to forecast the climate outlook to incorporate such issues into development*

plans". Key informant P08 also recommended establishing a database and data collection system and their utilisation for food security sector planning and the mainstreaming of CCA and DRR.

- **Diversification of expertise** was recommended by key informant P06, who said there should be an expert panel to identify mainstreaming needs and processes. The key informant said such a panel should lead the restructuring of the country's existing planning processes to ensure it is climate and DRR-inclusive.
- **Empowerment of local actors** was recommended to facilitate mainstreaming processes in the food security sector. Key informant P01 recommended giving authority and accountability to the lowest level so that they would be able to plan and implement programmes effectively. Key informant P02 also recommended empowering the government service at the lower levels, such as GN-level officials, and using them for economic development. P04 and P07 key informants also suggested empowering local and district-level officials for planning and decision-making processes rather than relying heavily on the national system. They further suggested the district secretary should be empowered to make policy decisions at the district level and take district development forward.
- **Implementation, monitoring, and evaluation** system strengthening were recommended by key informant P05, who suggested such systems could be integrated into the DCC. Furthermore, the key informant suggested that necessary guidelines and policy directives should come from the national level so that local agencies can implement, monitor, and evaluate them effectively.
- **Market-based solutions** were recommended by the key informant P03, who highlighted the need for establishing a system to decide the market and prices for food products. He said, *"there is no market control system and no government interventions for price control. The current system is quite fluid. There should be a mechanism to decide the prices involving all these actors, such as wholesalers, farmers, transporters, retailers, etc*.
- **Multi-stakeholder coordination platforms** were recommended by Key informant P03. He further explained the current issue: "there is no one institution to coordinate and facilitate food security. No matter what and who does it. There should be one institute to facilitate and support food security. All the agencies practising agriculture should be brought under one roof and support that process,"

indicating that mainstreaming of CCA and DRR into the food security sector will be feasible under such a coordination system.

- **Policies and legal provisions:** Key informant P05 explained that "*policy provisions at the national level should guide how all agencies should work together."* According to him, there should be a legal provision, and then the respective agencies will work together per their policies for mainstreaming CCA and DRR into the food security sector.
- **Reforming the education and awareness system** was suggested by key informants P02 and P03. According to them, the current education system does not address the needs of the industry, and the required expertise is not entering the food security and agriculture sectors, so reforming the education sector is a priority to meet the industry's needs.
- **Scale-out good practices** were recommended by key informant P01, who said that "we can also learn from other countries and their models. There are good practices worldwide; we can also study those, learn from similar case studies, and adapt them to our context for mainstreaming CCA and DRR into food security sector planning".
- **Pooling expertise and resources** and ensuring accessibility to them was recommended by key informants P01 and P02. Key informant P01 suggested this: *"we need to have an institutional framework that may include expertise, resources, input, and feedback systems to develop an integrated planning process*". The key informant P02 complemented this recommendation, saying that such frameworks will allow local partners and districts to get the maximum benefits and services for mainstreaming CCA and DRR into food sector planning processes.
- **Vision setting and strategic planning** were recommended by key informants P01, P03, P04, and P07. Key informant P01 explained this by saying that *"there should be a national-level agency to coordinate all these efforts to develop an integrated plan. It can be through the finance ministry, the National Planning Department, or any other related agency that is capable enough and authorised to bring all these agencies under one umbrella."* Key informant P03 highlighted the importance of setting a vision to develop the country based on agriculture, fisheries, and other mechanisms such as value additions. Key informant P04 also

explained the importance of having SWOT analysis and strategic planning frameworks that are more objective-based. Key informant P07 highlighted the need for reenergizing experts, officials, and sectors to facilitate mainstreaming processes and integrated planning in the food security sector.

Within the NCP farmers, there are numerous conventional drought forecasting systems. Farmers use a variety of adaptation strategies to deal with the effects of drought, including both on-farm and off-farm strategies. Drought policy should be an essential instrument of the country, and a drought early warning system should be put in place to reduce the effects of drought in the province including in Polonnaruwa district (Gunawardhana & Dharmasiri, 2015). Increased emphasis on drought policies and preparedness is required in district like Polonnaruwa to mainstream them into food security sector planning (Nianthi, 2018). The author further highlights that drought monitoring technologies and an early warning system at the community level must be improved. It is strongly advised that a regional drought preparedness and response network be established and the process of assessing risk and impact must be codified.

5.4.4 Data Analysis of the Case Study 03: Trincomalee District

5.4.4.1 Description of the Case Study 03: Trincomalee District

Trincomalee district consists of 11 divisional secretariat divisions and 230 GN divisions, with 131,819 families registered in the 2020 election registry (Department of Census & Statistics, 2022). Almost all divisional secretariat divisions have access to at least one public or private hospital. Piped water from the national water supply system or a community-based organisation is available in 114 GN divisions. As shown in figure 5-13, most GN Divisions report droughts, floods, and damages caused by wild elephants and other animals. Regarding social safety nets, 62,708 people received "Samurdhi" programmes in 2020.

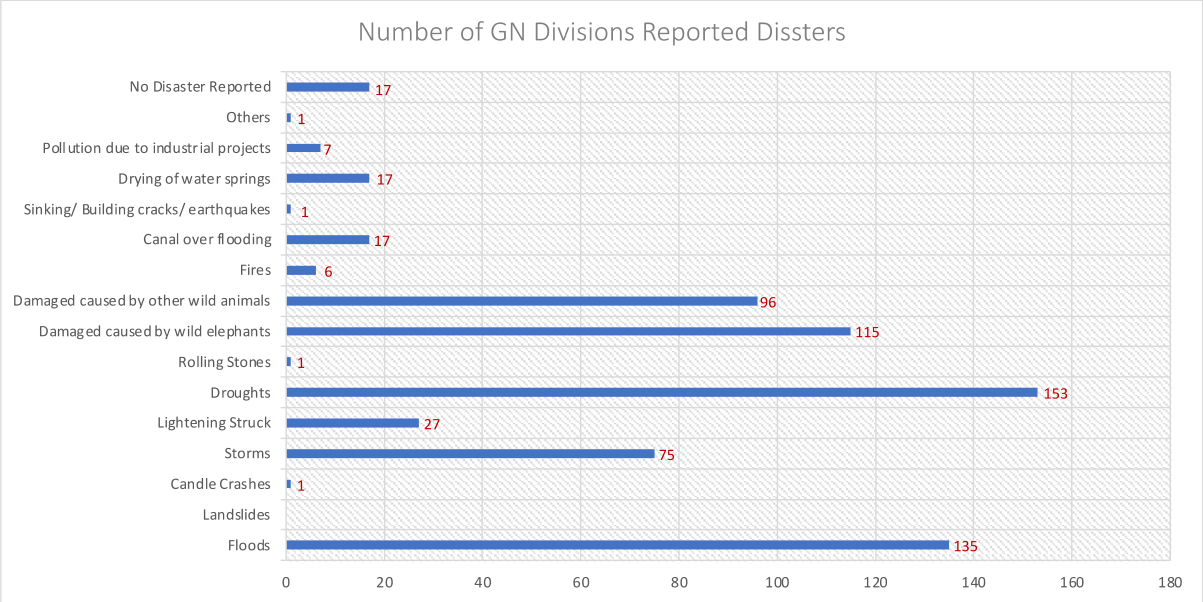


Figure 5-14: Number of divisions reported disasters in Trincomalee district over the past ten years.

(Department of Census & Statistics, 2022)

According to the Department of Census and Statistics, most GN divisions were in crop production (237 GN divisions), 100 GN divisions were in livestock, and 45 GN divisions were in the fisheries industry in 2020. 109 GN divisions engaged in non-agricultural activities, as shown in Figure 5-14

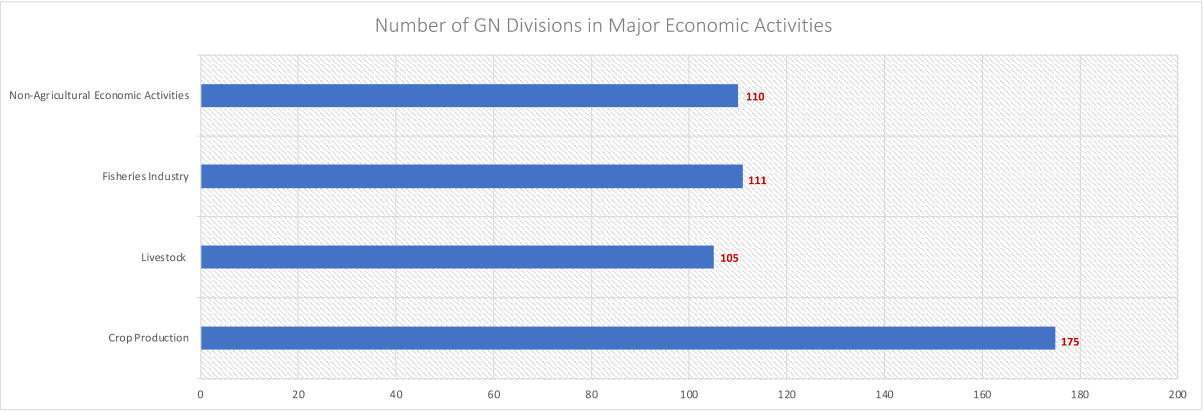


Figure 5-15: Major economic activities in Trincomalee district by GN divisions.

(Department of Census & Statistics, 2022).

5.4.4.2 Institutional setup for foods security and DRM in the Trincomalee district

The central government of Sri Lanka governs the Trincomalee district through the district secretary, also known as the government agent. Representatives from line ministries and departments such as agriculture, irrigation, agrarian services, animal health and livestock,

disaster management, meteorology, health services, wildlife, and so on make up the district government. The district hosts regular DCC meetings, at which all key stakeholder agencies, parliamentarians and other elected officials from local governments, farmer organisations and cooperative societies, and so on participate.

With technical assistance from respective line departments and agencies at the district level, the district secretariat coordinates cross-cutting issues such as disaster management, climate change adaptation, and food security. A district disaster management committee has been formed but is inactive until a crisis or disaster occurs. There is no dedicated institution for facilitating climate change adaptation in the food security sector besides agriculture production, coordinated by the Agriculture and Agrarian Services departments. The district disaster management coordinating unit reports to the district secretary while liaising with and reporting to the DMC. Divisional and GN-level disaster management committees should be established, but most are not active and functional. Irrigation, agriculture, agrarian services, and other food security-related agencies work with divisional offices and farmer organisations to plan and implement annual and seasonal programmes based on national targets. Cascade systems and minor irrigation schemes irrigate most of the district's paddy fields and other crops. DACs and the DCC work with specialized agencies, elected representatives, and farmer organisations to coordinate agriculture production issues and planning decisions. UN agencies such as UNDP, international non-governmental organisations (NGOs), local non-governmental organisations (NGOs), and community-based organisations operate in the district to support various disaster management and climate change adaptation projects and initiatives. Still, on a smaller pilot scale, their impact is yet to be seen.

The following section provides specific details and analysis based on interviews with key informants (semi-structured interviews) for Case Study 3.

5.4.4.3 Analysis of the Key Informants' Interviews Data from Case Study 03

5.4.4.3.1 Food Security Status in Trincomalee District

Trincomalee district is one of the main districts contributing to the agriculture, livestock, and fishing industries. Paddy cultivation, fisheries, livestock, and other field crops are practised in the district. Key informant T01 explained the current food security status, saying, *"if you look at the livestock and fisheries sectors, there is good production in this district. If you look at the land use plan of the district, it is mainly used for agriculture, and we do have irrigation and water supply systems in the district"*. Key informant T02 informed that *"most of the lands are*

used for paddy cultivation. 50% of these lands (around 25,000 hectares) are under major and medium irrigation schemes. They can cultivate both seasons, Maha and Yala. About 14,000 hectares are under rain-fed agriculture. As far as Paddy is concerned, production is there", indicating stable food availability is not a significant issue from the availability point of view. Key informant T03 is also explained as Trincomalee, a diverse agricultural district. He says, *"agriculture and fisheries are the main income sources of the district. I can say that they can manage their food requirements. When some food items are not available in the market, food security issues happen."* Key informant T02 also explained the food security issues, saying that the *"main problem is that once harvested, production is being taken away from the district by various wholesale rice millers. We don't have technology and processing facilities within the district."* Key informant T02 also explained that legumes and other field crops are only cultivated in the "Maha" season. The key informant further explained the seasonal food insecurity issues in the district, saying, *"during the Maha season, I believe that food security is ensured, especially during the harvesting. But other field crops and legumes are not secured during the Yala season. There is not enough production within the district. Prices will also increase because of that,"* indicating access issues due to fluctuating food prices. Key informant T03 explained that during the "Yala" season, farmers do not grow paddy or other field crops, so they have to depend on the production from other districts, which affects the food security of the district, specifically in rural areas. Key informant T05 also highlighted potential food security issues during the "Yala" season as production goes down due to a lack of water availability. According to T06, Trincomalee district is a historical cattle-rearing district, so farmers produce milk and meat from the cattle industry in the district.

Concerning food access, one of the main issues is the lack of paddy processing facilities in the district, according to key informant T02. Therefore, paddy is sold to wholesalers from other districts, creating food access issues. Key informant T03 explained how national policy changes, such as the organic fertiliser policy and other external shocks, change the prices of essential food items, creating access issues in the district due to supply and value chain issues. Import restrictions can sometimes increase prices for essential food items such as black grams for ethnic minority Tamils. He further explained the issue, saying, *"black grams are one of the most important food items for Tamil minorities, and the majority of them are vegetarian. As the government put some restrictions on importation, there was a huge shortage of black grams leading to price hikes resulting in availability and access issues in the district."* Key informant T03 also explained that production from the district does not directly go to the retail market. It

goes to the "Dambulla" wholesale market and is then returned to the retailer markets, which caused higher prices and created food access issues in the district. He further explained that during COVID-19, prices increased, and income was lost due to the loss of livelihood options, creating food access issues in the district.

Food stability is primarily affected due to the lack of production in the "Yala" season, according to key informants T02, T07, and T08. Key informant T02 further explained this issue: *"during the Yala season, other field crops and legumes are not secured. There is not enough production within the district."* Key informant T07 highlighted the food stability issues during disasters such as COVID-19, explaining that *"food was not secured due to COVID in suburban and rural areas."* Key informant T08 also highlighted the stability issues due to the lack of production in the district. I don't think they were able to find the required quantity as well as quality. I would say that they are *"fighting for daily meals,"* indicating stability issues.

Concerning food utilization, key informant T06 highlighted the issues related to hygiene and food safety, specifically milk and meats. Traditional farmers are not following hygienic practices in milking and processing meat, which creates food safety issues in the district. Lack of infrastructure, such as milk chilling facilities, also creates food safety and utilisation issues in the district, according to key informant T06. He further explained the issue: *"there is no clean milk production in the rural areas. The hygienic situation is not good, and they are not following very clean milking methods. Milk might even perish due to this unhygienic condition before reaching chilling centres. Several slaughterhouses in the district are kept in very unhygienic conditions"*, indicating food utilisation and safety issues. Key informants T01, T02, and T07 also explained the issues related to the lack of nutritional diets, specifically in the "Yala" seasons and during disasters due to the lack of income and diverse food products for consumption.

5.4.4.3.2 Observed climate changes in Trincomalee district.

Trincomalee district has observed several climate change impacts, according to key informants. Precipitation changes are the most common impact, according to key informant T06. He further explained that heavy precipitation leads to inundation and floods in the district. Key informant T07 explained that the rainy period should be 4-6 months during the monsoon period, but it has been reduced to 2–3 months. Temperature changes are another manifestation of climate change in the district. Key informant T07 explained the temperature changes, saying that *"we*

also observe and feel like it is becoming hotter and hotter every year, so we feel like the temperature is increasing, and we also observed that the nighttime temperature has been increasing, even in this year." According to the key informants, the district has observed climate change for the last ten years. We are in late September, and it feels warm compared to the past, they concluded.

According to climate estimates, there is a greater than 50% chance that the entire sandy beach region along the Trincomalee coast will be irreparably eroded by 2110. The main effect of shoreline recession is the elimination of the beach, and in severe cases, dunes and back-beach areas, resulting in loss of coastal habitats and assets (Mehvar et al., 2019). According to recent HadCM3 model outputs on climate variance for the 2050s, the Northeast monsoon (December to February) is expected to drop by 34% (A2) in the 2050s. Furthermore, HadCM3 model findings predict a decrease in rainfall throughout the months of December, January, and February (de Silva). There is an increasing trend of warming in Trincomalee district which is from 0.09 to 3.0 ^{0}C per 100 years (Zubair, 2017). Based on the study conducted analysing data from 1971-2011, it is evident that both daily minimum and maximum temperatures are increasing trend (Jayasinghe et al., 2013).

5.4.4.3.3 Climate and disaster nexus in Trincomalee district

Drought is one of the most common climate-induced disasters in the district. According to key informant T03, since the district is located in the dry zone, it experiences annual droughts. Key informant T05 also concurred with the occurrence of climate-induced droughts. Key informant T06 further explains the drought scenarios: *"in 2011 and 2012, there was a severe drought in the district in May, June, and September. In the past, we didn't experience such extreme events that impacted the livestock sector at this scale"*. Key informant T07 also confirmed that the district is frequently affected by droughts due to the impacts of climate change.

According to key informants, flood is another common disaster induced by climate change. Key informant T05 explained this, saying, *"rainfall might be the same. But we have observed that the intensity and timing of the season have changed. Rainfall could arrive early or late and also might receive higher precipitation in a shorter period, which might lead to floods."* Key informants T03 and T07 also confirmed that the district was exposed to floods induced by climate change. Key informant T05 explained the flooding situation, saying, *"if we get a high intensity of rainfall for a week, our tanks' capacity might not be enough. During the rainy season, if we cannot store water, we might have some inundation and floods."* Key informant T08 also concurred on the severe flooding due to climate change, saying that *"three years ago,*

we faced some unprecedented floods, and we lost our harvest because paddy lands were inundated," indicating the level of damage caused by the floods.

According to key informant T07, the district is also exposed to high winds and cyclones as Sri Lanka is located in the Bay of Bengal. Many storms are formed there. Therefore, he believes some cyclonic events may even come to the district. The key informant also expressed his concerns, saying that *"thundering and lightning are much higher compared to the past, so it might also be due to climate change,"* indicating a potential correlation between climate change and lightning.

Pests and diseases have also increased in the district, according to key informant T08. He explained this further: *"we experience a high density of insects and pests. For example, we frequently get brown planthopper attacks and lose our harvest. Crops such as maize and other field crops get damaged by armyworms, commonly known as the 'Sena Caterpillar,' which devastated our production".*

According to key informants, the seasonality, frequency, duration, and intensity of the above hazards have increased in the district. According to key informant T07, the duration of the monsoon season in the district has been reduced from 4-6 to 2-3 months. Key informant T05 emphasised the changes in rainfall intensity and seasonality that cause floods or droughts. According to key informants T05, T06, T07, and T08, seasonal changes are common. Key informant T08 explained the seasonal changes, saying, *"in the regular season, we should have received monsoon rain by now, but in this season, we believe that the rainy season has been delayed."*

Trincomalee is prone to flooding and has had several floods in recent times, affecting about 0.32 million people when the storm happened. This flood is caused by a combination of factors, including increasing rainfall intensity due to climate change, construction of buildings in low-lying areas or wetland reservations, poor maintenance of drainage canals in urban areas and irrigation canals in agricultural areas, silting of tanks, and an increase in the volume of water from the Mahaweli Ganga and other rivers (Suthakaran & Rajendram, 2021). The authors further highlight that extreme floods were occurred in 1913, 1921, 1941, 1944, 1946, 1947, 1957, 1963, 1965, 1984 and 2011and severe floods were in 1896, 1898, 1898, 1923, 1935, 1949, 1961, 1971, 2015 and 2018. The results of the flood risk assessment show that the divisions of Kuchchavely, Mutur, Kinniya, Verugal, Eachchilampattu, Seruvila, and Thambalagamam are more vulnerable to flooding. Out of 230 GN Divisions, approximately 30

GN Divisions are in high-risk areas, 52 GN Divisions are in moderate-risk areas, 43 GN Divisions are in low-risk areas, and the remaining GN Divisions are flood-free.

Having discussed climate change and climate-induced disasters in the Trincomalee district, the following section discusses the vulnerability of the food security sector to climate change and climate-induced disasters.

5.4.4.3.4 Vulnerability of the food security sector to climate change and disasters in Trincomalee district

According to key informant T05, the food security of the district depends on the availability of water from the major, medium, and minor irrigation systems as well as monsoon rainfalls. Agriculture production, livestock, and fisheries heavily depend on water and weather parameters; therefore, the district's food security sector is inherently vulnerable to climate change.

Drought is more common during the Yala season, and no Maha season drought has been reported. The dry zone is prone to recurrent droughts due to climate change, and Trincomalee district is in the moderate drought category (Alahacoon & Amarnath, 2022). Furthermore, the authors highlight that Trincomalee is particularly sensitive to agricultural drought, which has a negative impact on agricultural production and the vulnerable rural population, increasing their food insecurity.

Systemic vulnerabilities, as outlined below, further exacerbate the vulnerability of the food security sector.

- **The conflict between the livestock and agriculture** sectors will increase the food security sector's vulnerability. According to key informant T04, *"90% of the animals are thriving in this district following the free grazing system. Farmers from agriculture and livestock are complaining to each other due to limited lands for cultivation and free grazing. During the main cultivation season, somehow, they can control the cattle, but soon after harvesting, the cattle will again go back to the paddy land and graze there".* Based on the current farming system, they can't get the maximum crop density and production. Therefore, productive agricultural lands are used as grazing lands in the "Yala" season without cultivating suitable short-duration crops.

- **Cultural and traditional practices** also make the food security sector further vulnerable to disasters and climate change, according to key informants T03 and T04. Key informant T03 explained it further: *"even in Yala season, they are trying to cultivate rice. These two paddy cultivation seasons have become a cultural practice. When we look at the data, they are just doing paddy cultivation without assessing whether there will be a profit or not",* indicating that such practices will make the system further vulnerable. Key informant T04 also explained similar issues and difficulties in introducing climate-smart irrigation practices since farmers follow traditional practices and do not wish to change them.
- **Data and data reliability** is another issue in the district that makes the food security sector further vulnerable to climate change and climate-induced disasters. According to key informant T03, farmers apply traditional cultivation practices without data and assessments, which makes their production further vulnerable to potential climate impacts.
- **Early warning and forecasting issues** are key challenges in the district. Key informant T03 explained the issue: "Agro-advisories and early warnings are not also reaching into the last mile and all areas. It might be happening through isolated efforts. There is so much diversity and practical issues in the rural areas." Therefore, farmers are using historical data and traditional knowledge for planning and cultivation, which can be affected by climate change and climate-induced disasters.
- **Extension issues** also make the food security sector further vulnerable to climate change and disasters. Key informant T03 explained this issue: *"I think knowledge limitation is a main issue. The government promotes diversification very little,"* indicating that such a lack of extension by government agencies makes the sector more vulnerable to climate shocks.
- **Fragmented coordination** is another key vulnerability of the food security sector. The sector requires engagement and coordination between multi-stakeholders. Still, according to key informant T07, no common tools and approaches can be applied to enhance food security in the district, except for some isolated discussions at the national level.
- **Insufficient infrastructure** is another key issue in the district. According to key informant T03, there are very limited grazing lands in the district; therefore,

farmers use paddy lands for free grazing during the 'Yala' season without cultivating. Farmers are abandoning cattle rearing due to a lack of grazing lands and milk collecting centres; therefore, food security will be further challenged in the future.

- **Lack of market access** is another key vulnerability of the food security sector in the district. Key informant T03 explained that "*there is no well-established marketing network, supporting policies, or collection system for other field crops. That is also one of the reasons why farmers are not going for other field crops".* Key informant T08 explained the market failures, saying, *"there is a wholesale mafia here since there is no proper system in place to provide market access for the farmers."* Lack of market access makes the food security sector further vulnerable to climate change and climate-induced disasters in the district.
- **Lack of production planning** is another systemic vulnerability of the food security sector, according to key informant T03. He explained that farmers use traditional cultivation practices and norms without assessing data and production planning based on weather data.
- **Policy issues** are impacting the food security sector of the district to a greater extent, according to key informant T03. The government introduces trade and import restrictions for certain foods. Sometimes the government introduces new policies that promote specific food types without proper assessments. Organic fertiliser policy has also affected the food security of the district to a greater extent, according to key informant T03.

One of the key systemic concerns associated to agriculture and food security in the Trincomalee district is post-harvest losses during transportation, storage, and insect infestation (Dissanayaka & Wijayaratne, 2020). According to a study, various institutions distribute modern agricultural technology in the rural parts of Trincomalee district, however training and services are not reaching rural farmers sufficiently. In addition, due to a lack of knowledge and skills, the majority of farmers have not implemented emerging scientific information in their farming activities (Navaratnam, 2011). In the Trincomalee district, main issues include socioeconomic tensions, post-conflict challenges, and a lack of agricultural modernization (Köpke et al., 2019).

Due to such systemic issues, the food security sector in the district is further vulnerable to climate change and climate-induced disasters. The following section discusses constraints and

bottlenecks for mainstreaming CCA and DRR into food security sector planning in the Trincomalee district.

5.4.4.3.5 Limitations and bottlenecks for mainstreaming CCA and DRR into food security sector planning in the Trincomalee district

Food security sector planning is still in its early stages in the Trincomalee district. District planning primarily focuses on crop production based on the targets set by the respective national agencies for their district counterparts. Climate change and disaster risks are not taken into account in the planning. The following limitations and bottlenecks were identified by key informants:

- **The disconnect between early warning and application at the local levels** is a key barrier identified by key informant T03. According to the key informant, *"Agro-advisories and early warnings are not also reaching into the last mile and all areas."* It might be happening through isolated efforts. Considering the diversity and practical issues in rural areas, it is hard to plan and mainstream CCA and DRR into the food security sector in the district.
- **The disconnect between national policies and local-level needs:** Key informants T03, T06, and T07 identified this as another key bottleneck. According to key informant T03, *"most of the offices are trying to implement the programmes that are coming from the national level, but there is no proper assessment of what the real needs are on the ground."* When programmes or needs are defined at the national level, they might work in some areas but not in others, hindering the planning and mainstreaming processes at the district level.
- **The Fragmented approach to mainstreaming** is another key barrier to mainstreaming in the district. Key informant T07 explained the issue: *"all the sectoral development agencies develop their plans based on their allocations."* Key informant T06 also concurred on the same issues, saying that a lack of coordination in the approach to planning is one of the main hindrances to mainstreaming CCA and DRR in the district.
- **Governance issues** have become a major bottleneck for mainstreaming CCA and DRR into food security sector planning in the district. According to key informant T06, *"the main problem is the policy and governance. We have a top-down approach,"* suggesting the need for having an integrated policy framework and

diversified economic policies to support mainstreaming processes. Key informant T07 also confirmed the governance issues triggered by constitutional lapses.

- **Lack of communication, awareness and understanding** is another main issue, according to key informant T03. He further explained the challenge: "*there is not much understanding about the mainstreaming of DRR and CCA into this planning process."* According to the key informant, knowledge and understanding among the key stakeholders and farmers are quite low, making mainstreaming a daunting task in the district.
- **Lack of policies and legislation** also make mainstreaming difficult in the district, according to key informant T06. He further explained the gravity of the problem, saying that *"our country is running without appropriate policies. There should be a clear policy at the national level. There should be a policy for the eastern province"*. He further explained that policy should guide how resources and planning should be done to achieve the maximum potential of the district, ensuring food security.
- **Lack of resources and support systems** have also become a major bottleneck for mainstreaming CCA and DRR into the food security sector in the district. Key informant T01 explained this issue by saying, *"there is a resource gap. Although we received the Agro-advisory, farmers will not be able to adapt to those practices if we don't have seed banks, for example."* Key informant T08 also explained that resources and support systems are not reaching the farmers and end-users for mainstreaming CCA and DRR into their farming practices at the local level.
- **Lack of scale-ups and scale-outs** are also key issues in the district that hinder the mainstreaming process. There are project-based initiatives, but there are no plans or programmes that are sustainable. In reference to a donor-funded program, key informant T07 stated, *"I'm not sure whether these programmes will be scaled out or scaled up, and what would be their sustainability."* Key informant T08 also expressed concern about the lack of local scale-ups and scale-outs for greater impact.
- **Multi-stakeholder coordination issues** also setback the mainstreaming of CCA and DRR into food security sector planning in the district. Key informant T07 explained the issue: *"food security needs multiple agencies to get involved, and*

these tasks cannot be done alone. We need a lot of coordination and multi-stakeholder engagement. We don't have such mechanisms and relationships to support mainstreaming". Key informant T07 also explained similar issues, which he believes were exacerbated by governance and constitutional issues.

- **Political interferences** are major issues impeding the district's efforts to mainstream. "We have tried for the last 20 years about this concept of co-governance, but that has not been sustained because there is no enabling environment at the national level for supporting such policies," explained key informant T01. He further explained that "current political culture is not that good. Integrity is relatively low in the district due to corruption and political interference". Key informant T08 also concurred with this challenge, saying, "the country is gone to corruption. Local politicians are only interested in money." Both informants expressed their concerns that mainstreaming would not be feasible in the district due to such issues.

Having discussed key barriers and bottlenecks for mainstreaming CCA and DRR into the food security sector in the district, the next section discusses how end-users can be engaged based on the current practices and approaches.

5.4.4.3.6 End-user engagement for mainstreaming CCA and DRR into the food security sector in the Trincomalee district

Various mechanisms and instruments are available for engaging end users in the Trincomalee district. As discussed below, end-user engagement has numerous challenges and limitations when using them.

- **Current Practices of engaging end-users in the Food Security Sector in Trincomalee district:** One of the most common mechanisms for engaging end users is through farmer meetings and farmer organizations. According to key informant T02, there are farmer organisations at the local level as well as at the provincial level. Provincial, district, and divisional government staff and extension workers engage with the farmers through farmer organizations. According to key informant T03, government agencies sometimes select lead or selected farmers to implement their programs. According to key informant T04, they apply participatory rural appraisal (PRA) with the participation of farmers

in the cascade areas. He further explained that *"during this PRA process, we identified issues, challenges, and needs in each cascade system. Based on the PRA results, we have developed a Hotspots Agriculture Area Development Plan".* However, it should be noted that the PRA approach is only applied to externally funded programs. According to key informant T05, some government agencies directly get farmer requests and incorporate them into their plans. Another common mechanism is to involve them through farmers' visits to government offices, such as the divisional veterinary office and engage with them, explained key informant T06. The key informant, T07, explained that community engagement is done through pilot projects and government staff visiting the communities for consultations, engagement, and planning. Figure 5-16 summarises the main end-user engagement mechanisms in the Trincomalee district.

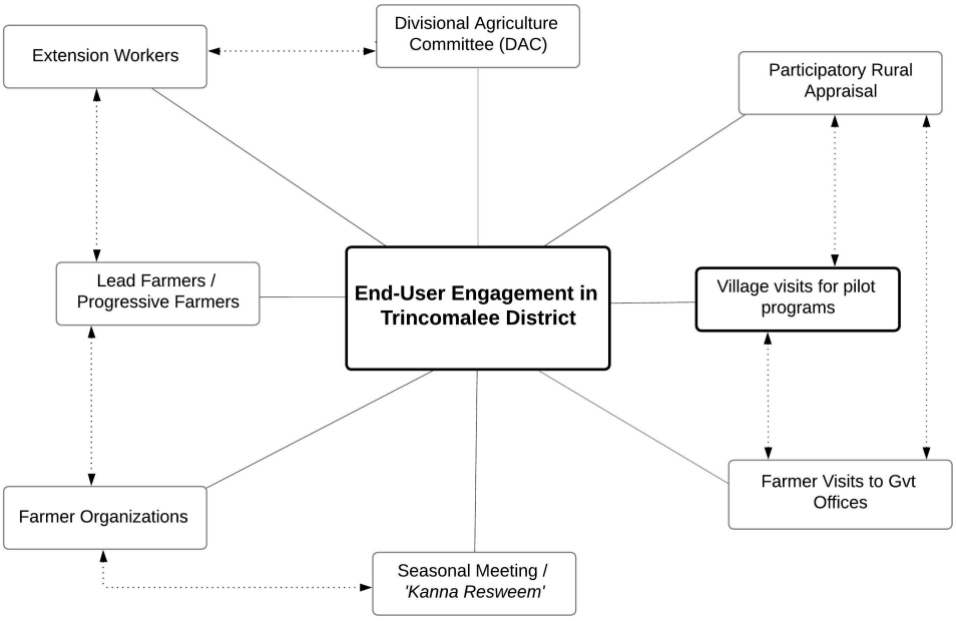


Figure 5-16: End-user engagement mechanisms in the Trincomalee district.

- **Challenges and issues in engaging end-users in the Food Security Sector in the Trincomalee district:** The main challenge is the hierarchy. According to key informant T01, the government and sectoral agencies are not utilising participatory approaches. Hence, community participation is used as just a word rather than a practical tool to engage communities at the local level. Another challenge is that sectoral agencies get their targets from the national level, and

end users are not involved in the planning from the beginning, according to key informant T03. According to key informant T06, financial limitations and allocations they receive from their parent organisations also restrict end-user engagement. He further explained this challenge, saying, *"sometimes we cannot address the problem within our financial limitations and the allocation we are getting."* According to key informant T07, the COVID-19 pandemic has also restricted end-user engagement to a greater extent. According to key informant T08, another significant challenge is the distinction between ceremonial listening and active participation. He further explained how key sectoral agencies engaged the end-users, saying, *"they talk a lot, and they say they will do this and that, but that's it from their side. What we are telling them is not implemented or integrated into their plans".* He further explained that a lack of willingness by the end users also makes their engagement challenging.

Following the discussion of the current practices and mechanisms for engaging end-users and their challenges, the next section considers the appropriate planning unit for mainstreaming CCA and DRR into food security planning at the district based on the opinions and suggestions of the key informants.

5.4.4.3.7 Appropriate planning unit and planning cycle in Trincomalee district

According to multiple key informants, the district conducts parallel and multi-level planning. Sometimes planning is guided by national agencies, provincial agencies, district agencies, divisional level agencies, or lower levels such as cascades, project areas, ecosystems, farm organisations, or village levels. Most key informants suggested the divisional level as the appropriate planning unit, as specialized agencies are present at that level. Key informant T02 explained the planning process and the unit: *"in the Trincomalee district, we have five segments, like zones. So there is an assistant director of agriculture for each of these five segments. We get the plans from these segments,"* indicating that zones are more or less similar to divisional secretariat divisions. Key informant T06 said: *"I believe the ideal planning unit for our country is the divisional level."* According to key informant T07, the planning should reach the divisional level. He said that going below the divisional level is difficult, takes a lot of time and resources, and the benefits may not be high.

5.4.4.3.8 Recommendations mainstreaming CCA and DRR into food security sector planning in Trincomalee district.

Climate change adaptation and disaster risk reduction have not been fully integrated into the food security sector in the Trincomalee district. As discussed below, key informants made several recommendations for mainstreaming and integrated planning in the district.

- **Advocacy for change** was recommended by key informants T01, T06, and T07. "Programs should incentivize people at the local level for integrated planning. There should be some advocacy to make sectoral-level interventions at the local level," explained key informant T01. He said many efforts and resources should be made available to advocacy organisations to bring stakeholders together.
- **Empowerment of local actors** is another important recommendation made by key informant T01. He highlighted the potential, saying that *"if we develop such a plan, we will be able to motivate these local officers because, if you do such a process, they will believe that I did this, and this is part of my responsibility, so there will be motivation, accountability, and incentive for these officers to implement such a program."* He further explained the recommendation, saying that local-level plans and mainstreaming should be done by empowering local officials at the lowest level and giving them ownership and recognition.
- **Financing and incentives** were recommended by key informant T03**.** He further explained that the government should develop mechanisms to motivate farmers and introduce guaranteed pricing schemes and incentives for mainstreaming DRR and CCA into planning processes.
- **Implementation, monitoring and evaluation system** was recommended by key informant T05 and key informant T07. Using examples from the provincial planning department, key informant T05 recommended having key performance indicators for each sector and measuring the progress against them. Key informant T07 suggested enforcing implementation guidelines, saying, "*communities, partners, and all these stakeholders need to adhere to those guidelines and policies and implement the plans."* He also emphasised the importance of multi-stakeholder efforts in this regard.
- **Knowledge generation and dissemination:** According to key informant T01, this is a critical need. *"There should be more knowledge products and tools to*

translate these skills and knowledge to communities," explained key informant T01.

- **Market-based approaches** were suggested by key informants T01 and T03."The concept of food sovereignty must be introduced in a way that people become independent and don't depend on others or markets for their food preferences and quality foods," according to key informant T01. Key informant T03 suggested that the government should introduce appropriate market-based solutions to ensure food security and related planning.
- **Multi-stakeholder coordination platforms:** Key informants T02, T03, and T07 recommended them. They further explained that such integrated planning and mainstreaming of CCA and DRR cannot be done alone. Multi-stakeholders should be engaged through coordination platforms. Such platforms should involve local governments, provincial governments, divisional secretariats, and communities in planning.
- **Policies and legal provisions** are prerequisites for mainstreaming and integrated planning, according to key informants T02 and T07. Key informant T02 explained that *"if there is a stable policy for agriculture, we should be able to support food security and allocate resources."* Key informant T07 explained the importance of implementing and enforcing guidelines, policies, and regulations regarding integrated planning and mainstreaming.
- **Scale-out best practices and pilot programs:** Key informants T02 and T07 recommended them. "There are many attempts to make our agriculture climate resilient and climate-smart. At the end of the program, we will see how these programmes can be scaled out or scaled up," added key informant T02. Key informant T07 also recommended scaling pilot projects funded by external agencies to have a greater impact.
- **System re-engineering with a unified planning system** was recommended by Key informant T06. He said the planning system should be redesigned to take advantage of local resources, natural capital, and potential. He further explained that *"we need to have clarity about our policy from the national level up to the provincial, district, divisional, and village levels. If we have such clarity and targeted development, then we will be able to achieve progress."* He suggested

an approach to follow targeted local development, keeping the division as the planning unit.

- **Vision setting and strategic planning** is another critical recommendation by key informant T06. He further explained this recommendation: *"the problem is that Sri Lanka's development is not holistic. We are always reactive. When it comes to sustainable development goals, they are all interconnected. But in Sri Lanka, we see this as a separate goal. So, our planning must be holistic and strategic"*. Such a vision setting and a strategic planning framework will advance the Sri Lankan planning system and mainstream it to the next level.

Some of the key mainstreaming measures suitable to Trincomalee district include creating interventions that account for shifting risk, include climatic information, weather trends, and local knowledge in vulnerability and capability assessments; create a capacity-building process for an integrated DRM approach; invest in capacity building on DRM and climate change; establishment monitoring and evaluation system for outcomes of mainstreaming; and develop stakeholder mapping related to DRM and climate change (Ibrahim & Fernando, 2010).

SECTION C

5.4.5 Cross-Case Analysis

This section compares observed climate change and climate-induced disasters, the vulnerability of the food security sector, limitations and bottlenecks for mainstreaming CCA and DRR into the food security sector, and measures and recommendations for mainstreaming CCA and DRR into food security sector planning in Case Study 1, Case Study 2, and Case Study 3 as discussed below.

5.4.5.1 Observed Climate Change and Disasters in the District

Observed climate change and disasters in the districts based on key informant interviews and documentary reviews were discussed in sections 5.4.2.3.2, 5.4.3.3.2, and 5.4.4.3.2. While Anuradhapura and Polonnaruwa districts are located in the North-central province in the dry zone of Sri Lanka, Trincomalee, a coastal district, is located in the Eastern province and therefore exposed to a range of coastal hazards in addition to floods and droughts. All three districts are exposed to droughts and seasonal floods. The impact of droughts largely varies due to the presence or absence of irrigation and water management systems in the respective districts. Anuradhapura district has major, medium, and minor cascade irrigation systems, whereas Polonnaruwa district is mainly covered by major irrigation schemes; thus, the effects of droughts in Polonnaruwa district were much lower than those in Anuradhapura district.

On the other hand, the Trincomalee district is predominantly covered by minor cascade irrigation systems and rainfed irrigation with major and medium irrigation schemes cover certain parts of the district; therefore, the impacts of droughts are severely felt. Trincomalee district is exposed to coastal hazards such as coastal surges and tsunamis (2004). Wild elephant and animal attacks were common in all the districts, but impacts were higher in the Polonnaruwa district due to the presence large wild animal sanctuaries and national parks. Concerning observed climate change, all three districts have observed climate change, including precipitation changes (intensity, magnitude, seasonality, and duration changes) and temperature changes (day and night temperature variations), leading to intensified hazards such as floods, droughts, pests and diseases, wild animal attacks, high winds and storms in all three districts. All the observed climate change and related disasters are listed in Table 5-1.

Table 5-1: Comparison of observed climate change and related disasters in the case study districts.

Case Study 1 (Anuradhapura District)	**Case Study 2 (Polonnaruwa District)**	**Case Study 3 (Trincomalee District)**
Observed Climate Change		
Precipitation changes (seasonality, duration, intensity and magnitude) Temperature changes (day and night temperatures) Evapotranspiration changes.	Precipitation changes (seasonality, duration, intensity and magnitude Temperature changes (day and night temperatures).	Precipitation changes (seasonality, duration, intensity and magnitude) Temperature changes (day and night temperatures).
Major climate-induced disasters impacting food security in the districts, identified by the key informants		
Droughts Extreme floods Wild animal attacks Pests and diseases.	Droughts Floods Pests and diseases Wild animal attacks Tornadoes and high winds.	Droughts Floods High winds and cyclones Pest and diseases.

According to past research, Sri Lanka is seeing a change in climate in terms of rainfall variability, an increase in climate extremes, and warming (Esham & Garforth, 2013b). In the North Central Province of Sri Lanka, the ambient temperature has been rising, causing more heat stress; more frequent and severe occurrences of extreme rainfall anomalies; and an increase in the frequency and severity of natural disasters (Dharmasiri & Jayarathne, 2021). Rainfall, temperature, seasonal pressure, wind system, and humidity are the primary determinants of Sri Lanka's climate. Sri Lanka is a tropical island that is extremely sensitive to the negative consequences of climate change due to temporal and spatial variations in temperature and rainfall conditions (Thadshayini et al., 2020). A great amount of literature has explained how climate change in Sri Lanka has led to statistically significant increases in average temperature, rainfall variability, and weather extremes. Prolonged droughts and flash floods have been observed to grow as weather extremes increase (Eeswaran, 2018).

5.4.5.2 Vulnerability of the Food Security Sector to Climate Change and Disasters

Key vulnerabilities of the food security sector to climate change and disasters are discussed in sections 5.4.2.3.4, 5.4.3.3.4 and 5.4.4.3.4. All four dimensions of food security, namely food availability, access, stability, and utilisation, are exposed to climate change and climate-induced disasters. The vulnerability of the food security sector of each district varies to a greater extent. Food diversity is much higher in the Anuradhapura district compared to Polonnaruwa and Trincomalee districts. However, food availability and production are lower in the Anuradhapura district due to water stresses and shortages.

In contrast, the Polonnaruwa district is irrigated by major irrigation schemes; therefore, two cropping seasons can be cultivated. However, food diversity is much lower in Polonnaruwa district, compared to Anuradhapura and Trincomalee, as it is predominantly a monoculture district for rice; thus, access to nutritious foods is lower in the district. Vulnerability of the food security in Trincomalee district is much higher than in the Anuradhapura and Polonnaruwa districts, as it is predominantly cultivated through rainfed and minor cascade irrigation systems. However, food diversity is much higher in the Trincomalee district, as it has all the sub-sectors: agriculture, livestock, and fisheries. Climate change and climate-induced disasters impact all three sub-sectors, leaving high exposure and impacts in the district. Unlike the other two districts, farmers in Trincomalee cultivate only one season (the Maha season), making them more vulnerable.

In addition to inherent vulnerability and exposure to climate change and climate-induced hazards, the food security sector in all three districts has reported systemic vulnerability, as stated in Table 5-2.

Table 5-2: Comparison of key systemic vulnerabilities of the food security sector for climate change and disasters.

Case Study 1 (Anuradhapura District)	**Case Study 2 (Polonnaruwa District)**	**Case Study 3 (Trincomalee)**
√ Abandoning Good Practices √ Data and data reliability √ Early warning and forecasting issues √ Extension issues	√ Data and data reliability issues √ Early warning and forecasting issues √ Fragile supply change	√ Conflicts between the livestock and agriculture sectors √ Cultural and traditional practices

√ Fragile supply change √ Governance issues √ Lack of assessing and measuring mechanisms √ Lack of production planning √ Lack of risk transfer mechanisms √ Negative coping mechanisms √ Policy issues √ Research and applications √ Lack of risk knowledge and awareness √ Lack of recognition for farmers and farming	√ Inadequate institutional and human resources capacity √ Lack of production planning and buffer stock √ lack of social safety nets and compensation mechanisms √ Negative coping mechanisms √ Risk knowledge, awareness and perception	√ Data and data reliability √ Early warning and forecasting issues √ Extension issues √ Fragmented coordination √ Insufficient infrastructure √ Lack of access to the market √ Lack of production planning √ Policy issues

Smallholder farmers of Sri Lanka are becoming increasingly vulnerable to climate change and variability. Agriculture is the only main source of income, therefore agricultural adaptation to climate change and extreme events is critical for their survival and food security (Esham & Garforth, 2013a). Climate change, extreme weather conditions and climatic events, sea level rise, ocean acidification, and temperature rise are all projected to have a substantial impact on coastal ecosystems and aquaculture affecting food security in Sri Lanka (Jayasinghe et al., 2019). The main drivers of productivity decline in the Dry Zone include land resource degradation, irregular weather patterns, biotic stressors, and a lack of adoption of improved agronomic methods. Other field crops planted mostly in drought-prone areas of Sri Lanka are extremely vulnerable to expected climatic changes. However, certain concepts and technology designed to fight severe climatic circumstances have yet to be accepted by farmers (Malaviarachchi et al., 2019). Sri Lanka is an agricultural country, with agriculture playing an important role in the national economy and food security. Because the agricultural sector is so reliant on natural resources like water, soil fertility, temperature, and rainfall, climate change has a greater impact on it. Climate change, including extreme weather events, has already

threatened Sri Lankan agriculture production, animal production, and the fisheries industry thereby impact the food security (Thadshayini et al., 2020). Water scarcity in Sri Lanka is getting worse due to climate change. The ability of the small-scale farmers who dominate rice production and the institutions that assist them to handle the difficulties presented by shifting water availability will determine whether these changes will jeopardize national-level food security (Williams & Carrico, 2017). Climate change affects agriculture industry both directly and indirectly, causing increased economic and food security effects in Sri Lanka. Climate change studies on nearly all key crops have revealed yield losses. Furthermore, climate change appears to be negatively affecting farm animal output, fisheries, and forestry. Due to inundation and salinity development, sea level rise poses risks to coastal agricultural areas (Eeswaran, 2018).

5.4.5.3 Limitations and Bottlenecks for Mainstreaming CCA and DRR into food security sector planning

Sections 5.4.2.3.5, 5.4.3.3.5 and 5.4.5.3 have discussed and highlighted limitations and key bottlenecks for mainstreaming CCA and DRR into food security sector planning in all three districts. Key limitations and bottlenecks are summarised and compared in Table 5-3. Most of the challenges identified by key informants were similar, except for very few district-specific challenges. Planning and mainstreaming arrangements are comparatively better organised in the eastern province, including the Trincomalee district, than in the northcentral province (Anuradhapura and Polonnaruwa districts). Furthermore, Trincomalee is a war-affected district due to 30 years of civil war in Sri Lanka, and the district is a multi-ethnic district home to Sinhalese, Tamils, and Muslims. Institutional, human, financial, technology transfer, education, communication, and understanding vary significantly in all three districts. Negative attitudes and the human factor for not cooperating with mainstreaming were evident in Polonnaruwa and Anuradhapura districts. Lack of tools, methodologies, land use planning, technical knowledge, and know-how were key district-specific issues in the Anuradhapura district. Political interferences are one of the key challenges in all the districts, which hinders the effective mainstreaming of CCA and DRR into food security sector planning processes. Key informants also identified a set of recommendations for enabling the mainstreaming of

CCA and DRR into the food security sector, as listed in Table 5-3. Recommendations were similar in all the districts except for a few district-specific recommendations that emerged from Polonnaruwa. One of the key recommendations that emerged strongly in all three districts were advocacy and empowerment of local actors to facilitate mainstreaming processes. Furthermore, the key informants in all three districts recommended visioning and strategic planning frameworks backed by policies and legislation. Considering the technical knowledge issues and gaps between the industry and the education sector, reforming education and awareness generation and pooling expertise and resources were specifically recommended in the Polonnaruwa district. Furthermore, market-based solutions were recommended in Polonnaruwa and Trincomalee districts as effective measures for mainstreaming CCA and DRR into food security sector planning at the sub-national level.

Table 5-3: Comparison of key limitations and bottlenecks for mainstreaming CCA and DRR into food security sector planning.

Case Study 1 (Anuradhapura District)	**Case Study 2 (Polonnaruwa District)**	**Case Study 3 (Trincomalee)**
Limitations and Bottlenecks for Mainstreaming CCA and DRR into Food Security Sector Planning		
√ The disconnect between national policies and local needs √ Fragmented approaches to Mainstreaming √ Governance issues √ Lack of accountability and monitoring √ Lack of data and evidence √ Lack of communication awareness and understanding √ Lack of leadership and initiatives √ Attitude and human factor	√ Attitude and human factor √ Disconnect between early warning and application at the local level √ The disconnect between national and local level needs √ Fragmented approaches to mainstreaming √ Governance issues √ Lack of accountability √ Lack of data and evidence √ Lack of financial solutions and resource use efficiency √ Lack of leadership	√ Disconnect between early warnings and application at the local levels √ The disconnect between national policies and local-level needs √ Fragmented approaches to Mainstreaming √ Governance issues √ Lack of communication awareness and understanding √ Lack of policies and legislation

√ Lack of mechanisms and mandated institutions √ Multi-stakeholder coordination issues √ Lack of policies and legislation √ Lack of scale-outs and scale-ups of good practices √ Lack of tools and methodologies √ Lack of land use planning and zoning √ The mismatch between administrative boundaries and ecosystem boundaries √ Political interferences √ Lack of technical knowledge and know-how	√ Lack of mechanisms and mandated institutions √ Lack of policies and legislation √ Lack of scale-ups and scale outs √ Lack of tools and methodologies √ Multi-stakeholder coordination issues √ Political interferences √ Lack of technical knowledge and know-how	√ Lack of resources and support systems √ Lack of scale-ups and scale outs √ Multi-stakeholder coordination issues √ political interference
Recommendations for Mainstreaming DRR and CCA into Food Security Sector Planning		
√ Advocacy for change √ Communication and awareness creation √ Data-driven solutions √ Empowerment of local actors √ Financing and incentives √ Implementation of monitoring and evaluation mechanisms √ Knowledge generation and dissemination √ Leadership and supervision √ Multi-stakeholder coordination platforms	√ Advocacy for change √ Avoid stand-alone planning processes √ Communication and awareness creation √ Create and recognise champions √ Data-driven solutions √ Diversification of expertise √ Empowerment of local actors √ Implementation of monitoring and evaluation system strengthening √ Market-based solutions	√ Advocacy for change √ Empowerment of local actors √ Financing and incentives √ Implementation of monitoring and evaluation system √ Knowledge generation and dissemination √ Market-based approaches √ Multi-stakeholder coordination platforms √ Policies and legal provisions √ Scale-out best practices and pilot programs

√ Policies and legal provisions √ Scale-out good practices √ Vision setting and strategic planning	√ Multi-stakeholder coordination platforms √ Policies and legal provisions √ Reforming education and awareness systems √ Scale-out good practices √ Pooling expertise and resources √ Vision setting and strategic planning	√ System reengineering with a unified planning system √ Vision setting and strategic planning

It is evident that policy and farm-level decisions have resulted in a number of unplanned and reactive adaptation actions in Sri Lanka. These adaptation efforts lacked a clear connection to the national development objectives and strategies and were dispersed among multiple initiatives (Esham & Garforth, 2013b). The authors argue that research is needed to develop and identify adaptation methodologies and practices that are practicable for smallholder farmers, especially in the dry zone where paddy and other food crops are primarily grown and needed for food security. To accomplish the anticipated expansion in the agricultural sector, concerted efforts are required to integrate climate change adaptation into national development strategies and assure its implementation at the national, regional, and local levels. To establish suitable strategies and institutional frameworks, it is vital to have a thorough grasp of farmers' perceptions of climate change, real farm-level adaptations, and what variables drive and constrain their decision to adapt (Esham & Garforth, 2013a). The authors further argue that non-climatic factor management should be a key consideration for improving farmers' adaptability, particularly in resource-constrained smallholder agricultural contexts in Sri Lanka. According to the findings of the regression analysis, human cognition is a significant determinant of climate change adaptation and advancing mainstreaming agendas. Their study also indicated that social barriers to adaptation, such as cognitive and normative variables, are just as important as other economic hurdles. This study emphasized the necessity of understanding the socioeconomic, cognitive, and normative components of local populations while developing and executing adaptation strategies and mainstreaming agendas.

5.5 Summary and link

The chapter analysed the gathered data through national experts and key informants in the three case studies. Firstly, data collected through national experts were analysed to identify and assess the current status regarding the impacts of climate change and climate-induced disasters on the food security sector in Sri Lanka. Then recommendations for reforming and restructuring the existing planning systems and mechanisms were analysed and formulated (refer to Section 5.3.3). Then data were analysed within each case study to assess the food security status, the vulnerability of the food security sector to climate change and climate-induced disasters, the limitations, and bottlenecks for mainstreaming climate CCA and DRR into food security sector planning, and recommendations for mainstreaming CCA and DRR into food security sector planning (refer to sections 5.4.2.3.8, 5.4.3.3.8, and 5.4.4.3.8). A cross-case analysis was provided after thoroughly examining each of the case studies, identifying critical differences and similarities between the findings of all three case studies. Following the analysis of the data gathered through case studies, the next chapter identifies the key findings of the research.

CHAPTER 6 : FINDINGS

6.1 Introduction

Chapter 5 discussed and presented the data analysis of the national experts' interviews and key informant interviews from the case studies. This chapter summarizes and compares the empirical research findings based on interviews with national experts and key informants from the case study. The chapter further describes the Framework developed through national expert interviews and case studies to mainstream CCA and DRR into food security sector planning at the district level in Sri Lanka. Afterwards, the chapter discusses the group validation findings and presents the validated Framework, along with a set of recommendations for reforming and restructuring the planning systems of Sri Lanka to mainstream CCA and DRR into the food security sector. Accordingly, the chapter is organized as follows.

- Firstly, the current status and vulnerability of the food security sector at the sub-national level are summarized.
- Secondly, the need for mainstreaming CCA and DRR into the food security sector is discussed.
- Thirdly, the challenges and limitations in mainstreaming CCA and DRR into the food security sector are summarized.
- Fourthly, findings from the national experts and case studies are compared with the literature.
- Fifthly, the Framework to mainstream CCA and DRR into food security sector planning is developed and presented. The validated Framework is then presented with the results of the group validation events.
- Finally, a set of recommendations to reform and restructure the planning processes for mainstreaming CCA and DRR into the food security sector is presented.

6.2 Vulnerability of the Food Security Sector at Sub-national Levels

According to the key findings of the case studies, all food security dimensions, namely food availability, food access, food stability and food utilization, have been impacted due to climate change and disasters at the district and local levels. Such impacts are due to inherent and systemic vulnerabilities of the food security sector to climate change and disasters, as discussed

in sections 5.3.1.4.6, 5.3.1.4.7, 5.4.2.3.4, 5.4.3.3.4, 5.4.4.3.4, and 5.4.5.2 and listed in Table 5-2. Although vulnerabilities of the food security sector were case-specific, many similarities were observed in terms of the nature and context in the Anuradhapura and Polonnaruwa districts, which are primarily rice-producing districts using major irrigation schemes, and minor cascade systems, in the Northcentral province. On the other hand, Trincomalee district is a multi-ethnic coastal district affected by 30 years of civil war, the 2004 Asian Tsunami and other frequent climate-induced disasters. It has a unique set of vulnerabilities as it is predominantly based on minor cascade and rainfed irrigation, leaving only one cultivation season, unlike the other two cases. The analysis revealed that most identified vulnerabilities led to food insecurity when climate change and disasters struck the districts (Figure 5-4, Figure 5-5). It was therefore evident that to make districts and communities food secure and resilient to climate change and disasters, these vulnerabilities and challenges must be overcome. Section 5.3.2.1 and 5.3.2.2 and related subsections based on the national experts' interviews presented the need and measures for mainstreaming CCA and DRR into food security sector planning at various levels.

Significant threats to Sri Lanka's food security sector include declining agricultural productivity, food loss along supply chains, low rural poor livelihood resilience, and the prevalence of high levels of undernourishment and child malnutrition, which are exacerbated by climate change and extreme events (Esham et al., 2018a). In Sri Lanka, climate is a major determinant of agricultural productivity. Temperature, rainfall, and humidity are especially important climatic characteristics since they have a significant impact on the country's agricultural productivity and food security (Marambe, Punyawardena, et al., 2015). The authors argue that overwhelming scientific data points to two basic trends in Sri Lankan climate: rising ambient temperatures, which cause more heat stress, and more frequent and severe occurrences of extreme rainfall anomalies such as droughts and floods and both of these anomalies severely affect crop and animal production, thereby food security. A new study highlights the difficulties that Sri Lanka's extension services and agricultural research organizations face (Scognamillo et al., 2022). They show that creating and marketing methods and technology is required for mitigating the negative effects of water stress, but it is insufficient for widespread adoption and more profitable and productive farm-level outcomes. According to the findings of a recent study, losses in the productivity of most agricultural products lead to increasing consumer prices, with a resultant decline in overall household consumption over the next few decades. Food insecurity will be exacerbated by the expected fall in crop yield and rises in food prices

(Abeysekara et al., 2023). Climate change-induced agricultural productivity reductions are expected to have a severe negative impact on food production and prices in all South Asian countries including in Sri Lanka. It is also evident that countries in this region, are likely to experience food security issues, given that it is home to over half of the world's poor and agriculture contributes significantly to the GDP and employment generation (Bandara & Cai, 2014). Due to its rising population, immense use of resources for economic growth, diverse geomorphological and topographical features, and other factors such as social, institutional, political, and governance-related drivers, and poverty, Asia-Pacific countries are highly vulnerable to harsher impacts of climate change and related disasters (Uchiyama et al., 2021).

The following section presents key mainstreaming measures addressing specific challenges and vulnerabilities.

6.3 The need for mainstreaming CCA and DRR into the food security sector

The findings from the national expert interviews and key informant interviews from the cases revealed that districts are not adequately addressing food security issues and mainstreaming CCA and DRR into food security sector planning. No specific mandated food security sector planning agency at the national, district, or local levels exists. As a result, it was evident that district administration and related line agencies are not mainstreaming CCA and DRR into food security sector planning, apart from providing basic and limited relief and food distribution or other social safety net programs when disasters or climate change impacted the food security at the local level. None of the districts investigated in this research had comprehensive planning processes for food security and mainstreaming CCA and DRR into their planning tools and frameworks. However, the national experts and key informants at the district level recognized the need and recommended various mainstreaming measures (see section 5.3.2.2) addressing the underline inherent and systemic vulnerabilities of the food security sector in Sri Lanka. Table 6-1 highlights the identified mainstreaming measures for addressing underlined vulnerabilities and mainstreaming CCA and DRR into food security sector planning processes.

Achieving food security needs a holistic approach capable of ensuring climate resilience of the entire food system while addressing nutritional problems caused by climate change impacts. As a result, there is a pressing need to work toward a climate-smart agriculture system that

addresses all aspects of food security and sustainable development (Esham et al., 2018a). According to the literature, climate change has a negative influence on global food security, growing poverty, hunger, and malnutrition, all of which disproportionately affect emerging countries and the poor and marginalized groups. Strengthening food sovereignty may be the key to mitigating such effects (Gunaratne et al., 2021b). The National Climate Change Policy, adopted in 2012, clearly supports the demand for adequate adaptation strategies to decrease the impacts on crop and animal production in order to achieve food security (Marambe, Punyawardena, et al., 2015). The authors argue that while some initiatives have already been put in place in to offset the emerging negative effects of climate change, there is still room for new entry points for adaptation and mainstreaming to reduce the climate vulnerability of agricultural sector while enhancing the overall community resilience. A nexus-based adaptation approach is critical for effective adaptation because it incorporates a nexus view into climate change adaptation plans and an adaptation perspective into development strategies (Rasul & Sharma, 2016).

Table 6-1:Vulnerability of food security sector and corresponding CCA and DRR mainstreaming measures.

	Systemic vulnerabilities of the food security sector	**Measures for mainstreaming CCA and DRR into Food Security Sector Planning Processes**
Institutional Vulnerabilities	Policy issues and lack of appropriate policies for supporting the mainstreaming processes.	• Advocacy for policy formulation and changes. • Decentralization. • Establish policy coherence.
	Governance issues.	• Improve governance, procedures, and enforcement. • Advocacy for good governance.
	Lack of institutional mandates and human resources.	• Formulation of policies and legal provisions. • Training and capacity building.
	Fragmented coordination in the sector.	• Strengthening institutions, mandates, and support structures. • Policy coherence. • Policies and legal provisions. • Governance and enforcement. • Decentralization.
	Extension issues.	• Financing and resource allocation. • Strategic communication and effective use of extension networks. • Training and capacity building.

	Lack of production planning and buffer stock.	• Enhance technology, data, and their applications. • Area-based strategic planning. • Comprehensive and consolidated planning. • Advocacy for policy formulation and changes. • Revival of historical best practices.
Social Vulnerabilities	Abandoning good practices.	• Revival of historical best practices. • Strategic communication and extension.
	Negative coping mechanisms.	• Enhance technology, data, and their applications. • Strategic communication and extension. • Revival of historical best practices. • Advance research and application in implementing policies and related programs.
	Subsistence farmers and lack of recognition.	• Strategic communication and extension. • Financing and resource allocation. • Enhance technology, data, and their applications. • Training and capacity building.
Technological Vulnerabilities	Research and application issues.	• Advance research and application in implementing policies and related programs. • Enhance technology, data, and their applications. • Training and capacity building. • Strategic communication and extension. • Financing and resource allocation.

	Lack of technological advances and innovations.	• Enhance technology, data, and their applications. • Training and capacity building. • Financing and resource allocation.
	Lack of data and data reliability issues.	• Enhance technology, data, and their applications. • Training and capacity building. • Strengthening institutions, mandates, and support structures. • Policies and Legal Provisions.
	Assessing and measuring mechanisms	• Enhance technology, data, and their applications. • Training and capacity building. • Strengthening institutions, mandates, and support structures. • Policies and Legal Provisions.
	Early warning and forecast issues	• Enhance technology, data, and their applications. • Training and capacity building. • Strengthening institutions, mandates, and support structures. • Policies and legal provisions. • Strategic communication and effective use of extension network.
Physical Vulnerability	Infrastructure and land use issues	• Area-based strategic planning. • Comprehensive and consolidated planning. • Policies and legal provisions. • Governance and enforcement.

Economic Vulnerabilities	Fragile supply chain.	• Enhance technology, data, and their applications. • Strengthening institutions, mandates, and support structures. • Comprehensive and consolidated planning.
	Lack of risk transfer mechanisms.	• Policies and legal provisions. • Governance and enforcement. • Financing and resource allocation.
	Climate-induced migration.	• Area-based strategic planning. • Comprehensive and consolidated planning. • Financing and resource allocation.

Awareness on climate change and its impacts on agriculture is increasing among the relevant stakeholders including farming communities. However, the implementation of field level adaptations are far below the rate of increasing trends of climate change. Farming systems and traditional agricultural practices can provide wide range of opportunities for climate change adaptation and mitigation in the country (Eeswaran, 2018). The author further argue that climate change communication could help to spread knowledge and skills about adaptation more effectively. Despite the fact that numerous study findings on various elements of climate change are accessible in Sri Lanka, there is a lack of consolidation of findings, which is a major impediment to effective communication. Seasonal climate projections could be such important communication tool which can help farmers, businesses across the value chain, and policymakers build better climate risk management strategies, ultimately assuring food security (Marambe, Punyawardena, et al., 2015). Extension services and systems should be changed to include farmer-friendly technology packages that promote climate risk reduction and contribute to more profitable farm-level outcomes (Scognamillo et al., 2022). Given the island nation's many issues in food security, poverty, climate change, and the persistence of development inequities, achieving food sovereignty in Sri Lanka will considerable policy reforms and structural adjustments in governance, administrative institutions, and across the wider society

(Gunaratne et al., 2021b). A recent study discovered that income growth, urbanization, structural changes in population demography, and a variety of other socioeconomic factors all had a major impact on changes in worldwide food consumption patterns. Aside from these, there are several notable variances in food consumption trends in Sri Lanka, particularly geographically, in urban, rural, and estate sectors. The Sri Lankan diet is shifting away from traditional cereal consumption and toward meat, seafood, dairy products, fast foods, and processed foods, posing a substantial danger to Sri Lanka's future food security and sustainability (Bandara et al., 2021). Food insecurity will be exacerbated by expected crop production declines and price rises. As a result, climate change will have a negative influence on overall GDP as well as most macroeconomic and microeconomic indicators in the Sri Lankan economy. These findings emphasize the significance of having future scientific research on climate change adaptation strategies, as well as the importance of establishing governmental policy responses to mitigate negative consequences on agriculture and food security sectors (Abeysekara et al., 2023). There is an urgent need for policy analysts and policymakers in Sri Lanka to design climate change adaptation policies to address the expected negative impacts of climate change-induced agricultural output reductions (Bandara & Cai, 2014). In order to address underlying vulnerabilities and promote food security, countries need an integrated approaches in mainstreaming it into the development agendas; protection of food production; storing food and seeds; water conservation; preserving livestock; food aid and nutrition; protecting livelihoods; maintaining natural resources; establishing monitoring and warning systems; collate data and indicators; use assessment tools; and maintain and strengthen local systems (Twigg, 2015).

6.4 Challenges in Mainstreaming CCA and DRR into the food security sector

All the challenges identified through analyzing the key informant interviews with three case studies were compared with challenges and limitations highlighted by the national experts. Despite the varied disaster and climate exposure levels in the case districts, challenges in mainstreaming CCA and DRR into the food security sector were more or less similar. Challenges and limitations highlighted by the national experts were also common to districts and selected three case studies. The researcher identified a comprehensive and valid list of challenges and limitations, as stated in Table 6-2. It also summarizes recommendations for overcoming the identified challenges for mainstreaming CCA and DRR into food security sector planning.

Table 6-2: Challenges and limitations in mainstreaming CCA and DRR into the food security sector

Challenges and Limitations	**Measures for overcoming the challenge**
The disconnect between National Policies and Local level needs.	• Advocacy for change. • Communication and awareness creation. • Empowerment of local actors. • Knowledge generation and dissemination.
A fragmented approach to integration.	• Advocacy for change. • System reengineering with a unified planning system. • Communication and awareness creation. • Empowerment of local actors. • Establishment of multi-stakeholder coordination platforms.
Governance issues.	• Advocacy for change. • Implementation of monitoring and evaluation mechanisms. • Policies and legal provisions.
Lack of accountability and monitoring.	• Implementation of monitoring and evaluation mechanisms. • Policies and legal provisions.
Lack of data and evidence.	• Data-driven solutions. • Financing and incentives.
Lack of communication, awareness and understanding.	• Communication and awareness creation.

	• Reforming education and awareness systems.
Lack of leadership and initiatives.	• Empowerment of local actors. • Strategic leadership and supervision. • Knowledge generation and dissemination. • Visioning and strategic planning. • Create and recognize champions.
Attitudes and human factors.	• Knowledge generation and dissemination. • Visioning and strategic planning. • Create and recognize champions.
Lack of mechanisms and mandated institutions.	• Policies and legal provisions. • Visioning and strategic planning. • Advocacy for change.
Multi-stakeholder coordination issues.	• Formulation and revisions of policies and legal provisions. • Visioning and strategic planning. • Establishment of multi-stakeholder coordination platforms. • Avoid stand-alone planning processes. • System reengineering with a unified planning system.
Lack of policies and legislation.	• Formulation and revisions of policies and legal provisions. • Advocacy for change.
Lack of scale-out and scale-up of good practices.	• Scale-out good practices.

	• Communication and awareness creation. • Knowledge generation and dissemination. • Create and recognize champions.
Lack of tools and methodologies.	• Reforming education and awareness systems. • Knowledge generation and dissemination. • Diversification of expertise and resources.
Lack of land use planning and zoning.	• Advocacy for change. • Policies and legal provisions. • Visioning and strategic planning.
A mismatch between administrative boundaries and ecosystem boundaries.	• Policies and legal provisions. • Visioning and strategic planning. • Avoid stand-alone planning processes.
Political interferences.	• Advocacy for change. • Policies and legal provisions. • Visioning and strategic planning. • Implementation of monitoring and evaluation system strengthening.
Lack of technical knowledge and know-how.	• Knowledge generation and dissemination. • Reforming education and awareness systems. • Diversification of expertise and resources.
Lack of financial solutions and resource use efficiency.	• Financing through multiple sources and incentive schemes.

	• Diversification of expertise and resources. • Market-based approaches.
Disconnect between early warning and application at local levels.	• Implementation of monitoring and evaluation system strengthening. • Knowledge generation and dissemination. • Data-driven solutions. • Communication and awareness creation.
Lack of resources and support systems.	• Vision setting and strategic planning. • Financing through multiple sources and incentive schemes. • Diversification of expertise and resources.

There remain hurdles and uncertainties in adopting climate change adaptation, particularly at the farmer level. Therefore, essential national policy frameworks must be improved in such a way that they empower farmers' coping capacity to adapt to the negative effects of climate change at local level (Eeswaran, 2018). The author further recommends that collaborative and participatory research projects must be encouraged in order to generate and disseminate new findings. These findings are critical for developing and strengthening both long-term and near-term regional-specific, multiple adaptation planning at various levels in order to sustain Sri Lanka's food security and economic growth in the face of climate change. Building and enhancing the agricultural sector's and farmers' resilience to climatic shocks need renewed commitments to substitute labour with capital, such as the growth of service markets or mechanization options (Scognamillo et al., 2022). Additionally, authors argue that the

establishment and strengthening of markets for additional crops is critical to supporting expanded agricultural production diversification. Some of the key barriers to mainstreaming climate change and disaster risk reduction into sectors include dominant structural adaptation ideologies, expert and bureaucracy-dependent policymaking processes, and a lack of adaptive and integration culture and capacities at the institutional level, all of which significantly offset the mainstreaming process that must be adequately addressed for climate change adaptation (Huq et al., 2017). In developing countries, the lack of coherence in coordination across agencies addressing climate change adaptation (CCA), disaster risk reduction (DRR), and food security (FS) policy exacerbates food insecurity concerns (Zembe et al., 2022a). South Asian countries, like many developing countries, often follows a sectoral model that ignores the interconnectedness and interdependence of the other sectors. Although the concept of a water-energy-food nexus is gaining traction, and adaptation to climate change has become an urgent need, little effort has been taken thus far to study the connections between the nexus perspective and adaptation to climate change (Rasul & Sharma, 2016).

6.5 Comparison between the empirical and literature findings

As shown in Table 6-1, key systemic vulnerabilities of the food security sector should be addressed through appropriate measures to ensure the effective mainstreaming of CCA and DRR into food sector planning processes. National experts and key informants identified a range of mainstreaming measures in the case studies, as shown in Table 6-1. According to FAO, there are four pillars for addressing DRR for food and nutrition security, which are institutional strengthening and good governance for DRR in agriculture sectors; information and early warning systems on food and nutrition security; preparedness for effective response and recovery in agriculture, fisheries, and livestock; and prevention, mitigation and building resilience with technologies, approaches, and practices across agricultural sectors (FAO, 2013). Mainstreaming measures identified by empirical evidence with national experts and key informants are contributing and attributing to above stated four pillars and largely can be placed under them. Furthermore, empirical evidence is largely in line with the indicative mainstreaming measures given by FAO for 'Synergies between DRR and Climate Change Adaptation for Food and Nutrition Security' (FAO, 2013). Furthermore, food security exposure to disasters and climate change stated in the literature is also revealed through empirical evidence collected from national experts and key informants from the case districts. In addition, empirical evidence also reaffirmed the DRR mainstreaming measures stated in the World Food Program Policy on Disaster Risk Reduction and Management for Building Food Security and Resilience (WFP, 2011b). Extreme events caused by climate change pose a significant threat to food security and the elimination of poverty. Therefore, strengthening food is needed to respond to the effects of climate change as well as addressing disaster risks. However, the link between food security, disaster risk reduction DRR, and CCA is not consistently recognised in policies, strategies and plans, resulting in fragmented implementation (Zembe et al., 2022b). The same issue around fragmented approaches to integration and implementation were identified through empirical evidence, as stated in the Table 6-2. It is evident through literature that climate shocks and successive disasters can induce substantial long-term damage to livelihoods and food security, while reversing the gains in poverty reduction, agricultural development, and hunger eradication (Trujillo et al., 2015). The authors further highlight that the apparent correlation between climate shocks, disasters and food security highlights the susceptibility of food production systems to natural disasters and climate change will increase this further. The same complex issues were identified through the empirical evidence as discussed in detailed in sections 5.3.1.4.6, 5.3.1.4.7, 5.4.2.3.4, 5.4.3.3.4, 5.4.4.3.4, and 5.4.5.2 and listed in Table 5-2. and section 6.2

In line with published literature, empirical evidence found that Sri Lanka faces many challenges in mainstreaming CCA and DRR into the food security sector. According to FAO, there are several key challenges for CCA and DRR mainstreaming into agriculture. Those include parallel structures for DRR and CCA, resulting in institutional parallelism and inefficiencies; government actions and attitudes that are oriented toward responding to disasters; a lack of efforts to develop a shared understanding, indicators, information system, and knowledge management system; ownership of and use of information on disasters and climate change and risks; lack of clear leadership and incentives for mainstreaming and power dynamics amongst government agencies; cross-sectoral coordination heavily relies upon political support; the relationship between national and subnational governments, as well as the lack of sufficient knowledge, resources and capacity at sub-national levels; a lack of involvement and influence by local stakeholders and communities; and influence of external actors on mainstreaming DRR and CCA (FAO, 2019). Many of the mainstreaming initiatives are planned, developed, and implemented independently, with little knowledge of how disaster and climate risk are linked with development sectors. Furthermore, progress in mainstreaming agenda is hampered by a lack of knowledge of how the combination of these concepts might result in greater risk governance in South Asia (Trujillo et al., 2015). Authors also emphases on the significance of political will and leadership, capacity restrictions, and institutional hurdles that must also be addressed promote mainstreaming across the disciplines and sectors. The research provided further empirical evidence and produced a comprehensive list of challenges and limitations in mainstreaming CCA and DRR into the food security sector in the Sri Lankan context. Table 6-2 summarizes a comprehensive list of challenges and issues related to mainstreaming CCA and DRR into food security sector planning. Thus, the research has significantly contributed to the advancement of theory and knowledge by highlighting real challenges faced by districts in mainstreaming CCA and DRR into the food security sector and measures to overcome them.

Furthermore, the Global Platform for Disaster Risk Reduction (GPDRR 2022) raised awareness about a few critical areas that must be addressed to mainstream disaster risk reduction and ensure a resilient agriculture sector and food security. Those can be summarized as the 'need for a multisectoral and multi-hazard approach to reduce vulnerabilities; natural resources and land-use as a critical infrastructure; integration of food preservation strategies in DRR planning and co-creating climate resilience for the agriculture sector' (UNDRR, 2022a). The integration of disaster risk reduction and climate change calls for multi-sector and multi-stakeholder interaction, a stronger conceptual model, increased ecological understanding, meaningful community

engagement, and novel use of spatial tools (Zarouk et al., 2021). The empirical investigation revealed a detailed menu of options for mainstreaming CCA and DRR measures into the food security sector in Sri Lanka, further contributing to theories and a body of knowledge on the subject area.

6.6 Framework to mainstream CCA and DRR into food security sector planning.

The conceptual Framework in Figure 3-2 illustrates how CCA and DRR can be integrated into food security sector planning at the sub-national level. Accordingly, primary data were gathered and analyzed to identify the inherent and systemic vulnerabilities of the food security sector to climate change and disasters to identify effective measures for mainstreaming CCA and DRR food security sector at the district level (see sections 6.2 and 6.3). Subsequently, challenges and limitations faced by the district governments in mainstreaming CCA and DRR into the food security sector were identified (see section 6.4). To address the challenges for mainstreaming CCA and DRR and the underlying vulnerabilities of the food security sector, a set of recommendations were made on how to overcome these barriers and empower district governments and other local actors to facilitate CCA and DRR mainstreaming into food security sector planning at the subnational and local levels. Consequently, based on the findings of the case studies and expert interviews, the researcher developed a framework for mainstreaming CCA and DRR into food security sector planning at local levels as presented in Figure 6-1. The Framework was developed as described in sections 3.4 and 3.5. It was then presented at the validation roundtable workshop, attended by 16 senior academics and researchers working in food security, CCA, and DRR (see section 4.10. 1.4)

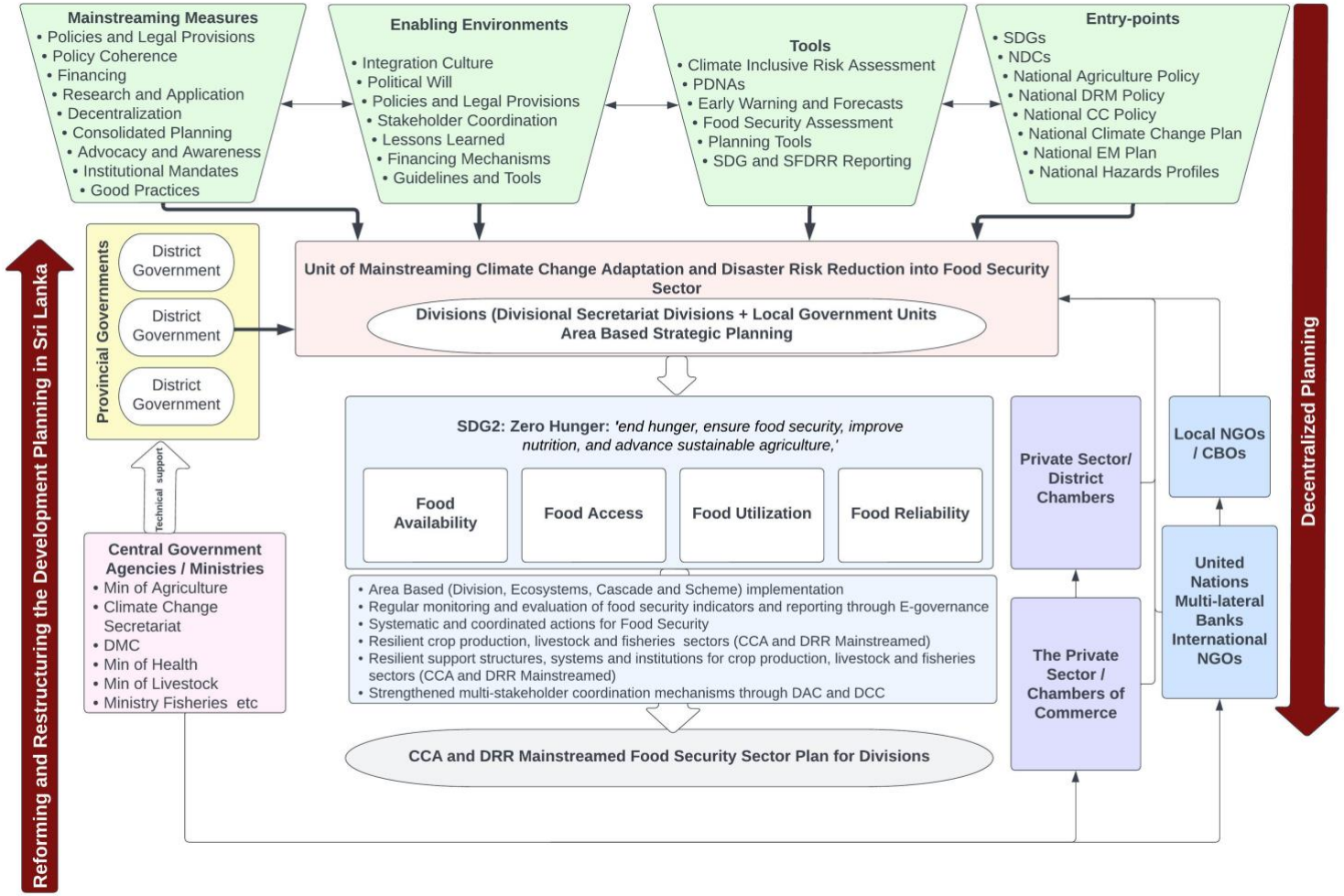


Figure 6-1: Developed Framework for Mainstreaming CCA and DRR into Food Security Sector Planning in Sri Lanka.

During the validation event, participants appreciated the depth and details of the analysis and remarked as a timely and relevant research to the current food security context in Sri Lanka. During the validation session, feedback and inputs were received from participants from the University of Ruhuna, the University of Moratuwa, the University of Sabaragamuwa and the Eastern University of Sri Lanka. There were four major feedback received during the validation, as stated below.

- Participant FV05 suggested identifying an entity that can lead and facilitate the overall planning and guide the reforming and restructuring processes to ensure food security. The researcher acknowledged the comments and clarified that the Sustainable Development Council and the Finance Commission of Sri Lanka could play a leading role as stipulated in the Framework; however, constitutional and legal provisions would be required. As this comment is a very relevant and essential to lead the implementation of the framework, those two entities were added to the framework clearly identifying their leadership roles to work with both national and local government settings in Sri Lanka.
- Participant FV09 inquired whether themes connected to food security could be quantified using weights assigned to each theme to assess the contribution and attribution of each. The researcher explained that the purpose of this research is to identify themes and concepts and design the planning framework and acknowledged that such quantification is possible from multiple disciplines such as economic, statistics and mathematics, but further clarified that such quantification could be addressed in further research studies taking the Framework further. Therefore the researcher did not attempt to incorporate this comment as it is beyond the scope of this research and it needs further research and estimation processes. However this has been added to the section 7.7: Further Research as it is very important area and a knowledge and a practice gap currently.
- Participants FV11 suggested incorporating e-governance and smart governance to address key challenges and barriers in mainstreaming the CCA and DRR into the food security sector planning process. The researcher acknowledged and confirmed that the experts also recommended e-governance, which will be incorporated into the Framework. Furthermore, the government of Sri Lanka and other development partners are promoting e-governance and smart governance across all development disciplines and administration. The researcher find this is a very relevant and should

be a critical aspect of the framework for its success implementation. Therefore e-governance was incorporated as one of the most important tools for mainstreaming CCA and DRR into food security sector planning as reflected in the revised framework.

- Participant FV12 suggested highlighting the Monitoring and Evaluation as a critical element of the Framework as it is one of the main issues in the Sri Lankan planning system. The participant also suggested reinforcing the framework through literature from other countries, specifically in South Asia, so that the Framework can be further strengthened beyond the context of Sri Lanka. The researcher agreed that M& is very critical aspect of any planning processes and framework so that its implementation progress can be tracked and assess against the baseline. Furthermore the research agreed that M&E tools can be embedded into the mainstreaming tool box of the framework, therefore M&E was added in the tools sections of the framework as reflected in the revised framework. The researcher also acknowledged the suggestion to add further literatures into the data analysis and the framework as reflected in the chapter 5 and 6.
- Participant F16 commented on the depth and details of the research and suggested that the Framework can be incorporated into the teaching of the proposed Master of Sciences in Building Resilience in Tropical Agro-Ecosystems to be launched by the University of Ruhuna, Sri Lanka. The researcher acknowledged this request and informed them that the thesis with the framework will be deposited in the library of the University of Huddersfield for public access so that they can access it in the future. The research did not modify the framework based on this comment as it is more related to the use and application of the framework in the future.

The conceptual framework presented in Figure 3-2 demonstrated the need for mainstreaming CCA and DRR into the food security sector at the local level. The Framework presented in Figure 6-2 illustrates how the mainstreaming of CCA and DRR could be facilitated to ensure food security at local levels. Thus, the validated Framework depicted in Figure 6-2 can be viewed as an expansion of the conceptual Framework, which illustrates how district governments of Sri Lanka could mainstream CCA and DRR into food security sector planning.

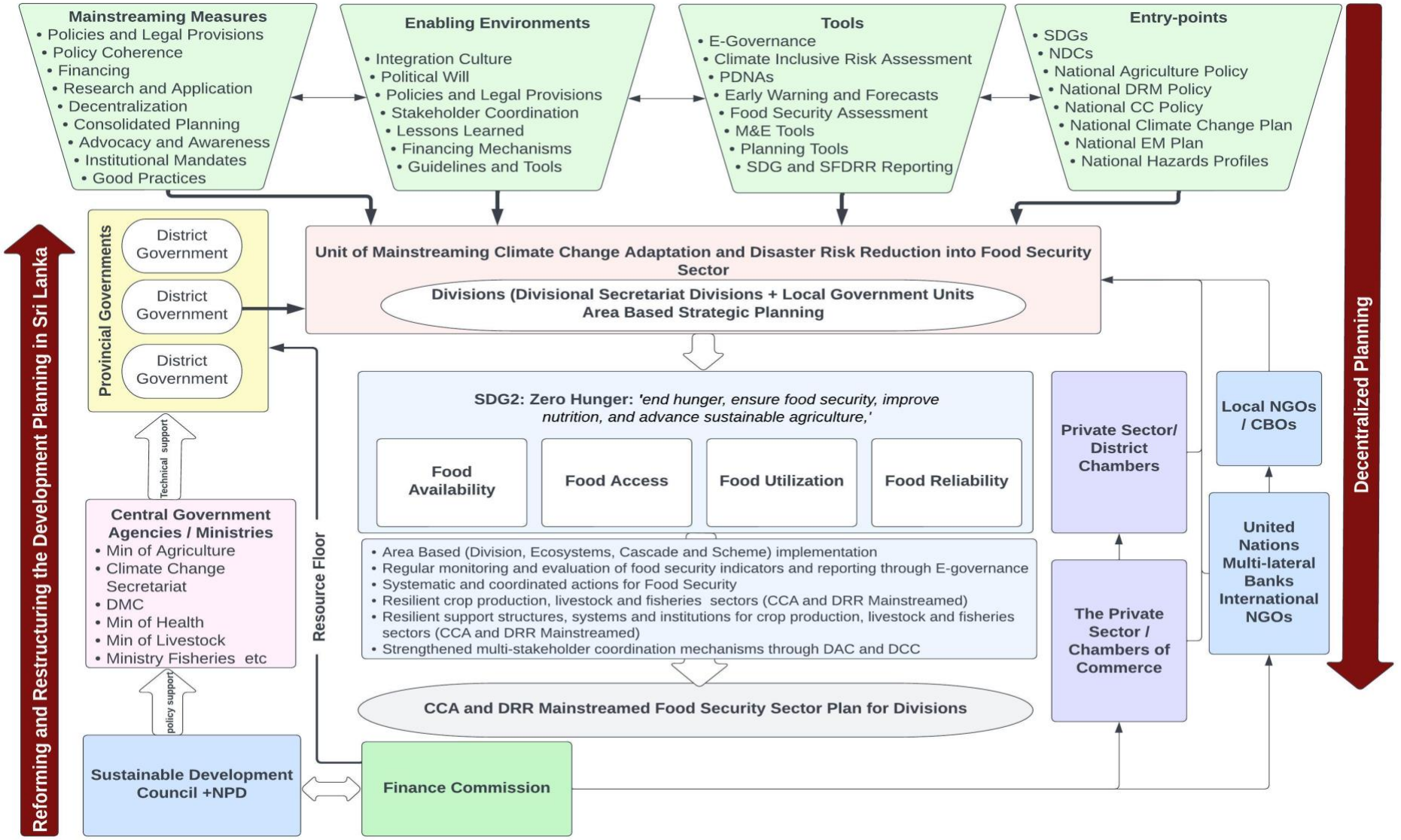


Figure 6-2: Validated Framework for Mainstreaming CCA and DRR into Food Security Sector Planning in Sri Lanka.

6.7 Recommendations to reform and restructure the planning processes for mainstreaming CCA and DRR into the food security sector.

Experts' opinions (Section 5.3.3) and key informants' suggestions (Sections 5.4.2.3.8, 5.4.3.3.8; 5.4.4.3.8) were gathered and analyzed for synthesizing recommendations on reforming and restructuring the current planning systems to effectively mainstream CCA and DRR into food security sector planning processes. Key recommendations are outlined below.

6.7.1 Vision Setting and Strategic Planning Framework

Longer-term vision setting, a strategic planning framework, and a theory of change should be applied to the Sri Lankan planning process. The current planning process is predominantly driven by the annual budgeting cycle without a longer-term vision, theory of change and strategic thinking. Therefore, as discussed in sections 5.3.2.2.2; 5.3.2.2.3; 5.4.4.3.8, and 5.4.2.3.8 experts suggested restructuring and reforming the planning processes to ensure that a rational strategy and theory of change with a longer-term vision setting, through a visioning process, should be integrated into the new planning frameworks.

6.7.2 Advocacy for Change

Expert believes that a transformational change should take place in the planning sector and processes of Sri Lanka. As discussed in section 5.3.2.2.1 and 5.3.3.8 the multi-level transformation from national to local level and the thinking process should be changed. The idea is to integrate disaster risk management and climate change adaptation into the food security sector, looking at the whole system, its components, and interactions, and facilitate system-level transformation. There should be a political and bureaucratic will to bring transformation; therefore, advocacy plays a crucial role. Such transformational change needs a political and educational revolution, governance, and leadership, which can be achieved through advocacy.

6.7.3 Policies and Legal Provisions

Experts also recommended having legal and policy provisions reflected in the constitutions or bringing constitutional changes facilitating integrated planning and their implementation at multiple levels as discussed in sections 5.3.2.2.8 and 5.3.3.1. Having enforcement mechanisms for mainstreaming and integrated planning processes is crucial to mainstreaming CCA and

DRR into the food security sector. The existing governance structure of the government and relevant policy provisions should be strengthened instead of creating shadow structures. If the current policies and legal provisions are inadequate, existing legislation such as Disaster Management Act, Environment Act, Sustainable Development Act and agriculture-related legislation will require revision to provide a more substantial enforcement authority and accountability to facilitate the integration.

6.7.4 Procedures and Guidelines

There should be tools, procedures, and guidelines for sectoral agencies to follow and facilitate mainstreaming in line with the national development vision of the country, which is currently lacking. As discussed in sections 5.3.2.2.5 and 5.3.3.5, the mandated agencies such as the Sustainable Development Council, the National Planning Department and the Finance Commission of Sri Lanka should develop a conceptual framework and related tools when introducing new strategies, policies and programs to bring all the actors together in an integrated manner. Some tools and guidelines are not comprehensive enough; therefore, revisiting them to redesign the approach is required.

6.7.5 Multi-stakeholders Coordination Platforms

The experts also recommended establishing or revitalizing multi-stakeholder coordination platforms allowing different agencies to share information and work together in achieving common goals such as mainstreaming CCA and DRR into sectors (refer to section 5.3.3.4). As food security is a multisectoral issue, having such active multi-stakeholder coordination platforms facilitate the mainstreaming of CCA and DRR in the sector. Furthermore, reforming current planning processes requires all parties' involvement to succeed, including coordination platforms and engagement mechanisms.

6.7.6 Implementation, Monitoring and Evaluation Mechanisms

Experts discussed and explained the need for having appropriate institutional mechanisms for the plan implementation, monitoring and evaluation in an integrated manner (refer to sections 5.3.3.7, 5.4.2.3.8, 5.4.3.3.8 and 5.4.4.3.8 for specific details). The emphasis must be on developing systems and facilitating the implementation, ensuring the sustainability of the plans. It should be part of the planning itself. Sustainability mechanisms should be embedded in the planning process itself. There should be a screening mechanism in the M&E system to

ensure every project and related activities of plans are screened to mainstream climate change and disaster risks at the design stage, and related tools should be developed. There should be improved capacity in implementing the M&E system, and all actors should be mobilized into a common M&E framework and accountability embedded within the M&E system.

6.7.7 Empowerment of Local Actors or Localization of Planning

As discussed in sections 5.4.4.3.8, 5.4.3.3.8 and 5.4.2.3.8, the experts recommended empowering local-level agencies and actors in planning and related decision-making processes. Food security, climate change and disaster risk reduction-related issues can be better addressed by looking at root causes and potential solutions at the local level. Local institutions and organizations can begin integrating climate change, disaster risk, and food security concerns into local development plans and programs without waiting for national support. Local and ground-level actors should play a more significant role, while national and district-level actors should facilitate and empower local actors for improved decision-making processes and integration of CCA and DRR into food security sector planning.

6.7.8 Diversification of Expertise

Each department should have a multidisciplinary staff. Diversifying expertise across sectors will help to ensure that multidisciplinary teams and experts are present in each sector to facilitate mainstreaming and integrated planning processes. Otherwise, mainstreaming climate change and disaster risk reduction into planning will not take place due to the lack of expertise and technical knowledge gaps within the sectors (refer to section 5.4.3.3.8, and 5.4.4.3.8)

6.7.9 Data-Driven Solutions in Planning and Mainstreaming

Sri Lanka's planning processes are not data-driven but based on annual budgets. Experts believe and recommend that plans be scientifically developed through data-driven processes and informed by research findings. Experts suggested that specialized agencies like the meteorology department should focus on producing quality and reliable data for informed, data-driven planning processes. Information and data on DRM and CCA should be publicly available so planners, planning agencies and related local actors can use them for regular planning and mainstreaming. In addition to financial resources, planning also needs technology and technology transfer. It is about data, information, and knowledge to use for planning. Moreover, data-sharing mechanisms should be established for effective planning and

mainstreaming CCA and DRR into the food security sector (refer to specific details in section 5.3.2.2.5; 5.4.2.3.8; 5.4.3.3.8, and 5.4.4.3.8)

6.7.10 Reform Education and Awareness Generation

Reforming the education and awareness generation process in the country will also support transforming the existing planning processes in the country. The experts believe the education system should be reformed for better education, argument methods, logical thinking and reasoning to facilitate creative thinking and planning at various levels. Such reforms will require multiple forms, media, and communication campaigns. Climate change has been declared a climate emergency in multiple countries, so such an emergency highlights the urgency that the campaign needs to address at multiple levels, including planning processes. Strategic communication to generate public discussions and dialogue is needed to facilitate reforming and mainstreaming CCA and DRR into the food security sector. Multiple means and processes should be adopted in awareness generation, considering the urgency of the need (refer to section 5.4.3.3.8 and 5.3.2.2.12).

6.7.11 Leadership

Mainstreaming CCA and DRR into the food security sector and reforming current planning structures and processes need strong leadership at multiple levels (refer to section 5.3.3.2). It is a change process that needs committed and visionary leaders to drive it. Visionary leaders must be able to drill down and debunk myths, comforts, and territories in order to support integrated planning and mainstreaming processes. Visionary leadership is required for planning and implementation at multiple levels, as Sri Lanka faces challenges in implementing, monitoring, and following up on mainstreaming. As planning is done in a knowledge-based society, leaders should know how mainstreaming works from a technical and operational point of view.

6.7.12 Strengthen Thematic Identities

Sri Lanka's planning processes are designed around ministries, departments, and their related institutions rather than thematic level planning. Therefore, planners and officials used their institutional identities in planning, which became a bottleneck for mainstreaming and integrated planning. Organizations must change their institutional or unit identity to facilitate mainstreaming and focus more on thematic identities such as food security and nutrition.

Otherwise, each agency portrays its institution as the best and most relevant. With this attitude, mainstreaming is challenging. A thematic identity will facilitate successful mainstreaming at the sub-national level, specifically at the district and provincial levels, as they operate as parallel systems (refer to section 5.3.3.4). Furthermore, related agencies under a particular thematic area should be brought under the same parent ministry to make integration faster and smoother.

6.7.13 Create and Recognize Champions

As discussed in section 5.4.3.3.8, creating and recognizing champions to drive the reform process and mainstreaming CCA and DRR into the food security sector is a priority. Multiple champions in different sectors with thematic identities and a common goal for advocating and promoting the mainstreaming process are critical to its success. Various organizations should recognize such champions to drive CCA and DRR integration into the food security sector.

6.7.14 Financing and Incentives for Mainstreaming

As disc used in section 5.3.3.6; 5.4.2.3.8 and 5.4.4.3.8, financial instruments for incentivizing mainstreaming are a vital recommendation to consider. Incentives could be given to the sectors and agencies for integrated planning processes. It can also be linked to banking systems as a prerequisite for credits or tax incentives. Experts also suggested dedicated budgets for mainstreaming in addition to the direct budget that they receive for sectoral interventions. Furthermore, building the capacity of national institutions to access global financial solutions such as the Green Climate Fund was highlighted. The Green Climate Fund has not accredited most Sri Lankan institutions. Therefore, if Sri Lankan agencies can be accredited and capacitated to access climate financing, such an approach will facilitate mainstreaming processes. Furthermore, there should be a mechanism for compensation and insurance schemes if their crops are getting damaged from disasters and climate change impacts. The risk financing sector should be further developed to support the mainstreaming of CCA and DRR in the food security sector.

6.7.15 Recommendations for the execution of reforming and restructuring the planning system.

As discussions in sections 5.3.2.2.13; 5.3.2.2.14; 5.4.2.3.8; 5.4.3.3.8 and 5.4.4.3.8, one of the main suggestions from experts was to establish or empower an existing organization with a

clear mandate, authority, and enforcement capabilities for restructuring the existing planning system, enabling integrated planning processes, and mainstreaming across all sectors. Experts also recommended the execution model of reperforming and restructuring the current planning system. Some of the recommended potential entities include the Sustainable Development Council of Sri Lanka and the National Planning Department (refer to section 5.3.2.3.1); however, it is accepted that the current mandate, authority, and enforcement capabilities of these entities should be reviewed and strengthened so that they can mobilize, guide, implement, monitor, and evaluate the overall process. The role of political leadership was also highlighted, and with the current constitution, the Executive President of the country should provide the leadership role (refer to section 5.3.3.2). If the current institutional, legal and ministerial frameworks are insufficient, the experts also recommended possible constitutional changes enabling integration and mainstreaming CCA and DRR into the overall socio-economic development planning of the country (refer to sections 5.3.2.2.8; 5.3.3.1; 5.3.2.2.9). The need for support systems was also discussed including the establishing Task Forces, Technical Working Groups, Universities and Think-tanks linked to industry. It was also recommended that all the planning secretariats at different levels (national, provincial, district, and divisional) be mobilized and institutionalized under the proposed central agency to coordinate, monitor, report, and evaluate progress (refer to sections 5.3.2.2.4; 5.3.2.3.2; 5.3.3.8 and 5.3.3.8).

6.8 Summary and link

This chapter discusses the main findings of the research, highlighting, comparing, and contrasting key informant interviews from three case studies, national experts' interviews, and literature. The chapter also presents a framework for mainstreaming CCA and DRR into food security sector planning from national to sub-national levels. Finally, the chapter summarizes the findings from the final validation roundtable exercise. It presents the validated Framework and a set of recommendations to reform and restructures the planning processes for enabling the mainstreaming of CCA and DRR into food security sector planning processes. Following the presentation of the key findings of this research, the next chapter presents the research conclusion.

CHAPTER 7 : CONCLUSIONS

7.1 Introduction

The thesis began with the Introduction Chapter, followed by a detailed literature synthesis in Chapter 2. Based on the literature reviews and international experts' opinions, a conceptual framework was designed and presented in Chapter 3. The detailed research methodology was then presented in Chapter 4 using Saunders et al. (2009) research onion. Chapter 5 presented a detailed analysis of the empirical data gathered through national expert interviews and key informant interviews from case studies. The main findings of the research are presented in Chapter 6. In this context, the research conclusions were reached by summarising the results of the research as follows.

- Firstly, the aim and objectives of the research are outlined.
- Secondly, the findings of the research objectives are discussed.
- Thirdly, the contribution to knowledge is discussed by explaining how research affects theory and practice.
- Fourthly, the limitations of the research are identified and discussed.
- Finally, some further areas of research are proposed.

7.2 Synthesis of the Research Aim and Study Objectives

The aim of the research is to design a comprehensive planning framework to mainstream climate change adaptation and disaster risk reduction into food security sector planning at sub-national levels in Sri Lanka. To accomplish this goal, the research specifically investigated how an integrated climate change adaptation and disaster risk management planning framework for the food security sector can be designed. Accordingly, the following objectives were designed and investigated through literature reviews, documents and archival records and empirical research:

- Investigate the need for and importance of mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka. This objective was addressed through literature reviews and national experts' interviews (see section 7.2.1)
- Explore effective methods and approaches for mainstreaming climate change adaptation and disaster risk management into food security sector planning processes

in Sri Lanka. This objective was explored through literature reviews, and empirical evidence gathered through national experts' interviews and key informant interviews from the case studies (see section 7.2.2)

- Design a comprehensive planning framework for mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka. This objective was achieved by designing the framework based on findings from the empirical data analysis and presenting them in Section 7.2.3.
- Make recommendations as to how planning structures and processes can be reformed to ensure effective mainstreaming of climate change adaptation and disaster risk reduction into the food security sector in Sri Lanka. This objective was empirically investigated through national expert interviews, case studies, and the validation roundtable discussion (section 7.2.4). The sections below highlight the key findings related to each research objective.

7.2.1 Objective 1: To investigate the need for and importance of mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.

The first objective of the research was to investigate the need for and importance of mainstreaming CCA and DRR into the food security sector in Sri Lanka. It was mainly investigated and explored through literature reviews (see Section 2.9.3) and the empirical evidence gathered through national expert interviews (see Section 5.3.2.1, and 5.3.2.2). Food security is a fundamental human right and a basic need; however, it has been challenged as never before due to the impacts of climate change and disasters (refer to sections 2.2 and 2.2.5; 2.3.4.1). It was evident from the literature and empirical data that climate change and disasters affect food availability, food access, food utilisation, and food reliability in Sri Lanka. Furthermore, the food security sector of Sri Lanka is primarily comprised of three sub-sectors: agriculture, fisheries, and livestock. All sub-sectors are highly vulnerable to climate change and disasters due to their heavy dependence on water, weather, climate, and other related atmospheric parameters (see the section 2.3.4.2 and 5.3.1.1). In addition, it was evident that the food security sector of Sri Lanka has a range of systemic vulnerabilities that make availability, access, stability, and utilisation of food beyond the reach of at-risk communities (refer to section

5.3.1.4.7). It is also revealed that planning processes, tools, and approaches are fragmented, and food security sector planning is at a very primitive stage at the subnational levels in Sri Lanka (see the section 6.4). Therefore, literature and empirical evidence reaffirmed that CCA and DRR should be mainstreamed into food security sector planning through multiple dimensions and sub-sectors, keeping the divisional administrative boundary as the planning unit. Evidence suggests that mainstreaming CCA and DRR into the food security sector will make the sector more agile and resilient to future climate and disaster shocks, enhancing food security of at-risk communities exposed to climate change and disasters (see the sections 5.3.2.1and 5.3.2.3.2).

7.2.2 Objective 2: To explore effective methods and approaches for mainstreaming climate change adaptation and disaster risk management into food security sector planning processes in Sri Lanka.

The second objective was to explore and investigate effective methods and approaches for mainstreaming CCA and DRR into food security sector planning processes in Sri Lanka. The effective methods were empirically investigated through national experts' interviews and key informant interviews with case studies and then validated through literature and the validation roundtable discussion with experts. Empirical evidence collected through experts' interviews and key informant interviews suggests that CCA and DRR mainstreaming is at a very primitive stage in Sri Lanka due to a range of challenges and limitations such as lack of policies and legislations, the disconnect between national policies and local level needs, governance issues, data and data reliability issues, fragmented approach to mainstreaming and planning processes, lack of accountability and monitoring, lack of awareness and understanding, lack of leadership and initiatives, attitude and the human factor, lack of mechanisms and mandated institutions, multi-stakeholder coordination issues, lack of tools and methodologies, lack of land-use planning and mismatch between administrative and ecosystem boundaries, political interference and lack of technical knowledge and know-how (refer to sections 5.3.1.4.7; 5.4.2.3.5; 5.4.3.3.5; and 5.4.4.3.5).

Reflecting on the systemic vulnerabilities and challenges in mainstreaming CCA and DRR into the food security sector stated in section 5.3.1.4.7, empirical evidence revealed a menu of mainstreaming measures, including advocacy and enhance understanding; area based strategic planning; comprehensive and consolidate planning; decentralisation; enhance technology, data and

application; financing and resource allocation; governance and enforcement; policies and legal provisions; policy coherence; research and applications in implementing policies and related programs; the revival of good historical practices; strategic communication and extension; strengthening institutions, mandates and support structures; and training and capacity building (see section 5.3.2.2). Specific CCA and DRR mainstreaming measures into the food security sector in each case study are discussed in section 5.4.2.3.8, 5.4.3.3.8, and 5.4.4.3.8 and the cross-case analysis presented in Table 6-1 and Table 6-2, along with the associated vulnerabilities and challenges.

7.2.3 Objective 3: To design a comprehensive planning framework for mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.

The third objective was to design a framework to mainstream CCA and DRR into food security sector planning at sub-national levels in Sri Lanka. The initial conceptual framework designed and shown in Chapter 3 (see Figure 3-2) was used to design a comprehensive framework for mainstreaming CCA and DRR into food security sector planning processes. As shown in Figure 3-2, the need for mainstreaming and the vulnerability of the food security sector to climate change and disasters were identified during the framework formulation process. Subsequently, mainstreaming measures were identified through national experts' interviews (see the sections 5.3.1; 5.3.2.1; 5.3.2.2), and empirical evidence gathered from the key informants in the case studies (see the sections 5.4.2.3.8; 5.4.3.3.8 and 5.4.4.3.8). It was followed by analysing how vulnerabilities could be overcome and mainstreaming challenges be avoided or minimised by applying a range of tools, entry points, and enabling environments identified through empirical investigation (see sections 5.4.5.2 and 5.4.5.3). The initial framework was developed based on the findings of the case studies and national expert interviews (see Figure 6-1). As detailed in Sections 4.10.1.6 and 6.6, the initial framework was presented to a roundtable discussion for validation. The framework was refined based on feedback and input from the validation roundtable discussion, and the validated framework is shown in Figure 6-2.

7.2.4 Objective 4: To make recommendations as to how planning structures and processes can be reformed to ensure effective mainstreaming of climate change adaptation and disaster risk reduction into the food security sector in Sri Lanka.

The final objective was to recommend how planning structures and processes can be reformed to ensure effective mainstreaming of CCA and DRR into food security sector planning at sub-national levels in Sri Lanka. The findings from the national expert interviews (refer to sections 5.3.2.2; and 5.3.3) and case studies (refer to sections 5.4.2.3.8; 5.4.3.3.8 and 5.4.4.3.8) were primarily used to formulate recommendations to mainstream CCA and DRR into food security sector planning, supported by the inputs and feedback received during the framework validation roundtable discussion. Mainstreaming CCA and DRR into the food security sector is a complex, multifaceted, multi-sectoral, and multi-level effort; therefore, it cannot be done by the sub-national entities and district governments in isolation. It needs serious, concerted, and continued efforts with leadership and perseverance that benefit multiple national, provincial, district, divisional, and local stakeholders. The research has recognised that national and district governments can be crucial in empowering divisional authorities and actors to mainstream CCA and DRR into the food security sector. However, district governments and divisional actors face many challenges in mainstreaming CCA and DRR into food security sector planning processes (see sections 5.4.2.3.5; 5.4.3.3.5; and 5.4.4.3.5). Therefore, several recommendations were proposed to reform and restructure existing planning processes, systems, and instruments to enable the mainstreaming of processes across multiple levels (see sections 5.3.3; 5.4.2.3.8; 5.4.3.3.8 and 5.4.4.3.8). As presented in the validated framework (refer Figure 6-2) , it is evident that divisional actors and district governments need technical support, resources, and policy directives from various national-level mandated agencies and line ministries, as well as working collaborations with other non-government agencies such as the United Nations, development banks, NGOs, the private sector, and civil society groups. Among them, it is essential to establish a new or restructure an existing agency with a mandate, technical expertise, resources, and legal provisions at the national level to coordinate and facilitate the mainstreaming processes across the administrative and planning layers. The Sustainable Development Council, the National Planning Department, and the Finance Commission of Sri Lanka can play a leading role in this process; however, their mandates and strategic, technical, tactical, and operational roles should be restructured and reformed to facilitate mainstreaming CCA and DRR into food security sector planning processes (see the section 6.7). Another key recommendation is to

avoid parallelism between the central and provincial governments at the district and local levels. Accordingly, it is recommended that district governments be organised under the provinces and provincial governments be coordinated through mandated agencies at the national level, while the technical ministries provide technical support under the central governments. Such a reform process requires legal and constitutional provisions; therefore, it is recommended that current legislation and constitutional amendments be made. A range of tools, entry points, mainstreaming measures, data and technology use, and financing should be made available for the district and divisional stakeholders to mainstream CCA and DRR into food security sector planning (refer to Figure 6-2). Empowerment of local actors for making district and divisional level policies, establishing multi-stakeholder coordination platforms, effective use of forecasting and early warning, reforming the education system to bridge the gap between the industry and the education sector, and research and data-driven solutions are recommended to facilitate the mainstreaming processes at the sub-national levels (see sections 6.7.7; 6.7.5 6.7.9; and 6.7.10).

7.3 Contribution to Knowledge

This study contributes to knowledge specifically on the existing theories on how to mainstream climate change adaptation and disaster risk reduction into food security sector planning at sub-national and local levels. Post 2015 development agendas focus on sustainable development goals and priority actions for achieving them. The SDG-2, Zero Hunger has gained recognition as a global and national priority goal across the world and establishes clear interlinkages with risk drivers such as climate change and disasters, which could offset the progress of SDGs leading to food insecurity, if not addressed promptly. Thus post 2015 development agenda has led to the development of various frameworks, strategies, plans and programs at global, national, and local scales and became a very popular subject for researchers and practitioners. Therefore, this research contributes to the existing body of knowledge related to theories in developing frameworks in food security sector which are climate and disaster inclusive. It also contributes to the theories related to decentralized planning and making mainstreaming possible at sub-national level, while establishing policy, advocacy, financing and regulatory functions and nexus at the national level. Nexus and policy coherence in development is an emerging research area so this research specifically contribute to the existing body of knowledge on climate, DRR and development nexus, while taking food security as the core. With regards to practice, this research also contributes to how sub-national actors can be empowered to facilitate

mainstreaming processes by identifying menu of mainstreaming options, enabling environments, mainstreaming toolbox and entry points as depicted in Figure 6.2, so that respective practitioners can take this framework forward for mainstreaming CCA and DRR into food security sector planning. Specific theoretical and practice contribution to knowledge is stated in the following section.

7.3.1 Contribution to the Theory

Chapter 6 of this thesis discusses the overall findings of the research. With regard to theoretical contributions, the research demonstrates how CCA and DRR can be mainstreamed into food security sector planning at sub-national levels. The study has contributed to the existing body of theory and knowledge by identifying how the mainstreaming challenges faced by district governments and other local actors could be overcome by applying various CCA and DRR mainstreaming measures in the food security sector. The area of research has become a popular study area after the launch of the post-2015 development frameworks, namely the SDGs, SFDRR and the Paris Agreement. The second Sustainable Development Goal (SDG 2) aims to eliminate hunger by 2030. It aims to end hunger and ensure food access for all by 2030, as well as double agricultural productivity and incomes of small-scale food producers, ensure sustainable food production systems, implement resilient agricultural practices, as well as strengthen capacity for adaptation to climate change, extreme weather, drought, flooding, and other disasters. As a result, many institutions and practitioners began advocating for mainstreaming DRR and CCA into the food security sector to achieve SDG 2, zero hunger, and climate-resilient agriculture and food systems by 2030. That led to the development of various frameworks, policies, strategies, and programs at global, regional, national, and local levels. However, some of those efforts were limited to conferences, policy dialogues, and reports and lacked the rigorous scientific investigations needed to promote mainstreaming through empirical evidence and research findings. Furthermore, some of those frameworks are sector specific and lack the policy coherence and nexus through an integrated approach to address food insecurity issues. Therefore, this research and its findings significantly contribute to existing theories and knowledge with a rigorous empirical investigation and evidence for the mainstreaming of CCA and DRR into food security sector planning at sub-national levels in Sri Lanka and to create disaster- and climate-resilient food systems for all through policy coherence and integrated planning processes.

7.3.2 Contribution to Practice

The study demonstrates the food security sector's related vulnerabilities to climate change and the challenges of three districts in mainstreaming CCA and DRR into food security sector planning processes. Furthermore, the study demonstrates what can be done to mainstream CCA and DRR measures to reduce vulnerabilities and overcome food insecurity challenges. The study has also provided a framework to mainstream CCA and DRR into food security sector planning at the sub-national level. A range of recommendations have been formulated for reforming and restructuring existing planning processes, systems, and instruments to mainstream CCA and DRR into food security sector planning. Thus, the framework, recommendations, menu of options and toolbox will be helpful to relevant policymakers, technical agencies, planning secretariats, practitioners, and other non-governmental actors to understand the challenges, assess vulnerabilities, use tools, set enabling environments, and identify entry points for mainstreaming CCA and DRR into food security sector planning processes at district and local levels. Furthermore, the findings will help the district governments understand their roles and identify other key stakeholders that should be mobilised for planning and mainstreaming CCA and DRR into food security sector planning and implementation. The study significantly contributes to implementing global frameworks such as the SDGs, SFDRR, and the Paris Agreement at local levels. Local and sub-national actions and capacity building have been highlighted and emphasised in all post-2015 development agendas. Subsequently, national agencies have developed national strategies and plans related to the SDGs, disaster risk reduction, and climate change; however, their application and implementation at sub-national and local levels are yet to be seen. Furthermore, COVID-19 and economic downturns have posed significant food insecurity challenges to Sri Lankan communities at multiple levels. Food insecurity has been recognised as one of the most pressing needs in Sri Lanka today. Thus, the framework developed through this research and the related recommendations for reforming and restructuring the planning processes will benefit the sub-national and national agencies in transforming global and national strategies into actions at local levels ensuring food security for all. It is clear that the research was conducted on a key priority area; thus, it makes a valuable contribution to practice by providing a framework and recommendations for mainstreaming CCA and DRR into food security sector planning processes in the Sri Lankan context. Furthermore, the research findings and the framework have been presented in multiple fora at local and international levels, which can also be considered a contribution to the practice.

7.4 Limitations of the Study

As explained in Section 4.12, various research techniques were applied to ensure the validity and reliability of the research. Multiple sources of evidence, including national expert interviews, case studies, and a roundtable discussion on the framework validation, were used to conduct detailed data analysis. However, generalising the findings to a wider context was limited as the findings were very specific to the selected case studies. Nevertheless, the national expert interview findings are not specific to case study districts, so that they can be generalised to all Sri Lankan districts. As recommendations were formulated based on the national experts' interviews and supported by case study findings, they can be generalised and applied to all Sri Lankan districts. The generalizability and applicability of the framework were also validated through an experts' validation roundtable discussion; therefore, the framework can be used in any district or country. However, due to time and resource constraints, the framework was not tested and applied in a real district- and divisional-level food security sector planning process. Another limitation of this study is that data collection was restricted to specific districts of Sri Lanka because the research problem was specific and directly related to the Sri Lankan context and time constraint, specifically due to COVID-29. However, limited information was collected from international experts in designing the initial conceptual framework, as discussed in Chapter 3.

7.5 Further Research

7.5.1 Test the developed mainstreaming framework in a chosen district and update the framework based on application experience and learning.

One of the study's limitations is that the developed framework was not tested and used in the real food security sector planning of a district. Therefore, the developed and validated framework is proposed to be applied to a selected case study district and used in the actual food security sector planning process. The learning and experience gained from applying this framework in the real planning process can be incorporated into the framework and update it.

7.5.2 Adopt the developed mainstreaming frameworks to a district or sub-national level government in another developing country and update based on application learning and experience.

Another limitation of this research is that data collection was confined to Sri Lanka. Therefore, future research could test the framework's applicability in a district of another developing country, and the framework could be updated based on the outcome of that experience. This was also suggested by the experts who attended the validation roundtable discussion.

7.5.3 Undertake a similar study with cases from developed countries.

Climate change, disasters, and food security are global concerns, as reflected in post-2015 development frameworks. However, the data collection and the research were confined to Sri Lanka. Thus, it is also suggested that a similar study be conducted using case studies from developed countries to test the framework's validity. It will allow knowledge transfer and sharing of good practices and lessons learned to be replicated in developing countries.

7.5.4 Quantify the impacts of climate change, disasters, and other external shocks on food security.

A range of climate change impacts, disasters, and other external socio-economic shocks affect food availability, access, utilisation, and stability in Sri Lanka. However, no attempt was made in this study to quantify the specific impacts and their weightage on the food security status. Future studies could address the various dimensions of food security and their vulnerabilities and quantify the contribution and attribution of climate change and disasters to food insecurity to choose and prioritise mainstreaming and mitigation options. This recommendation was also suggested by experts who attended the framework validation roundtable discussion.

7.5.5 Undertake similar studies without limiting to the food security sector.

This study was limited to the food security sector, targeting SDG Goal 2 and related sub-targets. Climate change and disasters also impact the progress of other SDG goals, targets, and priority sectors. Therefore, it is recommended that similar studies be carried out for other priority sectors of SDGs and that the developed framework be applied, modifying relevant elements according to the

sector. This approach will empower district governments and other local stakeholders to mainstream CCA and DRR into other priority sectors rather than just one sector.

7.6 Final Note

The main findings of the study were summarised in this chapter based on the literature review, international experts' opinions, national expert interviews, key informant interviews in case studies, and expert validation roundtable discussions. The study developed a validated framework to mainstream CCA and DRR into food security sector planning processes at sub-national levels in Sri Lanka. Literature and empirical evidence revealed that the food security sector of Sri Lanka has multiple inherent and systemic vulnerabilities; therefore, district governments and local stakeholders face a number of challenges and bottlenecks in mainstreaming CCA and DRR into the food security sector. As such, the study also proposes a range of mainstreaming options and recommendations for reforming and restructuring the planning processes in Sri Lanka to enable effective mainstreaming of CCA and DRR into food security sector planning. Thus, as explained in sections 7.3 and 7.3, this research contributed to theory and practice.

APPENDICES

Annex A: The list of publications by the author.

Book Chapters Published (peer-reviewed)

Madurapperuma, S. J. K., Amaratunga, D., & Haigh, R. (2021). Disasters, Climate Change and Development Nexus: Food Security Sector in Asia. In D. Amaratunga, R. Haigh, & N. Dias (Eds.), *Multi-Hazard Early Warning and Disaster Risks* (pp. 111-126). Springer, Cham. https://doi.org/10.1007/978-3-030-73003-1_7

Madurapperuma Arachchilage, S., Amaratunga, D., & Haigh, R. (2021). COVID-19 Nexus with Food Security and Sustainable Growth: Impacts, Implications and Road to Resilience in Sri Lanka. In R. Senaratne, D. Amaratunga, S. Mendis, & P. Athukorala (Eds.), *COVID-19: Impact, Mitigation, Opportunities and Building Resilience: From Adversity to Serendipity* (Vol. 1, pp. 598-608). National Science Foundation of Sri Lanka.

Book Chapters in Progress (accepted for peer-reviewed publication)

Madurapperuma, S. J. K., Amaratunga, D., & Haigh, R. (2023). Food Security, Climate and Disaster Nexus: Need for Policy Coherence in Risk-Informed Development In *Proceedings of the 4th Global Summit of Research Institutes for Disaster Risk Reduction:* Engaging Sciences with Action. Springer Nature (to be published in 2023).

Madurapperuma, S. J. K., Amaratunga, D., & Haigh, R. (2023). Climate Change, Conflict and Peace Communication, establishing Nexus with Resilience and Food Security. *In S.L.* Connaughton, S. Pukallus (Eds.), *The Routledge Handbook of Conflict and Peace Communication.*Routledge/Taylor & Francis, USA (to be published in 2023).

Madurapperuma, S. J. K., Amaratunga, D., & Haigh, R. (2023). Emergent or a Tip of Iceberg: Vulnerability of Food Security Sector in Sri Lanka. In Building Resilience in Tropical Agroecosystems. Springer, (to be published in 2023)

Journal Article (in Progress)

Madurapperuma, S. J. K., Amaratunga, D., & Haigh, R. (2023). Role of Climate Change and Disasters in the Current Hunger Crisis and Food Insecurity in Sri Lanka: In Innovative Approaches toward Healthy and Sustainable Environment: Air, Water, Food, and Waste Treatment. Special Issue of Sustainability (ISSN 2071-1050).

International Conference Papers Presented (peer-reviewed)

Madurapperuma, S. J. K., Amaratunga, D., & Haigh, R. (2019). Disasters, Climate Change and Development Nexus on Food Security Sector in Sri Lanka, *International Conference on Structural Engineering and Construction Management (ICSECM 2019)*: Kandy, Sri Lanka, 12th-14th December 2019.

Madurapperuma, S. J. K., Amaratunga, D., & Haigh, R. (2021). Disasters, Climate Change and Development Nexus: Food Security Sector in Asia, *International Symposium on Multi-hazard Early Warning and Disaster Risk Reduction (MHEW 2020)*: Colombo, Sri Lanka, 14-16 December 2020

Madurapperuma, S. J. K., Amaratunga, D., & Haigh, R. (2021). Risk and Climate Sensitive Sustainable Development in Asia: Need for Policy Coherence in the Post Covid Development Phase, *2nd International Symposium on Disaster Resilience and Sustainable Development (DRSD 2021):* Asian Institute of Technology, Thailand, 24-25 June 2021

Madurapperuma, S. J. K., Amaratunga, D., & Haigh, R. (2023). Food Security, Climate and Disaster Nexus: Need for Policy Coherence in Risk-Informed Development, *4th Global Summit of*

Research Institutes for Disaster Risk Reduction: Engaging Sciences with Action, Kyoto, Japan, 31st August to 01st September 2021

Madurapperuma, S. J. K., Amaratunga, D., & Haigh, R. (2023). Emergent or a Tip of Iceberg: Vulnerability of Food Security Sector in Sri Lanka. In *Building Resilience, First International Conferences on Building Resilience in Tropical Agro-eco System (*ICBRITAE 2023)*, Colombo, Sri Lanka, 15 -16 March 2023*

Annex B: Research Brief

Mainstreaming Climate Change Adaptation and Disaster Risk Reduction into Food Security Sector in Sri Lanka

Research Overview: This research aims to develop a comprehensive planning framework to mainstream climate change adaptation and disaster risk reduction into food security sector planning processes at sub-national levels in Sri Lanka. It will be achieved through investigating existing needs, approaches, challenges, and recommendations to reform the planning process to be disaster and climate inclusive.

Research Objectives:

- To investigate the need for and importance of mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.
- To explore effective methods and approaches for mainstreaming climate change adaptation and disaster risk management into food security sector planning processes in Sri Lanka.
- To design a comprehensive planning framework for mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.
- To make recommendations as to how planning structures and processes can be reformed to ensure the effective mainstreaming of climate change adaptation and disaster risk reduction into the food security sector in Sri Lanka.

Research Strategy: Multiple Case Study Strategy

Selected Case Studies: Anuradhapura, Polonnaruwa and Trincomalee districts of Sri Lanka
Three case studies have been selected through a two-phase screening process. The districts of Anuradhapura, Polonnaruwa and Trincomalee, which are exposed to climate change, disasters and food insecurity, have been selected as the case study district to collect data.

Evidence (Data) Collection

The research data will be collected using **Key Informants' Interviews** with government policymakers, technical experts, and industry practitioners through semi-structured questions. Guiding questions are attached in Annex C and E**.** Guidance questions, consent form, research brief, and an official letter will be sent to all the interviewees before the interview, and each interview will be approximately 45 minutes. The interviews will be recorded with the consent of the research participants with supporting notes. The hard copies, interview notes and audiotapes will securely be stored in the University, following the UK Data Protection Act 2018: General Data Protection Regulation (GDPR). To ensure confidentiality, data will only be accessed by the researcher (me) and supervisors, and the anonymity of the participant's responses will be ensured. The collected data will only be used for this research and other related publications. In addition, government policies, strategies, plans and other related publications and archival records related to climate change, disaster risk management and food security will be studied to get in-depth knowledge and understanding of the cases to be observed.

Data Analysis:

- Qualitative Analysis with a Computer-Assisted Program (Nvivo-20)

Analytic Techniques:

- Thematic Mapping
- Cognitive Mapping
- Cross-Case Synthesis

Benefits to you, your institution and Sri Lanka.

The research will develop a comprehensive framework for mainstreaming climate change adaptation and disaster risk reduction into food security sector planning at district levels in Sri Lanka. It will also formulate recommendations to restructure and reform existing planning instruments to facilitate the effective mainstreaming of CCA and DRR into the food security sector. Thus, the research findings and recommendations would benefit policymakers, technical experts and industry practitioners at the national, district and local levels. Ultimately the research will benefit and contribute to achieving a more resilient and food-secured nation against climate change and disasters.

Sisira Madurapperuma

Researcher

Global Disaster Resilience Center, School of Applied Sciences

University of Huddersfield

Email: Sisira.Madurapperuma@hud.ac.uk

Mobile: +66876977535

Prof. Dilanthi Amaratunga

Supervisor

Global Disaster Resilience Center, School of Applied Sciences

University of Huddersfield

Email: d.amatunga@hud.ac.uk.

Prof. Richard Haigh

Co-supervisor

Global Disaster Resilience Center, School of Applied Sciences

University of Huddersfield

Email: r.haigh@hud.ac.uk

Participant Consent Form

Title of Research Study: Mainstreaming Climate Change Adaptation and Disaster Risk Reduction into the Food Security Sector

Name of Researcher: Sisira Madurapperuma

Participant Identifier Number: _____

☐ I confirm that I have read and understood the participant information sheet related to this research and have had the opportunity to ask questions.

☐ I understand that my participation is voluntary and that I can withdraw at any time without giving any reason.

☐ I understand that all my responses will be recorded and anonymised.

☐ I give permission for the research team members to access my anonymised responses.

I agree to take part in the above study.

Name of Participant: _____

Signature of Participant :_____**Date:_____**

Name of Researcher: Sisira Madurapperuma

Signature of Researcher: _____Date: _____

Annex C: Interview Guideline: Expert Interviews

KEY INFORMANTS INTERVIEW GUIDELINES WITH EXPERTS:

Personal Details:

1. Name: ……
2. Organisation/Sector: ……
3. Designation / Title: ……
4. In what ways are you involved in disaster risk reduction, climate change adaptation, and food security in Sri Lanka?
    a. Working as a senior officer for a government organisation. ☐
    b. Work as a policy maker for a government organisation. ☐
    c. Serves as an advisor for a government organisation ☐
    d. Work in International Organization as an expert/specialist ☐
    e. Work with universities as academics/researcher ☐
    f. Work with NGO as a practitioner ☐
    g. Any other sector or affiliation (Please specify)

Note to the Researcher: Brief the Key Informant about the research topic, objectives, and protocols, including obtaining a consent form before proceeding with Key Informant Interview questions.

√ **Research Topic:** Mainstreaming Climate Change Adaptation and Disaster Risk Management into the Food Security Sector in Sri Lanka

√ **Research Question:** How could an Integrated Planning Framework be designed for mainstreaming Climate Change Adaptation and Disaster Risk Reduction in the Food Security Sector in Sri Lanka?

√ **Research Aim:** The research aims to investigate and develop a comprehensive planning framework to mainstream climate change adaptation and disaster risk reduction into food

security sector planning processes at sub-national levels in Sri Lanka.

Interviews Guiding Questions: For experts representing government officials, policymakers, other key actors, and experts. Guiding questions have been formulated under the following research objectives.

Objective 1: Investigate the need for and importance of mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.

1. How would you assess the current food security status in Sri Lanka?
2. How do climate change and disasters impact the Food Security sector in particular?
3. Why is the food security sector highly vulnerable to climate change and disasters?
4. How often and regularly the disasters and climate change impact the food security sector?

Objective 2: Explore effective methods and approaches for mainstreaming climate change adaptation and disaster risk management into food security sector planning processes in Sri Lanka.

1. How does the overall socio-economic development planning process, in general, and sectoral planning process, in particular, take place at different levels in Sri Lanka (national and sub-national levels)?
2. Why do you think that climate change adaptation and disaster risk reduction should be mainstreamed into sectoral planning processes in Sri Lanka?
3. How do you support or propose mainstreaming climate change adaptation and disaster risk management into food security sector planning processes in Sri Lanka?
4. Are there any specific planning processes or instruments/tools you use or are familiar with for the planning process in Sri Lanka?
5. How are the effectiveness of such planning frameworks and their implementation be assessed in the Sri Lankan context?

Objective 3: To design a comprehensive planning framework for mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.

1. What are the existing policies, strategies, plans, and programs related to climate change adaptation, disaster risk management and the food security sector in Sri Lanka?
2. Why are those various plans not integrated into a common and comprehensive planning framework in Sri Lanka?
3. How would you suggest integrating end-users and public views in such planning processes in the Sri Lankan context?
4. How and up to what level such integrated planning processes be institutionalised in Sri Lanka?
5. How would you suggest regularly updating and improving such a planning framework and related tools in the Sri Lankan context?

Objective 4: To make recommendations as to how planning structures and processes can be reformed to ensure the effective mainstreaming of climate change adaptation and disaster risk reduction into the food security sector in Sri Lanka.

1. What are the specific challenges and barriers to mainstreaming and integrated planning processes in Sri Lanka?
2. Suggest specific options or recommendations in reforming or restructuring the existing planning process of Sri Lanka to make those plans climate and DRR-inclusive.
3. What are the enabling conditions and prerequisites required for mainstreaming and integrated planning processes in Sri Lanka?
4. How would you suggest institutionalising such a reform process at different levels in Sri Lanka?
5. Where and how should the restructured integrated planning process be institutionalised in the Sri Lankan context to have meaningful impacts on the ground?

Annex D: Sample Interview Transcript: Expert Interview

Case Interviews: National-Level Expert

Interview Number: N001

Name: N001

Position and the Organization: [redacted]

Objective 1: Investigate the need for and importance of mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.

How would you assess the current food security status in Sri Lanka?

Climate change has impacted food production in Sri Lanka over the past ten years. It has been impacting the food security sector more or less every year. I have seen in the reports from the Agriculture Department, and based on my general understanding, that disasters occur more than in the past. There are insect attacks and unidentified diseases in the agriculture sector. These are either direct or secondary impacts due to climate change. The food sector is highly vulnerable to climate change compared to other sectors. I have also worked for the Agriculture Department, and the existing systems and mechanisms are not robust. There is no system to assess the demand and supply requirements of foods annually. Food security can be an issue since we do not accurately estimate our requirements. There are issues with regard to the stability of the quantity. Rice might be stable as the staple food. But other foods, such as sesame, finger millet, etc., are unstable. So nutritious food is lacking. The entire population is not having access to nutritious food. The issue has become doubled or trebled due to climate change. In rural areas, people do not have access to three meals during drought and floods. Only one carbohydrate source just to survive. In rural communities, not even 50% of the community has access to nutritious foods due to system errors, water management systems issues, etc. The food security issue, which was there in the past, has been amplified due to climate change, and it has been amplified by several folds. The severity of food security has increased, but it is not visible as people do not demand details of healthy and nutritious food. As a nation, people do not have enough protein sources. Body size has reduced generation by generation. The susceptibility to diseases and health problems is getting higher. It is a multi-dimensional issue, and climate change has amplified the issues over the last ten years. Some issues are visible, while

others are not visible through data. Aquaculture is one of the important protein sources, and this sector has also been affected due to climate change. Climate change impacts on food security should be one of the main issues that the country needs to address currently.

How do the disasters and/or climate change impact Sri Lanka?

There is a feeling impact, and it is common sense. Some say the drought is due to a water management issue; however, climate change has an impact, and we feel it. Even if we do not look at and analyse data, we can get examples such as continuous floods reported in 2015, 2016, 2017, and 2018. After a few months of the floods, there were droughts in all districts. I remember after a few months of floods in 2017, and there was a severe drought in all 24 districts.

How do climate change and disasters impact the Food Security sector in particular?

Floods have been impacted due to climate change. Within a short period, huge rainfall occurs, leading to floods. Also, dams release excess water, impacting the downstream so many hectares of cropping lands. Before 20 years, there were well-developed patterns and seasons, and the onset of rains was very regular. The rain came on time, people knew when to start Chena cultivation, and they knew the dates exactly on the rain onset, land clearance, and burning. Now there are no such patterns. Seasons have shifted. Rainfall severity has increased. The duration has changed. Drought severity has changed. Heat and temperature changes have changed. The difference between min and max temperature, a difference in the day length, etc., has been felt—all these effects on food security. In addition to direct damage, indirect impacts, such as insect attacks and diseases, on the agriculture sector have increased due to climate change. Some pests and diseases have changed and not responding to current chemical pesticides.

In summary, climate change has occurred in Sri Lanka, and it has been proven from data. The agriculture sector is more vulnerable. Coastal hazards and erosion have increased. Some areas have been permanently inundated due to sea-level rise in the south. High winds have changed. DMC issues warning almost every other day on high winds, which has impacted the fishery sector as fishermen do not go to the sea. So it has affected the fish harvest and the fishery sector. In almost all reservoirs in Sri Lanka, aquaculture is the main income and production source. When a dam releases excess water due to severe rainfall and excess water in a short period, seedlings escape the reservoirs with water release, which hugely impacts the production and fish harvest and protein intake.

Why is the food security sector highly vulnerable to climate change and disasters in Sri Lanka?

Climate change has amplified the existing issues. There were errors in the system. For example, in Agriculture production, many policy issues affected production, but climate change has amplified those issues. For example, the water management system is closely related to food production. Due to tropical weather conditions, we have a short period to forecast, and there were issues related to the reliability of our forecasts. People did not believe or trust our forecasts. There were institutional issues for water management, such as the Irrigation Department, Mahaweli Authority, Electricity Board and water board, and minor irrigation belonging to the Agrarian services department. We tried coordinating with the dam management authorities and stakeholders about releasing water from dams based on the forecasts to avoid floods created by releasing water from dams. But irrigation engineers did not agree as they could not trust the Met Department forecasts. So they raised concerns about what would happen if the forecasts were wrong from the Met departments. Many system errors are beyond climate change impacts on food security, such as system errors, lack of research, and not reaching innovations to farmers and political influences, especially for not implementing findings from research in the agriculture sector on the ground. Also, there are issues with Agriculture extension. It is very weak and has been politicised by appointing unqualified extension workers. So climate change has amplified the already existing problem.

How often the disasters and climate change impact the food security sector in Sri Lanka?

It depends. Certainly, I can say it is annual as well as seasonal. It affects different dimensions of the food sector differently. For Rice, it has periodic impacts. So, the disturbance is there. But severe impacts are periodic. For other crops, it is more seasonal or annual. Overall, the food security sector is impacted annually and seasonally. Disasters directly impact food production annually or seasonally.

Objective 2: Explore effective methods and approaches for mainstreaming climate change adaptation and disaster risk management into food security sector planning processes in Sri Lanka.

How does the overall socio-economic development planning process, in general, and sectoral planning process, in particular, take place at different levels in Sri Lanka (national and sub-national levels)?

Sri Lanka's planning process is pathetic. It is regime-based planning, than the socioeconomic planning process and manifestos changed. The basic election manifesto becomes the Socio-economic Development Plan of the regime. For example, President Mahinda Rajapaksa's manifesto, "Mahinda Chinthanaya," became the development plan for Sri Lanka for ten years. Then there was a plan for five years by the Good Governance government. Then with the regime change, there is a current manifesto called "Vistas of Prosperity and Splendour." We ratified various international instruments, such as SDGs and made commitments. But the main issue is that when the regime changes, there is no attention and continuity for the project started by the previous government. So, the planning is a mess in Sri Lanka. For example, poverty alleviation. When a particular government has identified long, medium- and short-term issues about poverty and then identified solutions and their implementation, if the regime change during the process, there is no continuity; they bring new projects. All the previous efforts and impacts are not there. This is common to all sectors, including Agriculture, food security, and other sectors such as road, megapolis, etc. All the investments made so far have become waste. There were good feasibility analyses and cost-benefit analyses. All the decisions are based on political decisions for personal benefit. So over the last 20 years, there has been no continuity in the projects or programs in Sri Lanka. These get changed when the regime changes. There is no implementation at the ground level. There is no scientific assessment to see whether their actions are relevant to the country or its development. Those projects are not addressing the root causes of the problems than fixing short-term gains. There are no projects with no long-term goals. Same with the disaster management sector. Following the Sendai Framework, DMC could not develop the National Disaster Management Plan for the last five years. Five years have passed since the Sendai Framework. We were not able to develop the plan. Even if we develop the plan and get the cabinet approval, there are no enabling environments to implement the plan. For example, we have set the goal to reduce annual motility by 20 -30%. There is no baseline to achieve this. These are just only planning, and how to achieve this target is not even thought about. In other countries, the policy will not change, although the government changes. But in our country, when the government changes, the policy also changes.

Why do you think that climate change adaptation and disaster risk reduction should be mainstreamed into sectoral planning processes in Sri Lanka?

For example, in the school sector, for integrating DRR, the leading role should be taken by the education ministry. The mandated Disaster Management Ministry or DMC should provide technical support, and

schools should integrate DRR and climate change into their sectoral activities. This can be done through policies, legislation, and governance. There are governance issues. There are also issues related to knowledge and technical know-how. Different sectors should integrate DRR into their sector development plans individually. However, their plans have given very little priority to the DRR sector. Reasons could be the lack of scientific knowledge, policy decisions to integrate DRR into sectors, etc. Therefore, this has not been properly mainstreamed into their development plans.

How do you support or propose mainstreaming climate change adaptation and disaster risk management into food security sector planning processes in Sri Lanka?

Issues related to Agriculture sector due to climate change are still there without finding any solutions. Lack of awareness of climate change, changing weather patterns, and lack of forecasts are still there without any solutions. Integration is missing in Sri Lanka. There should be legislative frameworks for supporting the integration. No laws exist for meteorologists to contribute to such services for the agriculture sector. But the Agriculture Department is doing some basic forecasts while the nationally mandated agency is not integrated into a common system for providing forecasts. So this system is not successful. Two main hazards are floods and droughts, get impacted due to climate change. So these two issues should be fixed. We have to enhance technology in this regard. We need to improve forecasts and go for forecast-based Agriculture, which will contribute to substantial progress in the food security sector. In the fishery sector, fishermen also go fishing without locations, and we do not have a system to detect them. Our research is low. Sometimes we get sudden pest attacks in the agriculture sector. So, food security has become a non-research sector, and in most cases, we depend on research from other countries. We do not get enough funding for research. We also do not get technology transfers from other countries. So, it has become a non-research culture. As long as we depend on research findings from other countries and their technology, our food security will be an issue. Therefore, my suggestions are to enhance technology, research institution development, substantial budget allocation for research, development of experts, fishery sector should be developed with new technology, etc. There should be a proper decision-making process to accelerate decision-making. There is no prioritisation of resource allocations in Sri Lanka for reach or other development activities. The fund management system is very weak in the government system. This is very common in the food security sector.

Are there any specific planning processes or instruments/tools you use or are familiar with for the planning process in Sri Lanka?

If I take farmers, the Agriculture Department has weather stations, some forecasts, etc. However, forecasts and technology might be there. However, the Met Department is the mandated agency for climate change and the forecast. There is an issue with the linkage between the agriculture sector and Met Department. For example, in India, I have seen how the Met Department gives its forecasts, how National Remote Sensing Center uses them, and how they develop the forecasts for farmers, farmer organisations, extension workers, the fishery sector, etc. They use forecasts and forecasts-based early warnings to ensure food security. They contribute and work together to stabilise food security as a country. Such a system is very weak in Sri Lanka and almost non-existence.

How are the effectiveness of such planning frameworks and their implementation be assessed in the Sri Lankan context

Government from 2005-2015, and then from 2015, under the treasury, plans were monitored by a monitoring team. The treasury evaluated it, and there were some good mechanisms at the national level. However, there is no priority on that now. So it all depends on the regime. If there is a system and persons who understand the value of data and make informed decisions, such a system will be activated, but if such people are not there, the system is not working.

Objective 3: To design a comprehensive planning framework for mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.

What are the existing policies, strategies, plans, and programs related to climate change adaptation, disaster risk management and the food security sector in Sri Lanka?

There is substantial progress in the agriculture sector, especially in developing agriculture policies. There are specialised agencies such as CARP and Hector Kobbekaduwa Agrarian Service Centre, and they are using data and analytics to develop such policies. There are mechanisms and institutions between the government systems for developing policies and procedures. In the fishery sector and within the fishery department, they have capture fisheries and aquaculture. When capturing fishery, the decline is supplemented by aquaculture. There is an aquaculture policy, and there is an aquaculture act, and these policies are being changed regularly. The disaster management act is there. Draft disaster management policy is there. There are policies such as school safety policy. Climate change-related policies are being developed. The national adaptation plan for the next 15 years is being drafted, and it seems to be a better policy. Within the climate change sector, a coordination mechanism is established at the national level. The mechanism has been established to coordinate sectors and related

implementation arrangements. The climate change secretariat and the Central Environment Authority, along with other stakeholders, are in the process of developing an integrated coordination mechanism and implementation arrangements.

Why are those various plans not integrated into a common and comprehensive planning framework in Sri Lanka?

One of the main issues is that there is no or weak mechanism for updating plans in Sri Lanka. One of the reasons is that the planned development mechanism has been identified as one of the actions. There are no legal provisions or background for the plan development and revision process. For example, Disaster Management Act No. 13 of 2005 should be updated and revised as time passes; however, there is no mechanism to update the Disaster Management Act in Sri Lanka. Therefore, there is no clarity on how that should be done, who should do that, and whose role is to update the Disaster Management Act etc. The process is not clear. There is no legal power and weightage to facilitate this process.

On the other hand, if you take countries like Japan, there are legal provisions within the disaster management act to modify it as time passes. After any major disaster event in Japan, they modify and revise their Disaster Management Act. They are very clear about who should do that and the time frame required for such provisions. Therefore, some policies and legal provisions in Sri Lanka have been outdated, and agencies cannot update those regularly. There is no enabling environment for the plan development and regular revision process. The integrated planning process also depends on personal attitudes and human factors. It depends on the person who led the process and his or her attitude towards integrated planning, Especially since there is no legal provisions or mandate for the integrated planning process and revisions. In Sri Lanka, it has become almost a personal decision rather than an institutional decision. Therefore, in Sri Lanka, most of the planning is at the department or in silos resulting in hardships at the lowest level, specifically for the farmers and at-risk communities.

How would you suggest integrating end-users and public views in such planning processes in the Sri Lankan context?

End-users and the general public should be engaged in the planning process, and their input should be integrated into the plan. In some cases, their input and opinions are being sought. For example, in 2018, when we developed the national disaster management plan for 2020 -2030, we went for wider consultations and met more than 20 victim groups in 10 districts, and their feedback and inputs were taken, their inputs were scientifically analysed, and used for developing the plans. But in Sri Lanka, this is not common to all sectors. All sectors are not engaging the end-users for planning processes.

This leads to so many issues at a later stage, and those issues are only visible much later. For example, there was no consultation in the road sector when the government was developing the Sothern expressway. Because of this, vast new flood-prone areas have been created due to Southern Express Road Construction. The general public had suggested many good suggestions which look scientifically sound, but those were not considered during the planning stage for constructing this Sothern Express Road. Likewise, I don't think the opinion and inputs are being taken sufficiently from the end-users for many sectors and their planning processes. If they had taken sufficient inputs from the end-users, there could not be this amount of issues and blames at a later stage. End-users in the Sri Lankan context are farmers and the general public, and they regularly complain that their inputs are not being sought for plan development processes. They should be part of the consultation process. If they develop the plan, it should be the real plan. But in Sri Lanka, end-user engagement in the planning process is insufficient. A group of consultants develops sector plans than the end-users. For example, a National Adaptation Plan (NAP) was developed by sectoral groups. I also represented the disaster management centre. The groups included only the government sectors, academia and NGOs. I'm sure ground-level people were not involved in the planning process, and ground-level issues were not addressed in the plan.

How and up to what level such integrated planning processes be institutionalised in Sri Lanka?

We should go as much as possible to the lowest level. Whether it is a development plan, climate change plan, or disaster risk management plan, the current reality is that it is being developed at the national level. But I think it should go to the lowest level from the national to the ground level. It does not mean we must consult all the villages, but we can select a representative sample to get the majority views. It should go up to the community and village level. I have seen the difference between the nationally developed plans and plans developed with inputs from local people. End users should be engaged in the planning process. For example, our 2013 -2017 plan was developed nationally. Then we developed the 2014-2018 comprehensive disaster management plan. The stakeholders also developed that. But the plan we developed later that is still pending approval was developed with the wider community consultations identifying grassroots-level issues and problems at the local level. Activities were designed based on stakeholder consultations and wider consultation with the community members.

Objective 4: To make recommendations as to how planning structures and processes can be reformed to ensure the effective mainstreaming of climate change adaptation and disaster risk reduction into the food security sector in Sri Lanka.

What are the specific challenges and barriers to mainstreaming and integrated planning processes in Sri Lanka?

One of the main issues is the human resource and their knowledge and expertise. Some of the planners don't have relevant subject knowledge. As a plan, everything will be there, but they may not have the subject knowledge. Another main issue is the governance issue. For example, the national disaster management policy does not give the legal provisions to have a plan. The planning always depends on the individuals, heads of the organisations or whether there are any policy provisions. Therefore, most Sri Lankan officials depend on the head of the organisation and their vision for the planning process. In Sri Lanka, they also expect a political blessing. Most officials think they can't do anything without a political blessing. Most of the officers believe that the plan cannot be implemented if it is developed without political blessing. Our planning process is not very scientific. They don't spend enough time. We do not do in-depth research and develop our plans. We don't get much support from universities. We don't have a platform to get their input and research findings into the planning process. There are no platforms to get their input and no legal provisions to get their involvement in the planning process. Interactions between academia and professionals are in a pathetic situation in Sri Lanka. University professors are interested in individual consultations rather than contributing to knowledge and knowledge dissemination. In other countries, for example, in Japan, there is space for some professors in the disaster management council to get professional inputs and expertise into the disaster management council interventions. So they can get professional input into disaster management policy decisions.

Can you suggest specific options or recommendations in reforming or restructuring the existing planning process of Sri Lanka to make those plans climate and DRR-inclusive?

The reform process has to start from the constitution itself. There should be provisions in the constitution stating how it should happen and continue, measures to ensure it does not change based on the regime changes, approval mechanisms, etc. There should be a high-powered committee to approve any plan. The high-powered committee should provide the overall development planning framework and the base. Clarifying how we maintain our commitments to international mechanisms

and instruments should be clarified. We make so many commitments at the international level, but there are no mechanisms to follow up and implement those. For long-term planning, a national-level agency should coordinate and manage the planning process. For example, in the Divineguma project, the previous government provided significant importance and weight with system-level support, compliance, implementation, monitoring, and evaluation support. But it failed due to political decisions, and the plan was weak due to the unscientific planning process and political decisions, and it did not answer the real cause. So, in summary, there are two main issues. Sometimes we have good plans, but the support systems, implementation arrangement, and monitoring and evaluation mechanisms are not in place, so the projects fail.

On the other hand, the support system might be good, but the plan could be weak, so the projects fail. Those are the two sides of the issues in plan implementation in Sri Lanka. There should be legal provisions and enabling environment. There should be sustainability mechanisms embedded in the planning process. The plan should be developed scientifically with data-driven processes. There should be proper monitoring and evaluation from the planning development to the implementation process. If we can fix the two main issues I mentioned above, we can solve the planning problems in Sri Lanka. There should be a legal provision and enabling environment. Sustainability and continuity in implementing the plan should be identified within the plan itself. The plan should be developed based on research and research findings. Targets and goals should be developed to address the issues and root causes of the problems.

Annex E: Interview Guidelines: Key Informant Interviews with Case Studies

KEY INFORMANTS INTERVIEW GUIDELINES WITH DISTRICT INFORMANTS

Personal Details:

1. Name: ……
2. Organisation/Sector: ……
3. Designation / Title: ……
4. District / Case: ……..……
5. In what ways are you involved in disaster risk reduction, climate change adaptation, and food security in your district?
    a. Work as an administrator for a government organisation in the district. ☐
    b. Work as a technical officer of a government organisation. ☐
    c. Work in International Organization as an expert/specialist. ☐
    d. Work with universities as academics/researcher. ☐
    e. Work with NGO as a practitioner. ☐
    f. Work as a farmer or representative of farmer organisations in the district. ☐
    g. Any other sector or affiliation (Please specify).

Note to the Researcher: Brief the Case Key Informant about the research topic, research objectives and the protocols, including obtaining a consent form before proceeding with Key Informant Interview questions.

√ **Research Topic:** Mainstreaming Climate Change Adaptation and Disaster Risk Management into the Food Security Sector in Sri Lanka

√ **Research Question:** How could an Integrated Planning Framework be designed for mainstreaming Climate Change Adaptation and Disaster Risk Reduction in the Food Security Sector in Sri Lanka?

√ **Research Aim:** The research aims to investigate and develop a comprehensive planning

framework to mainstream climate change adaptation and disaster risk reduction into food security sector planning processes at sub-national levels in Sri Lanka.

Interviews Guiding Questions: For key informants representing three case studies. They could be government officials, policymakers, technical officers, other non-state actors such as NGOs, academics, and community participants such as farmers. Guiding questions have been formulated under the following research objectives.

Objective 1: Investigate the need for and importance of mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.

1. How would you assess the current food security status in your district?
2. How do the disasters and/or climate change impact your district?
3. How do climate change and disasters impact the Food Security sector in your district?
4. Why is the food security sector highly vulnerable to climate change and disasters in your district?
5. How often and regularly the disasters and climate change impact the food security sector in your district?

Objective 2: Explore effective methods and approaches for mainstreaming climate change adaptation and disaster risk management into food security sector planning processes in Sri Lanka.

1. How does the overall socio-economic development planning process, in general, and sectoral planning process, in particular, take place at different levels in your district (national, provincial, district, divisional and community levels)?
2. Why do you think climate change adaptation and disaster risk reduction should be mainstreamed into sectoral planning processes in your district?
3. How do you support or propose mainstreaming climate change adaptation and disaster risk management into food security sector planning processes in your district?
4. Are there any specific planning processes or instruments/tools that you use or are familiar with for the planning process in your district?

5. How are the effectiveness of such planning frameworks and their implementation be assessed in your district?

Objective 3: To design a comprehensive planning framework for mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.

1. What are the existing policies, strategies, plans, and programs related to climate change adaptation, disaster risk management and the food security sector in your district?
2. Why are those various plans not integrated into a common and comprehensive planning framework in your district?
3. How would you suggest integrating end-users and public views in such planning processes in your district?
4. How and up to what level such integrated planning processes be institutionalised in your district or beyond?
5. How would you suggest updating and improving such a planning framework and related tools regularly in your district?

Objective 4: To make recommendations as to how planning structures and processes can be reformed to ensure the effective mainstreaming of climate change adaptation and disaster risk reduction into the food security sector in Sri Lanka.

1. What are the specific challenges and barriers to mainstreaming and integrated planning processes in your district?
2. Suggest specific options or recommendations in reforming or restructuring the existing planning process in your district to make those plans climate and DRR-inclusive.
3. What are the enabling conditions and prerequisites required for mainstreaming and integrated planning processes in your district?
4. How would you suggest institutionalising such a reform process at different levels in Sri Lanka, including in your district?
5. Where and how should the restructured integrated planning process be institutionalised in the Sri Lankan context to have meaningful impacts on the ground?

Annex F: Sample Interview Transcript: Case Study Interviews

Case Interviews: Case Study 2

Interview Number: P001

Name: P002

Position and the Organization: [redacted]

Objective 1: Investigate the need for and importance of mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.

How would you assess the current food security status in your district?

The topic of food security affected by climate change and disasters is a very new subject in our district. That's the overall situation. There is no government-led process of planning or programs to address food security in the face of climate change and disasters specifically to ensure an emphasis on quality and nutritious value as well as quantity throughout the year across the district. People are just focusing on their daily requirements and making arrangements to meet daily needs. There is no government or private sector involvement in ensuring food security. There is some involvement from the private sector on the supply chain side. There are no well-developed plans and programs or planning processes in Sri Lanka. This is not only in this district but across the country.

The prices are changing rapidly, and prices are going very high due to disasters and climate change. Sometimes vegetable prices are very high and cannot offer by poor communities. Sometimes it goes like 600% to 700 % or even 1000%. This price fluctuation is due to rains, droughts, or other disasters, and productivity goes low. These ad hoc price changes are purely because there are no well-planned programs or planning processes to ensure food security during such external shocks. I cannot say there is food security, based on the definition, that we have such a system in place. Based on the definition, I don't believe that food security is there across the country.

People sometimes might take the quantity, but they don't have the quality and nutrition value. They don't understand, and there are no programs to ensure quality. One of the main concerns is whether they can get such a quality diet throughout the year and the period. So we cannot believe it. High-income and middle-income families may consider food quality, but poor rural people cannot think

about the quality. They are more focused on quantity. Even if they know, they cannot afford it and do not have access to the required quantities and quality. For example, when pregnant women go to the clinics, they are informed that they need to get this amount of nutrition and quality diets; although they know the requirements, they cannot meet the quality and quantity requirements due to income issues. So, we cannot be happy with the quality of food security ensured in our district.

How do the disasters and climate change impact the Polonnaruwa district in general?

There is definitely a climate change in our district, and patterns are changing throughout the year. For example, this year, the Northeast monsoon onset was delayed. As part of the seasonal cropping planning meeting (Kanna Resweem), As a senior government officer, I went to the meeting, and we decided the cultivation amount, distribution of water, cultivation period, harvesting period and so on. We do so based on past data and experience and our understanding of the onset of the rainfall, monsoon period, dry period, etc. Although we planned like that, the Northeastern monsoon was delayed. Because of that, the rain was there during the pollination period of the Rice. Then during the dry period, we also experienced pest attacks such as Brown Plant Hopper, especially in a district like Moneragala.

Such disasters, rains and pests and pests and diseases affect rice production. We had planned to cultivate 67,000 hectares this year. We were expecting 330,000 to 335,000 metric tons of rice production. With climate change and its impacts, it is possible to reduce the harvest by up to 25% to 30%. Due to climate change impacts, unlike in the past, we cannot tell exactly when the rain will onset when the dry period comes, so we cannot predict the season and seasonal planning that impacts the production. During the last few months of the season, there was a huge rain that we even thought would lead to floods. But in the regular season, this period is supposed to be dry. If a flood occurs during this period, then crop and production damage would be much, much greater. But the rain stopped just before occurring floods. But there is a huge impact already on the production from rain as well. Now, if our overall planned production in our district is not met in this particular season due to climate change and disasters, then there is no proper plan or program to address the food security issues of the country. With this context, I cannot say there are sufficient enough programs by the Agriculture Department or other concerned Ministries to ensure food security. There are isolated efforts, but those are insufficient to address the impact of climate change and disasters. On food

security, my overall point is that we cannot be happy that there is at least 50% food security assured in the country which is affected due to climate change or disasters.

How do climate change and disasters impact the Food Security sector in your district?

Agriculture products and food prices are rapidly fluctuating in Sri Lanka. The main reason for price changes is that we cannot face climate change and disasters. Production gets changed despite our planned cultivation targets, which are affected due to water stress or drought or floods or climate change impacts. So to address those issues, there are no programs to adapt our interventions. I don't think our forecasting and early warning have been developed to the level they should have. So climate change is directly impacting the agriculture sector. We have only a few days or weeks advance forecast, which is insufficient for planning. We should be able to forecast at least four months in advance so that we will be able to plan our cultivation season based on the forecasts. But I don't think there is a capability within the current institutions and experts responsible for forecasting. When we plan for cultivation, we don't know whether there will be floods, droughts, or whether we should go away from those areas to other areas etc. We don't have that information because we don't have a reliable forecast. The highest impact in the agriculture sector is on vegetables, fruits and other field crops. One of the main impacts on these crops is price fluctuation and price changes. Another impact is direct damage to production, then also impacts the price. High-income and middle-income families can maintain food security, despite some price fluctuations. But the rural poor and the poorest people will be unable to afford these high prices. They have to compromise either quantity or quality. They cannot afford dairy products, fruits or other balanced diets because of the price changes. So, they might spend it on Rice and sugar, wheat flour, etc. The impact of climate change will impact the highest to the lowest strata of society. No matter how much we give them advisories and input, they cannot afford it because we don't have a planned program to address those issues. When it comes to wild animal attacks, there is a huge impact from monkeys, wild boars and Peacocks on production, and that has been a major issue in districts like Polonnaruwa because they directly damaged production and harvest. On average, about 30% of the harvest and production get lost because of wild animal attacks. Because of this, prices also will increase. That will impact food security. Most of the rural people are not living in urban areas, and they are living near the forests or wild animal sanctuaries, so their harvests get damaged by the wild animals. They are living in the most vulnerable areas. They are the ones who get impacted by food security because of those impacts. Wild animals attack their properties, their houses and their crops. We have seen by ourselves the amount of damage caused to the cultivation of these people. They attack banana trees, coconut trees etc. Because of this, even though they produce their products, they will lose the opportunity

to make their food because of the wild animal attacks. While animal attacks have been increasing, not only because of climate change, but people also are encroaching on their natural habitats for cultivation and farmlands. Wild animals usually don't change their natural habitats and cross paths; they return to their habitats and destroy crops and products.

Also, farmers send their cattle for grazing in the jungle, which leads to a lack of food for wild animals, so they tend to come to the farmlands. 41% of the land mass of the district belongs to forests and is under the control of the Wildlife Department as protected lands. Some other lands belong to Mahaveli Development Scheme. Around 7% of the land area is water resources. So, the land areas available for cultivation and farming are much less in the district. They don't have enough land for paddy and other field crops. When there is not enough farmland, people try to encroach on the protected areas and forests, and when they cultivate those lands, wild animals attack production.

Why is the food security sector highly vulnerable to climate change and disasters in your district?

I believe the food security sector is more vulnerable to climate change and disasters than other sectors. One of the reasons is that our district is agriculture-based. The main cultivation in our district is Rice. Around 67,000 hectares have been allocated for Paddy cultivation. For other field crops, around 3,000 to 3,500 hectares have been allocated. All other field crops, including cereals and others, would be a maximum of 5,000 hectares. So other fields, crops and coconuts etc., are traded from other districts to this district. If any disaster or climate change impacts Paddy cultivation, then there will be a significant impact on the food security of the people in the district.

How often and regularly the disasters and climate change impact the food security sector in your district?

This is an annual phenomenon, but it is happening slowly. For example, as I told you, the Northeast monsoon period shifted. It was not a significant delay but slowly shifted from the regular period. We had continuous droughts in the district before I assumed my duties. In any case, the weather gets drier in this part of the country after August. Usually, August until November is the dry period for our district. It did not significantly impact this time as the rain was there early in the dry period. We had dry periods towards the end of the drier season, which was much higher than usual. In 2018 and 2019, the North Central Province, including the Polonnaruwa district, was affected by droughts. There was also disturbance and destruction to the crops. There was no drought in 2020. Usually, we

get severe drought every three to four years. So, we believe climate change is happening, but it's slowly happening in our district.

Objective 2: Explore effective methods and approaches for mainstreaming climate change adaptation and disaster risk management into food security sector planning processes in Sri Lanka.

How does the overall socio-economic development planning process, in general, and sectoral planning process, in particular, take place at different levels in your district (national, provincial, district, divisional and community levels)?

There is a process by which these plans come from the national level to the departments and the districts. The process is not 100% perfect, but there is a system. For example, when developing their agriculture plan for the country they developed, they developed those based on information and district plans, if any. In the past, those plans were developed by government agents and with relevant institutions and production targets at the divisional level for paddy and other field crops with support from the agrarian development centres. Then we compile all these divisional and district plans and send them to the national level. Based on these district plans, they developed the national plan. But there is an issue about whether these plans are real, coming from the divisional or the lower level. So, there is an issue with the reliability of the plans. If the plans and data at the local level are wrong, then the national plan will also be wrong. A similar process is followed for food security and other sectors such as health, roads, infrastructure, health, irrigation, and agriculture. Some agencies and departments don't prepare a plan at the district or divisional levels; they just request the data and information and then develop their national plans. Usually, the format for data collection or plans is sent at the national level. If these ground-level plans were sound and implemented, then there shouldn’t be facing the current situation that we are facing today and these kinds of challenges at the ground level and in the country. The issues must be lower than what we are facing now. The problem is the reliability of the plans that we are developing. And I also believe that national plans have to be developed in an integrated manner. For example, if you take food security, in addition to Agriculture Department, other agencies such as the meteorology department should be involved. Agriculture is one of the sectors which will be affected by climate change, and they need to look at the future forecasts of the weather and climate in the country before planning. The question is whether the Agriculture Department is integrated with other technical agencies which are supposed to provide

technical advisories and forecasts, such as the met department, national building planning organisation, geological survey and mines bureau and the disaster management centre. The question is whether these plans are integrated and whether these data are being used from various sources to develop the forecasts. These things are not happening in our country. In most cases, they get the data from the interprovincial agriculture director working at the district level. When the agriculture director is developing their plan, they never consider disasters. The entire system does not consider disasters when developing its sector or plans. Even the irrigation department is not thinking about disasters, and climate change impacts their plans. Perhaps, the irrigation department might be thinking on a lighter note, but Agriculture Department is not thinking at all. We don't see any integrated plans in our district when the agriculture sector develops plans without enough information and futuristic thinking about disasters. We are failing in our food security because we don't develop our plan based on the data, historical evidence and future forecast. There is a database maintained by the Agriculture Department involving farmers, but it's not well developed yet. It's at the primary stage. But they don't have a system of saying this product should be developed in this particular area in this amount. They don't have dynamic planning. They don't look at the needs, demand and supplies besides just cultivation. Even if they forecast that there will be heavy rain in the next few months, there is no system to maintain and ensure access to food security. They don’t have cold storage or other systems to maintain excess production. There is one cold storage in Dambulla, but that's also not functioning. Although they might be preparing smaller plans, they don't consider and develop integrated plans considering the disasters, climate change, and food security. I believe this issue must be considered thoroughly and in-depth, but it is not happening at the district level. It will take so many years to have hope for this kind of integrated planning at the district level. We have a very primary system. We don't have such well-advanced integrated planning. We don't know which areas will be flooded or affected by droughts in our districts, so we don't have those details and risk profiles. Even in infrastructure development, when constructing roads, they don't consider disasters and mitigation measures to minimise future impacts. They just do the construction. In some areas, once they've done the construction, those areas get inundated by floods. Some areas are prone to earth slips. During the rainy season, you can see how many roads get closed due to landslides in the country. Had we developed our road systems based on the risk assessment and constructed roads by applying mitigation measures, then we don't need to close our roads during the rainy season. Regarding planning templates, there was a recent development in the format that we

need to submit to the national planning department. When we submit our plans to the NPD, we have to incorporate some data and information related to disaster management as part of that format. Even if we submit that information, we don't know whether it is followed up by someone and taking action. But we saw changes in this format last year when they added this disaster management component. However, we don't see from the national agencies those who are directly and indirectly related to disaster management, climate change and food security are taking enough actions to develop appropriate planning guidelines and plans to be implemented at the local level while considering climate change, food security and disaster risk reduction. I don't think any integrated plan and integration efforts by the responsible agencies, including agriculture and related technical agencies, as of now, although these plans are happening at the national, district and sub-national levels. The authorities and people argue and debate how realistic these plans are. So, the reliability of the plans at all levels is an issue. A realistic plan based on the actual data is a question. Considering the risks of Sri Lanka, every agency should have disaster management as part of their planning processes when it comes to integration. But I don't see this process happening in Sri Lanka. Sri Lanka is not an exception, as we face climate change impacts like the rest of the world. Therefore, all agencies should have integrated planning processes across the country and sectors. There is very little consideration in planning, but it is insufficient at this stage.

Are there any specific planning processes or instruments/tools that you use or are familiar with for the planning process in your district?

We are in the very primary stage when it comes to integrated planning for climate change adaptation and disaster risk reduction in the food security sector in Sri Lanka. This is not only for the food security sector but also the main issue in Sri Lanka in the overall planning process. If you take the road, we keep constructing roads, and after a couple of months, another department comes and disturbs that road to put water pipes or electricity cable etc. So, we don't have an overall integrated planning process. Why can't they have an integrated plan, and they all know what they will do in the coming year? Why can't they do it together than doing ad hoc individual activities and construction? Had we used integrated planning, they would not destroy or disturb the recently constructed road for another development work. When it comes to disasters, we can't reach integrated planning. You know highways are being constructed, but I don't think they are considering any disaster risks associated with those constructions. Here, we are at the very basic and primary level of planning.

How is the effectiveness of such planning frameworks and their implementation assessed in your district?

As a senior government official, I don't have any mechanisms or tools to assist the progress of the development work being done at the district level. If I take health, education or any other sector, we may tell the progress in general. Agriculture and irrigation are not my sectors, but I intervene to a certain level. I can just look at the data from those sectors to see whether progress has been achieved. Apart from that, there is no system or tool for me to see the progress of these activities being implemented. There is a traditional mechanism, such as after harvesting, there might be a "harvesting survey" by the Census and Statistics Department. We might be looking at how many metric tons per hectare, but these are very traditional ways. The respective ministry might be doing a very preliminary progress report, but no district-level system exists to assist. There is no integrated mechanism at the district level to measure the progress. District Coordinating Committee is a place where we take policy decisions only. For example, we don't go into sector-specific targets and plans in the education sector. Rather we'll take it like general trends and overall progress compared to the last year instead of comparing achievements against the plan. There is no performance-based evaluation. There is no comparison of that particular year against the targets they have put forward, if any. It saws that they are thinking a little about it, but there is no theory of change to bring the desired change.

Objective 3: To design a comprehensive planning framework for mainstreaming climate change adaptation and disaster risk management into the food security sector in Sri Lanka.

What are the existing policies, strategies, plans, and programs related to climate change adaptation, disaster risk management and the food security sector in your district?

Polonnaruwa is the Rice producing district of the country. About 40% of the country's requirement is produced in our district. Because there are three big rice mills in the district, but during the last few months, even our people in the district could not find Rice within the district. Even if you go now, you will not be able to find Rice in some of the retail shops. There was a huge shortage of Rice across the county during the last month. But when it comes to harvest, there were no significant

changes compared to the previous years. What was the reason for it? Sri Lanka said they are self-sufficient in rice production, and we have Paddy Marketing Board. The idea of having a Paddy Marketing Board is to purchase Paddy during the excess production and harvesting period and maintain buffer stock to be used during shocks and shortages.

During the last season, Paddy Marketing Board could buy less than 10,000 metric tons nationwide. G.As of eight districts purchased 26,000 metric tons, and I could purchase 13,000 out of these 26,000 metric tons. In other districts, they purchased 1000, 2000, or 3000 metric tons. So, it shows no trust from our people in the Paddy Marketing Board. During the Yala season, we could not even purchase that amount of Rice for both the PMB and the district secretaries. All these things and current issues are happening, although there is a certified price by the government and a paddy marketing board. The government purchased Rice from the market, but its prices are still increasing.

Rice is sold for over 15 rupees per kilo than the certified price. So PMB could not meet the challenges of the shortage, high prices and all other related issues. A new program by the government says that since the government is giving subsidised fertilisers, farmers are bound to sell at least 1,000 kilograms of paddy back to the paddy marketing board. There is a rice mafia in the private rice millers' industry in Sri Lanka. So, if we have a buffer stock, we can face such a shortage due to disasters or the private sector mafia. But when it comes to other field crops, vegetables and fruits, there are no strategies, programs or policies as we try to do with Rice. So, prices are increasing in those in case of external shocks.

The government also has started developing storage facilities through financial support from the World Bank. There is one in the Medirigiriya area as well. The provincial development banks do the management of those storehouses. So, since it is under the management of banks, they keep looking at the prices, and when the prices go up, they advertise to farmers to bring Rice so that they can sell their products at a higher price. When they sell their products, they can repay the bank credits and other loans and earn additional income. For these warehouses, it's for dry foods such as Rice, cereals, peanuts, mung beans, and other dry products, not vegetables and fruits. These are very small-scale initiatives and policies. But we don't have such a system for vegetables, fruits, and other field crops. We sometimes see that bananas and vegetables are destroyed in massive quantities because they cannot sell during the peak season and don't get enough income. Post-harvest losses also happen in fruits such as papaya during the peak season or during disasters. Then during the offseason, prices are extremely high so that people cannot afford to buy, which leads to food insecurity. So, we don't

have a national program to address these food security issues. From time to time, we have some plasters to solve certain issues, but those are very small scale, and there is no significant impact on the ground. For example, there was a huge shortage of big onions. But farmers had big onions in their stores. But it didn't come to market. So the government gave me money to buy Big Onions from the farmers and sell to wholesale cooperatives. During the Covid-19 lockdown, there was a shortage of vegetables, and we were given money to buy vegetables and send them to Colombo. So likewise, there are short-term patchwork and solutions, but no long-term proper programs and policies address food security issues. The government will take some actions when they feel the issue, but there is no proper planning in advance. Once the problem is over, then there is no program, and there is no continuity.

Why are those various plans not integrated into a common and comprehensive planning framework in your district?

The main reason for not having an integrated plan is the lack of policy at the national level. If there is an integrated policy, all institutions will work according to that policy and support the implementation of that. Currently, our implementation arrangements are in silos, and institutions do their things, and whenever they face an issue, the government tries to intervene and implement patchwork and short-term solutions on a case-by-case basis rather than having an integrated planning process. There should be an integrated policy involving agriculture, the irrigation met department and other related agencies, and there should be a national policy for food security that policy can be implemented at multiple levels. If there is a plan, different organisations can develop various programs in line with the plans to achieve food security.

How would you suggest integrating end-users and public views in such planning processes in your district?

End-user engagement is very low. It is even less than 10%. I believe that they should be involved much more than that. However, when it comes to farmers, they are not genuine and pleasant as we think. When we think outside, we believe they have a good personality and are good. But when you work with them, you will feel how selfish they are. They are more focused on individual gains than system-level gains. But they have a huge knowledge base, which is much higher than some of the

experts in the field. When trying to get that knowledge into the planning, we must also be mindful that they are selfish and looking for individual gains. Whenever they are giving suggestions and proposals, that is more for their benefit rather than the overall system. If we can have a system where we can screen the good ideas and make sure that these are not individual interests but rather for system-level benefits, then their input will be very useful for integrated planning processes. Currently, it is happening less than what they can contribute.

In some cases, it is not happening at all. The agencies that are taking input from the end users should be smart enough to ensure that they screen their suggestions to ensure those are not personal interests. There should be a validation mechanism for their views.

How and up to what level such integrated planning processes be institutionalised in your district or beyond?

The best would be to start from the divisional level, then come to the district, and then go to the national level. This is how our administrative structure has been organised in this country. So if we plan this way, that would be easy to implement. We can use the existing administrative mechanisms to implement the policies, programs and plans. If we take only the district, there is little engagement from the divisional level and farmers. The end users, in most cases, are engaged at the divisional level, so that would be easier to implement if we start at the divisional level. End-users engagement at the district level is not that high. Although there are ecosystem and irrigation boundaries, such as Mahaweli, those systems also can be brought under the divisional secretariat level. It is no barrier. For example, there are three types of irrigation systems in Polonnaruwa District. One is major irrigation schemes. The second one is small-scale irrigation schemes managed by Agrarian Service Department. And then we have provincial irrigation schemes.

Some of the tanks also belong to wildlife. Then we have Mahaweli zones under Mahaweli Authority. At the division, we can bring all these partners together and prepare plans in an integrated manner. Traditional ways of working together across administrative systems are based on norms and practices. For example, there is a program called “Wari Sawbhagya”. In this program, we are renovating irrigation structures and tank systems. I convey this program in the district, mobilising the provincial irrigation department, agrarian services department, irrigation schemes etc. So I give the leadership at the district level for this program. We discuss at the DCC and finalise the tanks to be renovated, and then we submit the integrated program to Colombo.

When we select tanks, we have some criteria to follow. We discuss this with the technical agencies. We discuss with respective implementing agencies. We discussed this with the political leadership and then decided on the final list to be submitted to Colombo. We also consult the farming communities. These are happening as some of the good practices. This should go to the next level with national policies and programs, so that impact would be much higher. I believe that policy formulations and policy approvals have to be at the national level so that we can implement this program effectively. My engagement is only at the policy decision at the district level, and I cannot involve much in the national-level policy-making processes. So we need the national level policy provisions so that we will be able to implement those at the local levels. Authority and accountability should be given to the lowest level so we can implement programs.

Agriculture is a short-term intervention. At a minimum, there should be a five-year plan. Within the five-year plan, there should be annual and seasonal plans. Within the long-term plan, we should break it down into annual plans with a specific target to achieve during each season. If we focus on Rice, we are just only talking about two seasons, Yala and Maha seasons.

Objective 4: To make recommendations as to how planning structures and processes can be reformed to ensure the effective mainstreaming of climate change adaptation and disaster risk reduction into the food security sector in Sri Lanka.

What are the specific challenges and barriers to mainstreaming and integrated planning processes in your district?

There should be a national-level agency to coordinate all these efforts to develop an integrated plan, whether it's the finance ministry, National Planning Department, or any other related agency that is capable enough and authorised to bring all these agencies under one umbrella. Currently, it is being done by the National Planning Department, but there should be a department or different agency or institution capable and have the legal mandate who can provide the guidelines and the way ahead when it comes to integrated planning. There should be an institute with all the requirements. There is no such institution in Sri Lanka. If you look at the Economic Development Ministry, they are looking only at one side. There should be an agency looking at agriculture, health, irrigation, food and all other related development work to bring all these sectors into a common development

planning framework. We don't have such an institution, one of the biggest barriers to integrated planning. When we talk about disaster management sector strategies, programs, capability, and capacity within disaster management center are quite low. This is another big challenge and a barrier. The third barrier is the lack of data and information, specifically concerning climate forecasts, and early warning in advance of five to six months is another big challenge. We cannot make forecasts in advance for five to six months with high reliability and accuracy. We have only one to two days forecast and predict rains, which might change in a day or two. So, we cannot make any advance forecast for the sectoral interventions. We should be able to do so. Another big challenge is the attitude of the government officials and the distance between the institutions regarding their protocols or institutional mandates; they are not working together and don't have positive attitudes towards integrated planning. That's one of the biggest challenges and must be minimised. There is no willingness for integrated planning by these agencies. The next barrier is the financial one. In order to follow an integrated planning process, you need to have resources in hand, but there are no financial resources for such an integrated planning process. Another barrier is whether we have the number of experts to bring all these sectors together and go for integrated planning. We don't have enough experts in this sector covering food security and integrated planning. Perhaps we might have experts, but we don't know whether we can get their support, where they are, and their availability. We don't know. We don't have such details. We can tap into their resources and expertise, considering their opinions, political affiliations, or any other views. So, we need an institutional framework with expertise, resources, input and feedback to develop an integrated planning process.

Suggest specific options or recommendations in reforming or restructuring the existing planning process in your district to make those plans climate and DRR-inclusive.

All the challenges I mentioned above should be converted into opportunities, and those barriers should be overcome and converted into solutions. If we can put the institutional system in place, we can support the integrated planning process. We may not achieve a 100% perfect solution, but I think we can take a starting point and entry point to commence the planning process. As of now, it's a dream, but if we take a starting point, we will be able to see what practical solutions and approaches we can adapt as part of the process. We can also learn from other countries and their models. There are good practices worldwide; we can also study those, learn from similar case studies from other countries, and adapt those to our context. If we take our older generations, food security was part and

parcel of their culture. It was there in the past, even though it may not be the case in urban settings. In most villages, around 90% of people were food secure because they had the traditional coping mechanisms and systems. I've seen my grandparents' home, and they had their coping mechanisms. Every house in the traditional village had something called "Wee Bissa", a place where Paddy was stored for later use. They did not sell all the cereals and kept some amount for future use during any shortage or shocks. They also had something called "Dum Messa", a smoking dryer rack in the kitchen above the cooking place where they could dry and store some dry foods such as Jak fruit, breadfruits, etc. They also had traditional ways of storing potatoes and sweet potatoes for a long period. They also had a system of storing limes during the excessive period to be used during the shortage. Likewise, there were many traditional coping mechanisms to store and ensure food security within the country at the rural level. All these systems were in place to face future food insecurity issues and external shocks to ensure their food security. Even if it is too much for consumption, they can sell during the shortage and earn some income. These traditional mechanisms and copying systems were in place to ensure buffer stock at the household level so that in case of a shortage, they would be able to use it. In that system, they were producing their food and storing and maintaining buffers stuck at the household level to be used in the future during food insecurity. I believe we need the revival of these old traditional systems, which are very important at the local level. So, we can use the new knowledge and technology but also revive some of the good practices they had for thousands of years in the country. I recommend having a national-level institution capable of looking at the old system and copying mechanisms, bringing new knowledge, technology and future climate forecasts and supporting institutions to bring all this new technology for food security in the country. Another barrier is that if good ideas come from the opposition or people associated with the opposition parties, we don't take them and just neglect their ideas. We should not worry about political affiliation; we should focus on food security and get the policies and programs right.

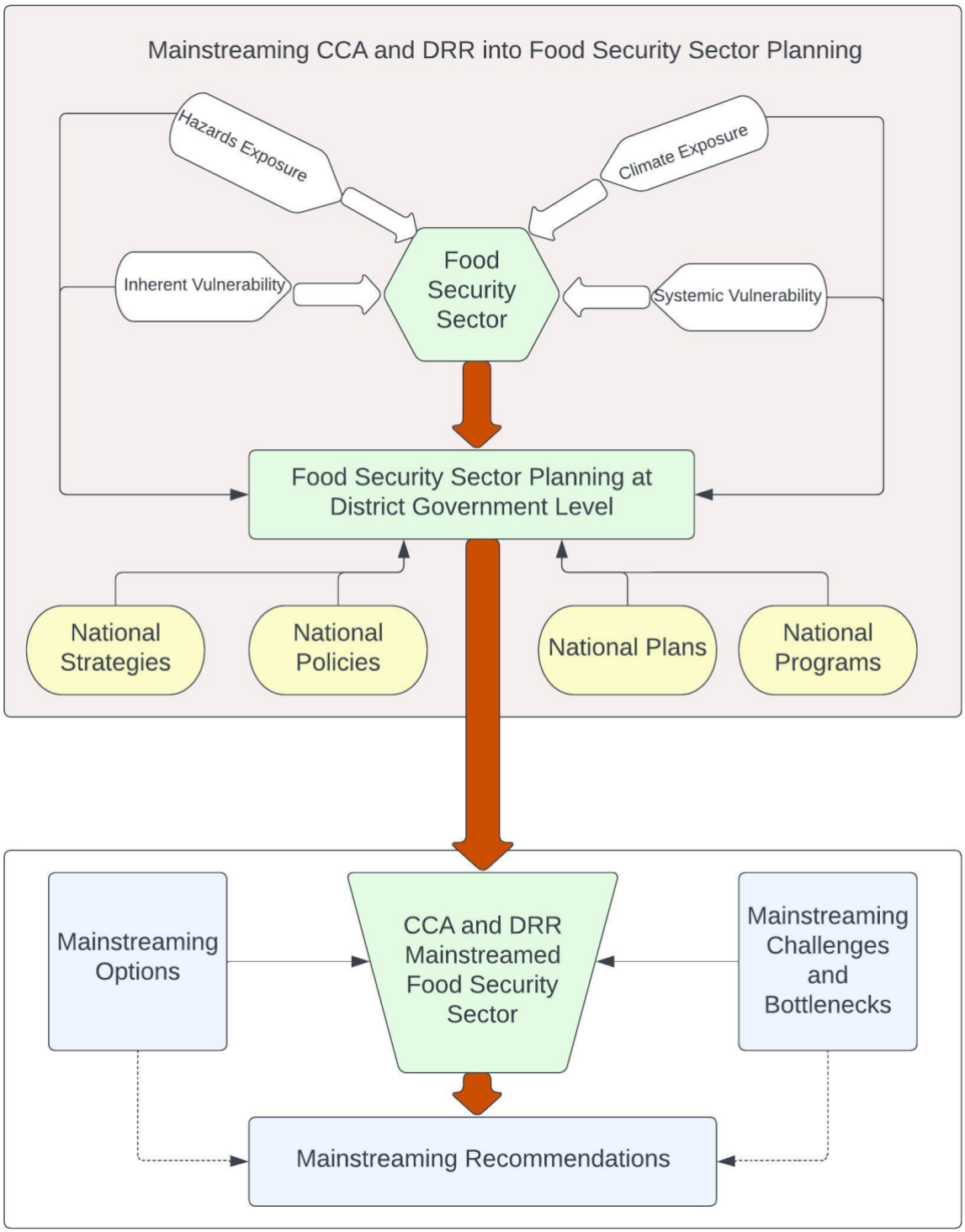
What are the enabling conditions and prerequisites required for mainstreaming and integrated planning processes in your district?

There should be well-defined legal frameworks to support the institutional reform process. That will be very useful in creating the enabling environments. The second thing is that we should be able to bring new technology and make the environment enabling for introducing and adopting new technologies. For example, if we can use Doppler Radar for forecasting, that would be very useful

so that the farmers can get the forecast for preparing their cropping calendar and plans. We don't have such a technologically enabling environment, so we must make that environment within the country. A policy framework should bring all the agencies into a common and integrated planning framework. That will support the legal framework, but there should also be a policy framework. If there is a legal and policy framework, then we can't avoid implementing integrated planning processes. There should be a financial resource as well in order to support such a planning process. Another important area is knowledge. There should be a knowledge environment for supporting integrated planning. These are basic prerequisites that we need to put in place for integrated planning processes. If we have this background, nobody can avoid planning and implementing those plans in an integrated manner. We cannot avoid reaching the targets if all these enabling environments support the overall process. We must also ensure a proper decision-making process; leadership development is very important.

Furthermore, the leadership must also be connected with their career development through promotion or properly rewarded for those implementing integrated plans. So human resource development is an important area in this integrated planning process. While countries achieve food security through integrated planning and programs, individuals also should be rewarded for their contributions to food security. In the current system, there is no difference whether you do it or you don't. There is no accountability. There is no promotion. There is no career development. There is no recognition, so people are not incentivised to go for integrated planning. Even the people who were going out of the box and implementing such plans also tend to think that I've done this, but what is in return, there is no progress and progressive movement for support in such efforts. People get frustrated because their performance, achievement and contributions are not recognised, so there are no further efforts for integrated planning. If we create this enabling environment, I don't think it will be difficult to make this integrated planning.

Annex G: Initial Conceptual Framework to Mainstream CCA and DRR into Food Security Sector Planning in Sri Lanka



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