Economic Research Institute for ASEAN and East Asia

Towards a Resilient ASEAN

Volume 2

Advancing Disaster Resilience and Climate Change Adaptation: Roadmaps and Options for Implementation

Edited by

Venkatachalam Anbumozhi, Jeremy Gross, and Stefan Wesiak

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Volume 2: Advancing Disaster Resilience and Climate Change Adaptation: Roadmaps and Options for Implementation

Published by
Economic Research Institute for ASEAN and East Asia (ERIA)
Sentral Senayan 2, 6th floor
Jalan Asia Africa No. 8
Central Jakarta 10270
Indonesia

Published in December 2019.

Cover Art by Artmosphere.
Book Design by Alvin Tubio.

National Library of Indonesia Cataloguing-in-Publication Data
ISBN: 978-602-5460-20-3

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FOREWORD

Few detailed studies have been carried out on the distributional economic and social impacts of disasters. This may be because of the intrinsic complexity that characterises making long-term social and economic calculations.

The global interdependence of food supply chains is well known. Thus, when one part of the agricultural production network is affected by natural hazards or climate-induced disasters, the consequences reverberate globally—supply decreases and food prices increase.
In agricultural production systems, food supply, supply chain infrastructure and transport to and from local markets are all vulnerable to disruption by natural disasters and climate change, so affecting the availability and affordability of food.

In the developing countries of Asia, we see, for example, that 22% of the total economic impact of natural disasters is in the agriculture sector: on crops, livestock, fisheries, and forestry. But as data is scarce, little is known about the substantial impact of natural disasters and climate change, by which we mean the burden placed on those people who rely on agriculture for their very livelihood. None of the primary global hazard databases are consistent in their accounting of direct and indirect agriculture losses from natural hazards, although some national databases separately record losses in agriculture.

To better understand this distributional impact of disasters on food security and to assess the policy implications, the Economic Research Institute for ASEAN and East Asia (ERIA) organised a study that brought together leading academics from around the globe with policymakers from the Association of Southeast Asian Nations to examine various approaches to build resilience into food value chains, share knowledge, and gain a better understanding of risk reduction from different disciplinary perspectives.

This two volume study, the outcome of that research, address the varying vulnerabilities of people, places and sub-sectors. It also introduces concepts and methods of analysis as well as illustrates the impacts on food security at the local, national, and regional levels. Volume One sets the stage by focusing on the relationship between natural disasters and climate change, and exploring their economic and social aftermaths more broadly. Volume Two goes on to discuss the resilience measures currently available before presenting national 'adaptation roadmaps' in terms of information sharing, preparedness, and enhancing effective decision-making capacity through a focus on improving the role of the financial markets via investment and insurance.

Together, the two volumes clarify pathways for resilience for addressing disaster risk management and adaptation to climate change. As stakeholders in this field continue to research, debate, analyse, and propose new options for improving resilience, publications such as this provide fresh insights that can be used to develop effective policies. This study emphasises the need for holistic actions: improved resilience of global food security rather than narrow sectoral approaches; innovative disaster-risk management measures rather than reliance on established patterns; and ensuring governments and the private sector take the lead in implementing robust institutional frameworks rather than entrusting the task to communities and international agencies.

I would like to thank the authors of all the chapters for their contribution, skilfully woven together by the editors of the two volumes. I would also like to thank the government officials, from Cambodia, the Lao PDR, Myanmar, and Viet Nam, who all participated in this study through ERIA's Capacity Building Programme. Although originally joining as observers, each went on to produce a national 'adaptation roadmap', an achievement beyond our original expectation.

I am confident that together these two volumes will make a significant contribution to policy development and academic understanding in this field, where new insights are urgently needed.

Hidetoshi Nishimura
President

INTRODUCTION

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The basis for this second volume is the juncture of two separate trends identified in Volume 1: (i) all countries in the Association of Southeast Asian Nations (ASEAN) and East Asia face increased risk from a full range of known natural disasters and previously unknown hazards such as climate change; and (ii) disaster consequences are having greater adverse effects on food security and the natural resources environment.

Therefore, governments, the private sector, and communities must take action to prepare for and to mitigate the effects of natural and climate-induced disasters. However, despite even their best efforts, the fury of nature or the folly of economic activities regularly will result in disastrous climate events that overwhelm not only local response capacities but also those of entire nations or regions. When this happens, the full range of players, from policy-making communities, international actors, and local societies, is called upon to intervene. This requires integrated risk management and the development of adaptation responses.

The regional response to disasters and climate change is convoluted, at times chaotic, and always complex. Every country has its own risk profile based on vulnerability fluctuations, evolving or deteriorating emergency management systems, cultural, economic, political and institutional characteristics all playing a part in adapting to risk. Each of these qualities influences the interaction of policy or decision makers with local, national, and international agencies.

Disaster risk management, climate change adaptation, and resilience—as an integrated practice as well as a profession—is rapidly expanding and improving at the regional and country level. Such a change is driven by the evolving capacity building needs of governments and non-governmental organisations, as well as the international community, in one or more of the four phases of disaster risk management: mitigation, preparedness, response, and recovery.

The second volume of this book is written to serve as a guideline for practitioners, policymakers, local decision makers, and anyone interested in disaster risk reduction and developing adaptation roadmaps. Volume 2 provides the reader with essential introductory information, principles for effective practices, guidelines for action in a range of sectors and settings, case studies, and links to useful tools and resources for the application of an integrated approach to resilience. This volume is not intended to replace individual country or organisational policies on disaster risk reduction and climate change adaptation; rather, it seeks to foster complementary practices and coordination between multiple actors working towards a common goal.

This volume is organised into three parts. The chapters in Part I outline the case for tackling vulnerability and investing in resilience along with the key gaps, obstacles, and opportunities for such investments in adaptation roadmaps. Part II presents four country case studies and sectors of focus, therein identifying potential policy, capacity, and investment instruments that can be applied to address disaster risk management, climate risk reduction, and residual risk management for achieving food security. Part III presents a policy framework to ensure a resilient future based on identifying critical steps that can help jump-start greater actions on climate information, human resources development for enhanced decision-making capacity, and financing sectoral actions over the next decades.

Chapter 1 provides the background to the impact and management of disasters and climate change on food security. Included in this discussion is the vulnerability of countries and sectors as well as the evolving practices of reactive and planned adaptation. Several of the issues unique to Southeast Asia are touched upon, while in-depth coverage is included in the later chapters.

Chapter 2 addresses the current policy strengths and weaknesses, and defines actions and strategies to deal with the impact of climate change and disasters. Varying levels of capacity are identified, and adaptive solutions are discussed in detail. Where applicable, the foundations of resilient development are illustrated.

Chapter 3 examines the existence of structural and non-structural adaptation measures and risk management practices and assesses their efficacy. Disparity in the adoption of best practices between countries in relation to their vulnerability is discussed in detail, as is climate or disaster risk perception—an important and influential component of building adaptation roadmaps.

Chapter 4 covers the mitigation of disaster risk and climate vulnerability through institutional innovations. A critical overview of preparedness through extension systems is followed by several practical topics including communication, social networking, training, early warning systems, and preparedness obstacles.

Chapter 5 addresses the financing issues related to adaptation roadmaps. The need for regional cooperation is explained, followed by a description of market-based instruments such as insurance, as a mitigation option. Finally, various obstacles to effective financing models are identified and explained.

Chapter 6 examines actions needed to strengthen resilience through the development of integrated disaster risk management framework strategies, so combining climate change adaptation, disaster risk reduction, disaster preparedness, post-disaster relief, disaster risk financing goals under a single framework and pursuing them through joint initiatives.

Chapters 7 to 10 discuss the various players involved in climate change and disaster risk management through the presentation of adaptation roadmaps for Cambodia, the Lao People's Democratic Republic, Myanmar, and Viet Nam. These include coordinated action amongst governmental agencies, non-governmental organisations, and various international organisations to develop an effective response system and shorten the recovery period when disasters occur in the future. The components of adaptation roadmaps addressed include opportunity factors, the economics of resilience, and other coordination-related issues.

Chapter 11 concludes by presenting guidelines and specific points that must be considered in the management of climate risks and disaster resilience. These include policy coordination, minimum standards for climate information, enhancing decision-making capacity, equality in funding, and the future of regional cooperation. The guidelines seek to encourage readers to integrate investments in adaptation and resilience into their areas of work; and to promote, incentivise, and support parallel actions on the part of public and private sector actors over the next 15 years (2020–2035). They focus on the steps required to ensure that adaptation actions and resilience investments happen and that this occurs as an integral part of achieving the Sustainable Development Goals in 2030.

Through this volume, we aim to provide a composite structure, integrated approach, and ideas for critical reflection. We invite readers to consider how we can ensure that the actions we know are required to strengthen disaster resilience, climate change adaptation, and food security are taken. This volume cannot serve as a manual or handbook, and does not present all the answers. Instead, when read as a companion to Volume I, it can encourage policymakers and decision makers to envisage what a resilient future is, and equips them with a framework and ideas to identify practical actions that will result in the realisation of that vision. It seeks to effect change, identifying ways to overcome key information, decision-making, and financing gaps and obstacles to turn existing rhetoric and commitments on strengthened resilience into responsibilities, accountability, and targeted actions that can be undertaken within the context of a sustainable future.

PART

I

Towards Resilient Food Systems

CHAPTER 1

Food Security in the Face of Disasters and Climate Change

ADAPTATION ROADMAP

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ABSTRACT

It is clear that climate change and recurrent natural disasters have a serious impact on food security. Given the high likelihood of further climate variabilities and extreme weather events, and resultant potential impacts on food security, it is essential to address adaptation strategies for food security. Adaptation strategies must be implemented to improve the productivity of agriculture under the existing state of climate change to improve future variability, while meeting growing demands for food security. The objectives of this chapter are to outline the impacts of natural disasters and climate change on food security, and to suggest adaptation strategies that can help manage risks and achieve resilience. Achieving an adaptation action plan will require the integration of disaster risk management and climate change-related issues with other risk factors. This information will help policymakers make decisions to address the impacts of natural disasters and climate change, and achieve food security.

1.1 Introduction

Reducing risks to food security from natural disasters and climate change is one of the foremost challenges of the 21st century. The effects of natural disasters and climate change threaten agriculture by decreasing the production of crops, fisheries, and livestock (Food and Agriculture Organization [FAO], 2016). About 60% of the Earth's surface is occupied by croplands, pastures, and forests; and these are gradually being exposed to threats from increased climatic variability. Unusual changes in temperature and rainfall patterns lead to more frequent droughts and floods, which have long-term effects on ecosystems. The increased intensity and occurrence of storms, droughts, flooding, and precipitation variance also impact food security.

Food security is a situation in which all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 1996). The four main components of food security are availability, access, utilisation, and stability (FAO, 2009). Several factors influence food security, such as population growth leading to elevated food demand, higher commodity prices, and resource degradation, as well as climate change and natural disasters. More than 80% of those who are food insecure live in countries prone to natural hazards and climate change, and derive their livelihood from agriculture while having a significantly low asset base (FAO, 2015).

Natural disasters and climate change are major risks for long-term food security, and have devastating impacts at the household level. Natural disasters, including droughts, storms, tsunamis, earthquakes, landslides, and floods can occur anytime anywhere, affecting food security and human life. Over the last decade, natural disasters caused $1.3 trillion in damages and affected over 2.7 billion people. Agriculture accounted for 23% of the damage caused by natural disasters from 2005 to 2014. Disasters like flash floods can cause crop, human, and economic losses in minutes, while prolonged droughts can destroy livelihoods more slowly. Agriculture is the main sector affected by drought, accounting for about 84% of the total economic impact (FAO, 2018). Natural disasters limit the capacity of food production by affecting crop yields, seed reserves, livestock, fisheries, farm equipment, infrastructure, supply systems, and food trade, resulting in economic losses and disrupting the internal equilibrium in vulnerable nations (De Haen, 2008; Sperling, 2008).

Climate change poses additional challenges to food security. More extreme temperatures and precipitation due to climate change affect agricultural productivity by facilitating the spread of pests and diseases, decreasing the efficiency of crop-water use, and reducing the nutrient content of crops, in turn affecting household income and food security (Wheeler and von Braun, 2013). Simultaneously, sea-level rise directly causes flooding, salinisation, and increased groundwater salinity, threatening food production. Agricultural production in the developing countries of Asia and Africa is adversely affected by climate change, putting the livelihoods of large numbers of the rural poor at risk and further increasing their vulnerability to food insecurity by affecting aquatic life (by influencing reproduction and migration timings). Climate change has the potential to affect food security at the global, national, and local levels by disrupting food availability, access to food, and food quality. Extreme weather events can affect food access by impacting transport and food distribution, both locally and globally. The climate is a highly important driver of the food supply chain from production to consumption; this is especially true at the production level, as it affects the quantities and types of food produced and the adequacy of production-related income. Extreme weather events can damage or destroy transport and distribution infrastructure and adversely affect other nonagricultural parts of the food system (FAO, 2015).

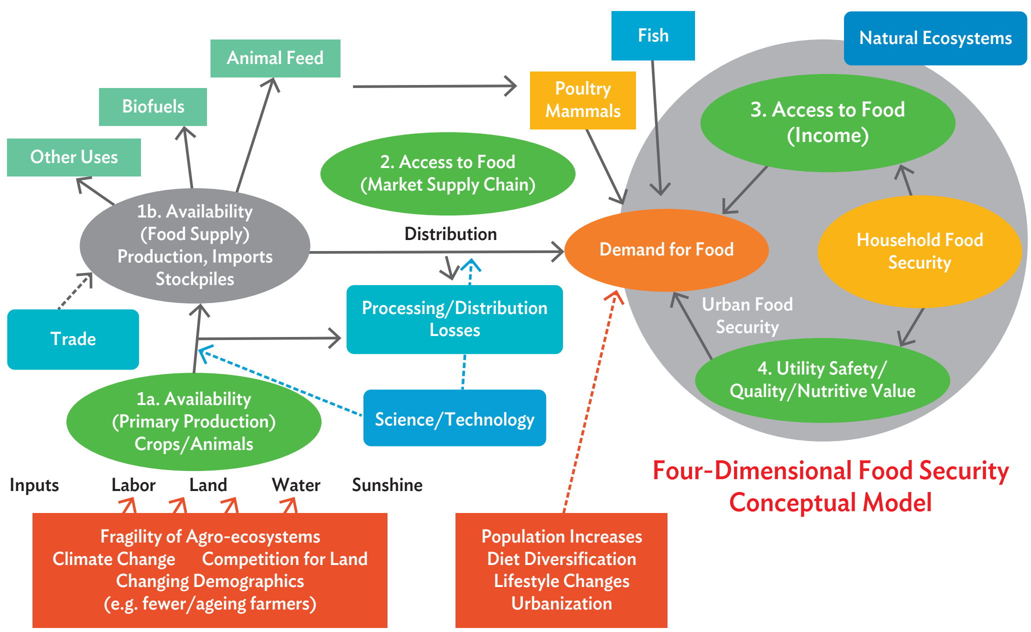
Given the inevitability of natural disasters and climate change impacting agricultural systems, adaptation is necessary to maintain future food security. More studies are required to incorporate multiple systems and interests in adaptation, and formulate a response to the imminent threat to the food system. Adaptation strategies that manage disaster risk reduction and face climate-related extreme weather events aim to diminish the factors that contribute to these risks, and subsequently to support and promote food security (Wheeler and Braun, 2013). Adaptation to climate change includes changes in socioeconomic systems to reduce their vulnerability both to the long-term impacts of climate change and to extreme climatic events. Extreme weather-related events are hazardous to food security and often exceed the capacity of a country or community to cope. The development of adaptation strategies to respond to the effects of disasters and climate change will require cooperation at the local, regional, and global levels, across disciplinary boundaries, and between different sectors of the economy. Improving the ability of communities to adapt to climate change and manage disaster risks requires addressing vulnerabilities at the local level, involving stakeholders, and ensuring that adaptation initiatives are compatible with existing decision processes (Brooks and Kelly, 2005).
In this chapter, we discuss natural disasters and climate change impacts on agricultural production and food security. Ensuring food security and adaptation are ways to mitigate

the negative effects of climate change. We also discuss adaptation strategies, outlining core principles, priority actions, and the implementation of proposals to achieve food security in the contexts of the Association of Southeast Asian Nations (ASEAN) and of the wider world.

1.2 Food Security and Effects of Natural Disasters

Food security fundamentally deals with the continuous availability of and access to food for people in appropriate quantities and quality to meet dietary requirements (Pinstrup-Andersen, 2009). There are four significant pillars of food security that are crucial to achieving sustainability: availability, access, utilisation, and stability over time. Food security initiatives focus on one or some combination of these pillars (Figure 1.1). Many factors, including natural disasters, extreme weather events due to climate change, a growing global population, land degradation, lack of water resources, rising food prices, and environmental stressors, have significant impacts on food security (Premanandh, 2011).

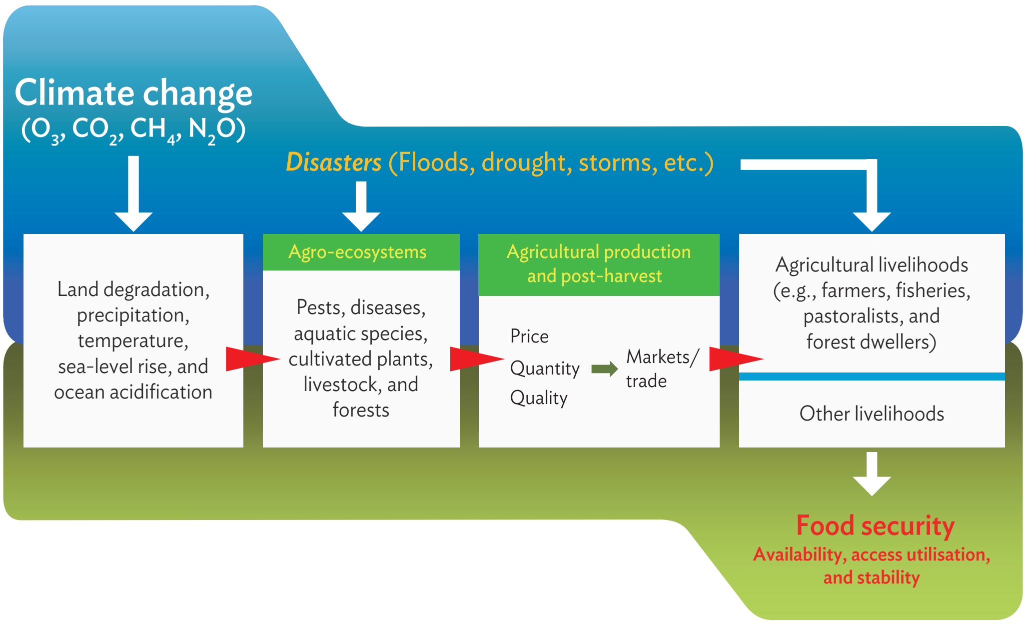
Figure 1.1: Food Security and its Components



Source: Teng, P. (2013), 'Food Security: Challenges and Opportunities for Collaboration', Presentation given during the Symposium on Metro Agriculture and Urban Food Security: An Explicative Symposium with Global Innoversity, 5 September; Desker, B., M. Caballero-Anthony, and P. Teng (2014), *ASEAN Food Security: Towards a More Comprehensive Framework* (No. PB-2014-03).

A natural disaster is any natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (United Nations International Strategy for Disaster Reduction [UNISDR], 2009). Natural disasters can be biological, geophysical, meteorological, climatological, and/or hydrological. Major factors that contribute to the intensification of the severity and frequency of natural disasters are climate change, urbanisation, and environmental degradation. The frequency and severity of droughts, floods, storms, and other disasters triggered by climate change have increased since the 1980s, causing severe agricultural losses in several developing countries and placing them at risk of food insecurity. Crop yield losses lower the availability of food commodities in local markets, leading to food inflation and reducing households' purchasing capacity. This restricts access to food, reduces savings, and may lead to the sale of vital productive assets, thus destroying livelihoods (UNISDR, 2015). Eventually, this leads to a reduction in the quantity and quality of food for consumption, resulting in food insecurity and malnutrition, especially amongst the most vulnerable (Figure 1.2).

Figure 1.2: Overview of Impacts of Natural Disasters and Climate Change on Food Security



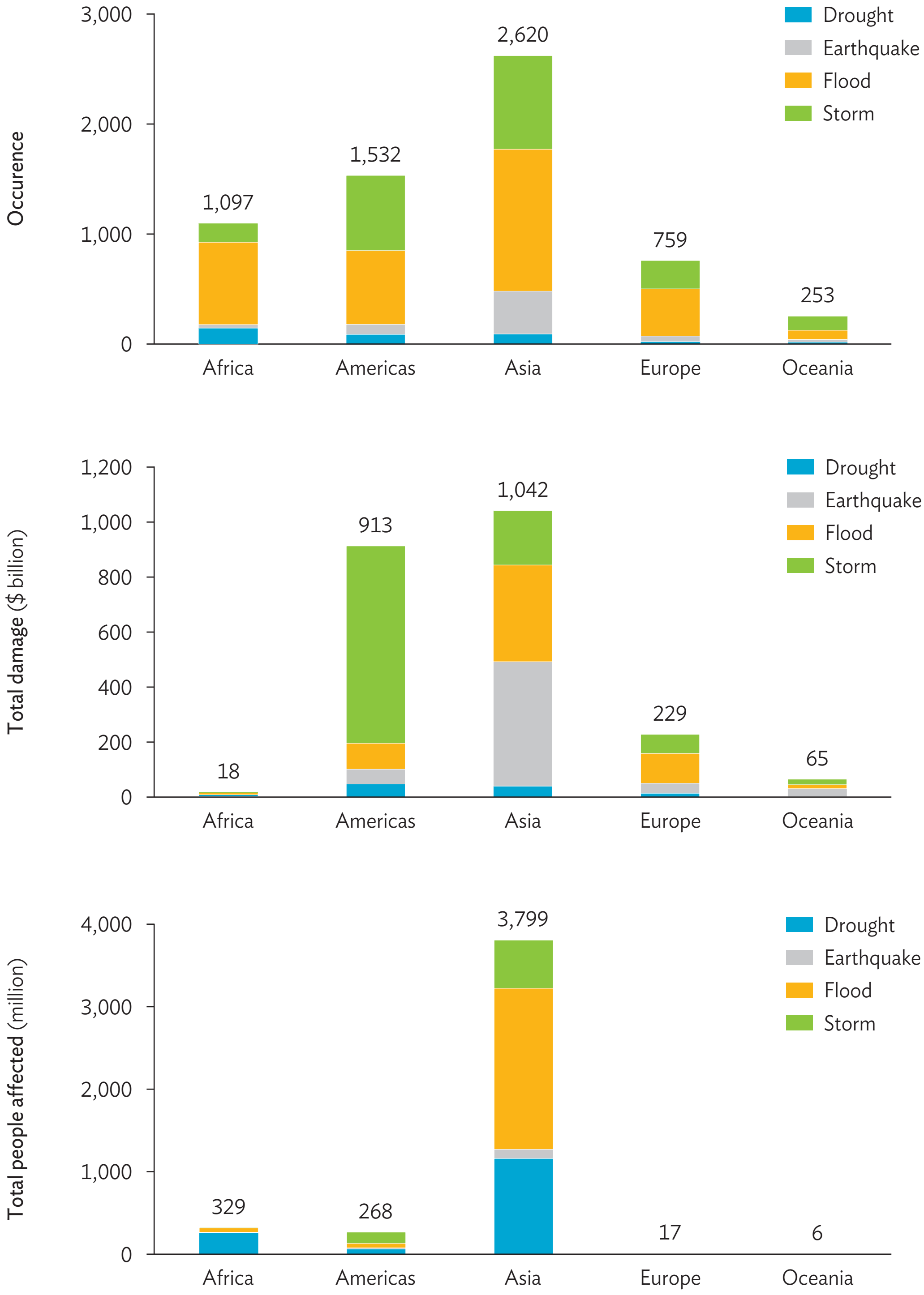
CH_4 = methane, CO_2 = carbon dioxide, N_2O = nitrous oxide, O_3 = ozone.

Source: Modified from Food and Agriculture Organization (2015), *Agroecology to Reserve Soil Degradation and Achieve Food Security*. Rome: Food and Agriculture Organization. http://www.fao.org/3/a-i4803e.pdf (accessed 10 May 2018).

Over a given period, agricultural damage and losses due to disasters accumulate, impacting the agricultural economy and limiting growth and development in this sector. For instance, the Philippines has been one of the ASEAN countries hardest hit by natural disasters, particularly typhoons, floods, and droughts. Between 2006 and 2013, the Philippines was affected by 75 disasters, mostly floods and typhoons or tropical storms, causing $3.8 billion in losses, of which $477 million was economic losses to the agriculture sector. From 2001 to 2010, the country endured a total of 184 typhoons (18 typhoons per year, on average). Natural disasters not only affect people, but also negatively impact the economy and environment in the affected area (FAO, 2015; Israel and Briones, 2012).

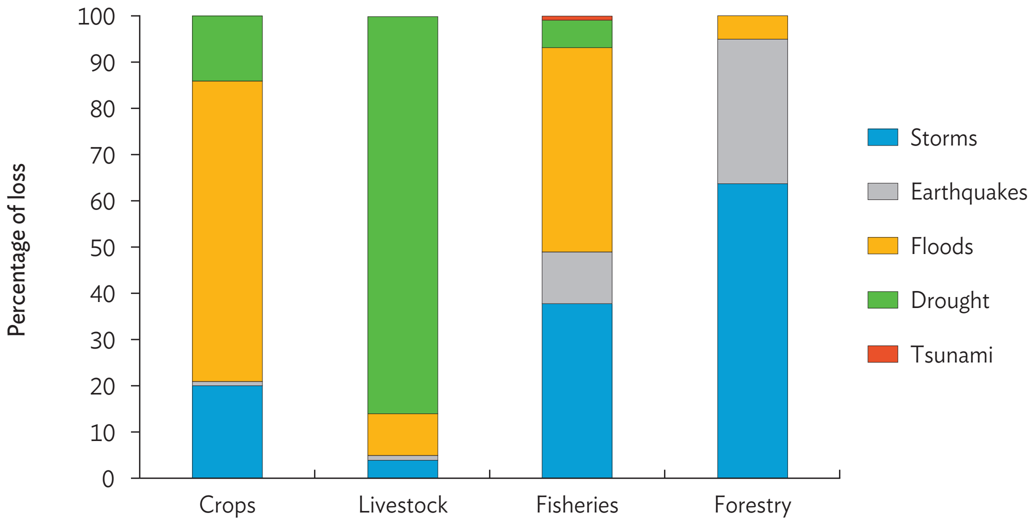
Globally, the average annual number of disasters between 2005 and 2014 (including all natural and climate-related disasters) was almost double the number of disasters that occurred in the 1980s. The occurrence of natural disasters, the damage that they inflict, and their impact on livelihoods and economies are increasingly having a major effect on Asia (Figure 1.3). According to the Emergency Events Database, in 2018, 301 country-level disasters occurred affecting 102 countries. In total, 6,261 natural disaster events occurred from 1997 through March 2018 affecting 4,419 million people; the damage inflicted resulted in around $267 billion in economic losses (Figure 1.3). Globally, disasters cause $250 billion–$300 billion in economic losses every year, on average. In developing countries during 2005–2016, there were, on average, 260 natural disasters every year, causing 54,000 fatalities, affecting more than 97 million people, and costing about $27 billion in economic losses (Emergency Events Database). From 2005 to 2014, natural disasters in developing countries caused approximately $93 billion in crop and livestock losses. In a study of 332 disasters in 87 developing countries from 2006 to 2016, the FAO found that agriculture—including crops, livestock, fisheries, aquaculture, and forestry—absorbed 23% of damages and losses from natural disasters. This rose to 26% in the case of climate-related disasters such as floods, droughts, and storms, indicating the susceptibility of smallholder farmers to natural disasters (Figure 1.4). Of the various kinds of disasters, floods are especially destructive, accounting for two-thirds of crop losses and related damage. In terms of crop losses, the 2010 flood in Pakistan is considered the most catastrophic recent disaster, causing almost $4.5 billion in damages. Another major recent disaster was the 2008–2011 drought in Kenya, which caused $1.5 billion in crop losses. In terms of livestock, the drought was the most harmful disaster, damaging 86% of the sector in Kenya, and causing $8.9 billion in losses. Floods and storms cause major losses for fisheries and aquaculture, while storms account for two-thirds of all disaster impacts on forestry, especially considering the impacts of the 2007 Hurricane Felix in Nicaragua and 2008 Cyclone Nargis in Myanmar (FAO, 2018).

Figure 1.3: **The Impact of Disasters from 1997 to March 2018 on Different Continents**



Source: Data from the Emergency Events Database, 2018 database. https://www.emdat.be/ (accessed 16 March 2019).

Figure 1.4: Percentages of Crop, Livestock, Fishery, and Forestry Losses Due to Storms, Earthquakes, Floods, Droughts, and Tsunamis (2006–2016)

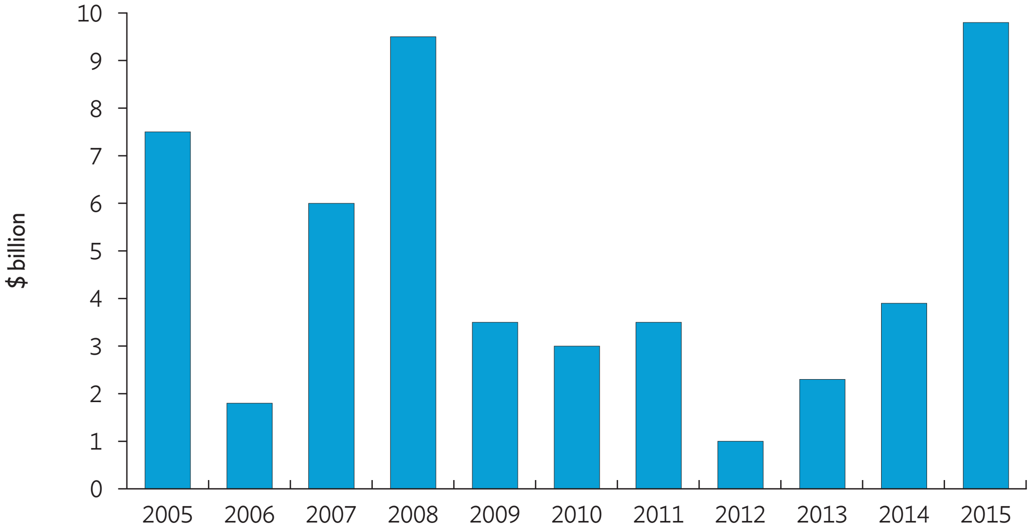


Source: Data from Food and Agriculture Organization (2017), *The Impact of Disasters and Crises on Agriculture and Food Security*. Rome: Food and Agriculture Organization. http://www.fao.org/3/I8656EN/i8656en.pdf (accessed 10 May 2018).

In Asia, agricultural production losses from 2005 to 2015 were found to be highest in the years 2008 and 2015 (Figure 1.5). The losses in these two years were primarily due to the sequence of monsoon floods and earthquakes that occurred in Southeast Asia. Asia's production loss in 2005–2015 was $48.0 billion (about 50% of total losses), of which $32.0 billion was lost in South Asia and $14.5 billion in Southeast Asia (FAO, 2017).

Some 70% of the world's disasters take place in developing, low-income countries (Gaire et al., 2016). Asia is the most disaster-prone area in the world, and is facing an increasing risk of natural disasters and resultant production losses. In particular, the presence of the Himalayas raises the probability of an outbreak of disasters, especially floods and severe droughts, in Asia in the coming decades (Kim et al., 2015). In addition to floods, Asian agriculture is challenged by earthquakes and tsunamis, which have caused losses of $9 billion so far, and by extreme temperatures, which account for over $7 billion in losses. These production losses correspond to 333 million tonnes of cereals, pulses, meat, milk, and other commodities. These losses are significant at the national level and highly significant at

Figure 1.5: Total Crop and Livestock Production Losses Due to Natural Disasters in Developing Countries in Asia (2005–2015)



Source: Data from Food and Agriculture Organization (2017), *The Impact of Disasters and Crises on Agriculture and Food Security*. Rome: Food and Agriculture Organization. http://www.fao.org/3/I8656EN/i8656en.pdf (accessed 10 May 2018).

the regional level (FAO, 2015). In Asia, disaster-related production losses were high across all commodity groups. Cereal production (especially of rice and wheat) registered $12 billion in losses over the past decade. Natural disasters also caused production losses of $7.3 billion in fruit and nuts, $6.0 billion in livestock, and $5.0 billion in vegetables (FAO, 2015).

The Global Climate Risk Index (CRI) developed by Germanwatch analyses quantified impacts of extreme weather events in different countries, considering fatalities as well as economic losses. The CRI determines the degree of exposure and susceptibility to extreme events by studying the deaths and economic losses caused by disasters. The CRI analyses the socioeconomic impact of extreme weather events such as floods, storms, landslides, earthquakes, droughts, wildfires, hail, and tornados. According to the 2018 CRI, which was created based on 20 years of data (1997–2016), the top 10 countries facing long-term climate risks include six Asian countries. Based on the average data for 20 years, the three most vulnerable countries in the world are Honduras, Haiti, and Myanmar. In general, developing countries are more susceptible to climate risk (Eckstein et al., 2018) (Table 1.1).

Table 1.1: The Long-Term Climate Risk Index of the 10 Countries Most Affected from 1997 to 2016 (Annual Averages)

CRI Ranking (1997–2016)	Country	CRI score	Total Losses ($ million) (PPP)	Losses per Unit GDP in %	Number of Events (1997–2016)
1	Honduras	12.17	561.11	1.968	62
2	Haiti	13.50	418.77	2.730	72
3	Myanmar	14.00	1,277.86	0.694	43
4	Nicaragua	19.33	234.60	1.127	44
5	Philippines	20.17	2,893.41	0.611	289
6	Bangladesh	26.50	2,311.07	0.678	187
7	Pakistan	30.50	3,816.82	0.605	141
8	Viet Nam	31.83	2,029.80	0.549	216
9	Thailand	33.83	7,696.59	0.967	137
10	Dominican Republic	34.00	243.53	0.262	49

CRI = climate risk index, GDP = gross domestic product, PPP = purchasing power parity.

Source: D. Eckstein, V. Künzel, and L. Schäfer (2018), 'Global Climate Risk Index 2018', *Bonn, Germany: Germanwatch*. https://germanwatch.org/en/14638 (accessed 10 May 2018).

Natural disasters are a major cause of food insecurity in the developing world, as they impact all four pillars of food security. They negatively influence economic and physical access to food supplies by affecting agro-ecosystems via decreased crop production, loss of fisheries, and livestock reduction. Natural disasters also make it difficult to control weeds, pests, and the spread of diseases (Figure 1.2). Disasters such as droughts and floods also have long-term impacts and can abruptly influence victims' earning capacity, causing standard asset losses for people who depend on agriculture, and subsequently affecting food prices and the food supply chain. It is estimated that the food price index doubled from 2002 to 2011 due to recurrent increases in agricultural commodity prices. This increase was associated with three drought incidents (2001–2007) in Australia and a heat wave during the summer of 2010 in Central Asia, amongst other disasters (FAO, 2015).

Agriculture is considered one of the main economic activities in developing countries accounting for 10%–20%, on average, of the national gross domestic product (GDP) in middle-income countries, and more than 30% of GDP in low-income countries. In countries where the economy is driven by agriculture, disasters can trigger major losses, up to 30%–40% of both national GDP and employment. For example, damage to fisheries caused by the

2016 tropical cyclone in Fiji reached about $100 million, or 2.3% of the country's 2015 GDP. Similarly, GDP growth in Indonesia has been limited by recurrent wildfires that have cost the country an estimated Rp221 trillion, more than twice the renovation cost of the 2004 tsunami (World Bank, 2016). In Nepal, agriculture (including a mix of crop and livestock production) accounts for 34% of annual GDP. In 2015, in earthquake- and landslide-struck basins, and in other parts of central Nepal, more than 73.3% of the population depends on agriculture, either for survival or for commercial farming (Government of Nepal, 2015). Similarly, in a study of average 5-year growth during 1961–2005, disasters were observed to have a significant impact on GDP, with droughts having a negative effect, and floods having a positive effect (Israel and Briones, 2012). The effects of natural disasters differ based on the type and severity of the disaster (Fomby, Ikeda, and Loayza, 2013). For example, during 1991–2013, drought had detrimental effects on crop and livestock in sub-Saharan Africa, causing production losses of 90%, or more than $30 billion (FAO, 2015). However, in a few cases floods had positive effects due to the greater availability of water, which benefitted the crops and provided additional nutrients carried from the uplands to lowlands (Israel and Briones, 2012). Floods also temporarily create a more abundant water habitat for inland fish and other aquatic animals. However, when flooding is severe, this positive effect can vanish and it can damage farm infrastructure, supplies, facilities, and stored seeds (Loayza et al., 2012). The frequency of extreme weather has been rising globally, indicating the urgent need for Asia to adapt to natural disasters. Understanding the damage and loss sustained by the agricultural sector is key for managing disaster risks and supporting national resilience policies, planning, and action.

1.3 Effects of Climate Change on Food Security

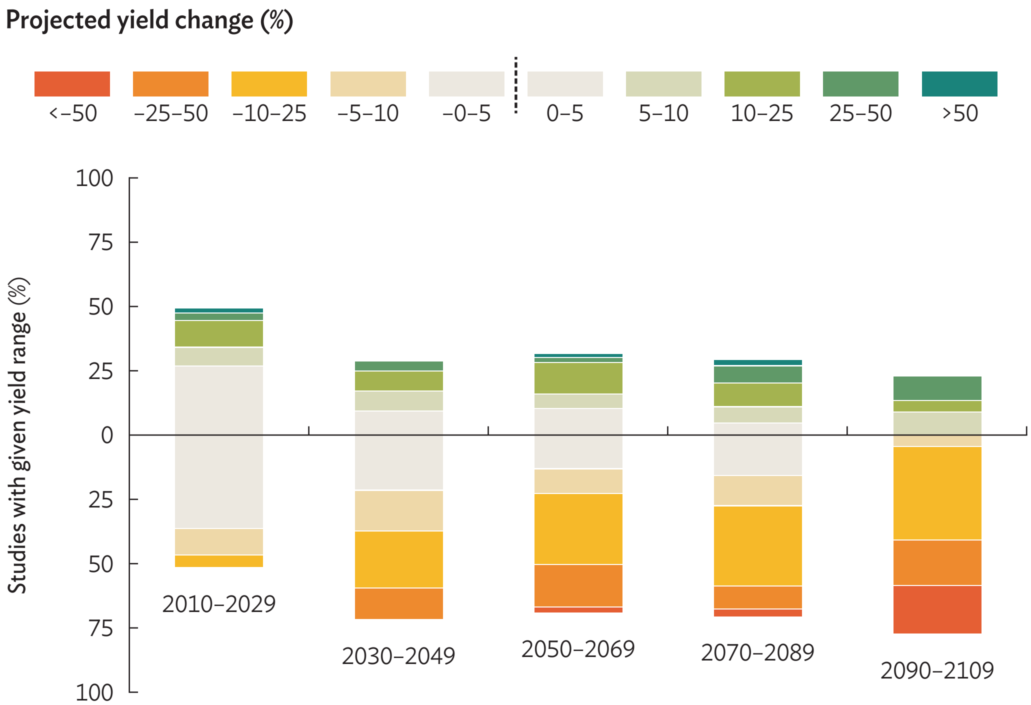
The Intergovernmental Panel on Climate Change (IPCC) defines climate change as 'a change in [the] state of the climate that can be recognised (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer' (IPCC, 2012). Changes in the climate occur due to natural processes and external factors caused by human activities, such as burning fossils emitting greenhouse gases, farming, and deforestation; these changes impact natural resources, biodiversity, land use, and agro-ecosystems, amongst other things. The main characteristics of climate change are an increase in average global temperatures, changes in precipitation patterns, the melting of glaciers and polar ice caps, an increase in ocean temperatures, and increased ocean acidity due to seawater absorbing heat and carbon dioxide (CO_2) from the atmosphere. These changes are expected to continue and intensify in the future

(Solomon et al., 2007). Global climate change has already had observable effects on the environment. It has also been predicted that climate change over the next century will modify river flows and sea levels throughout the globe, and affect rainfall (IPCC, 2008).

Research has shown that agricultural yields will likely be severely affected over the next century by unusual rates of change in the climate system (Jarvis et al., 2010; Thornton et al., 2011). Climate change greatly influences the conditions in which agricultural activities are conducted. Plants, animals, and ecosystems in every region of the world are adapted to the prevailing climatic conditions. For instance, in experiments conducted in controlled conditions, some cultivated C_3 plants react favourably to an increase in atmospheric CO_2 by producing more biomass and increasing the yield. Similarly, many weeds that compete with crop plants for nutrients and water also reacted favourably to increased levels of CO_2. Studies show that elevated CO_2 levels selectively favour invasive and noxious species of weeds, stimulating their growth and making them difficult to control (Ziska and George, 2004). A rise in CO_2 concentrations changes the strength of plant defences against pests and pathogens (Zvereva and Kozlov, 2006), permitting pests and weeds to establish themselves (Rosenzweig et al., 2001). Pests and diseases are also influenced by changes in the climate, with possibly negative impacts. Climate change will also impact the abundance and distribution of pollinating insects, which may reduce the pollination of flowering plants, lowering their production (Hegland et al., 2009). Hence, climate change alters the relationships that exist amongst crops, pests, pathogens, and weeds. Climate change reduces crop yields by affecting pollinating insects, creating water scarcity, increasing ground-level ozone concentrations, and reducing fishery production (Myers et al., 2017) (Figure 1.3).

Although some crops can see yield increases when CO_2 levels are elevated, the higher temperatures caused by increased CO_2 reduce crop yield. Crop growth models that study the effects of CO_2 combined with the effects of temperature, water availability, and limited nitrogen have predicted yield losses (Figure 1.6) (Challinor et al., 2014; Rosenzweig et al., 2014). Changes in production caused by climate change will surely impact food commodity prices, making them difficult to buy in vulnerable countries. According to modelling studies that compare scenarios 'with' and 'without' climate change, estimated world market export prices in 2030 relative to 2010 export prices will rise by a higher percentage in the 'with' climate change scenario than in the 'without' climate change scenario (Willenbockel, 2011). Global sea-level rise from glaciers melting due to thermal expansion will affect food security by flooding agricultural lands near coastal areas and increasing the salinisation of groundwater (Adams, 1989; Myers et al., 2017). Additionally, rising sea levels also cause destructive

Figure 1.6: Estimated Output Reduction in Crop Yields Due to Climate Change (2010–2109) (%)



Source: Challinor, A. J., J. Watson, D. B. Lobell, S. M. Howden, D. R. Smith, and N. Chhetri (2014), 'A Meta-Analysis of Crop Yield Under Climate Change and Adaptation', *Nature Climate Change*, 4(4), p. 287.

erosion, wetland flooding, soil contamination, and habitat loss for fish. Salinity levels in the soil can significantly influence plant growth and production, as well as the quality of available drinking water (Adams, 1989; Myers et al., 2017; Shrivastava and Kumar, 2015).

Asia is particularly vulnerable to climate change because it has high population densities in vulnerable areas exposed to climate-related hazards such as floods, cyclones, and droughts, as well as long-term climate changes such as gradual changes in monsoon patterns, glacier melt, and sea-level rise. In Asia, most vulnerable people live in the river deltas of Bangladesh, Cambodia, India, Myanmar, Viet Nam, Thailand, and Pakistan, where rising sea-levels will affect 2 million people by 2050, and result in the loss of farming areas in coastal regions (Table 1.2) (Webster, 2008). The IPCC (2014) estimates that, by 2050, rising sea levels could directly displace more than 3 million people living in delta areas in

Table 1.2: Loss of Agricultural Area from Sea-Level Rise in ASEAN Countries (hectares)

	With a 1-meter rise	With a 3-meter rise
Myanmar	295,000	1,214,000
Thailand	199,000	796,000
Cambodia	35,000	118,000
Viet Nam	2,513,000	4,281,000

ASEAN = Association of Southeast Asian Nations.

Source: Asian Development Bank (2012). *Guidelines for Climate Proofing Investment in Agriculture, Rural Development, and Food Security*. Manila: Asian Development Bank. https://www.adb.org/sites/default/files/institutional-document/33720/files/guidelines-climate-proofing-investment.pdf (accessed 4 May 2018).

Bangladesh and 7 million–18 million in Viet Nam. Sea-level rise will also cause losses of arable land in Asia, which produces 88% of the world's rice. According to the FAO, more than 100 million hectares of agricultural land in Bangladesh and 2.6 million hectares of land in Viet Nam, where rice is the predominant crop, will be affected by the 1-meter rise in sea levels. As most of the population in these countries depends on farming and fishing, the rise in sea levels will impact their livelihoods. Increased temperatures are also expected to cause the glaciers in the Himalayan region to melt, causing more frequent flooding in the short term and higher risk of drought in the long term. Wheat production along the Indus Valley depends on water from these glaciers, and the risk of flooding and drought can stress sensitive livelihoods in these regions. Sea levels are expected to rise by an estimated 57–100 centimetres by the end of the century, exacerbating coastal flood risks and storm surges and impacting livelihoods in coastal areas. Each year, the Philippines is threatened by about 19 tropical cyclones, of which between six and nine make landfall, with devastating effects on crop production, land, agricultural tools, and fishing boats. Climate projection studies show that large parts of Southeast Asia will experience changing rainfall patterns due to substantial changes in the climate, which will impact rain-fed agricultural systems (FAO, 2017).

Quantification studies of 23 Southeast Asian cities indicate that rising sea levels will expose an estimated $864 billion in assets to floods by 2100. Losses will also be inflicted on infrastructure, industries, coastal zones, and agriculture in the region. In the next century, it is estimated that Indonesia, the Philippines, Thailand, and Viet Nam will face mean economic losses from climate-induced disasters equal to losing 6.7% of their collective GDP each year, double the global average loss (Asian Development Bank [ADB], 2014).

One of the most significant impacts of climate change is the potential increase in food insecurity due to changes in the productivity of agricultural land, seasonal variability, and greater magnitude of disasters. Climate change affects all four dimensions of food security in complex ways. Variations in crop yields influence food availability, especially in key producing areas, due to rising temperatures, a decrease in or loss of arable land, and low availability of water for agriculture. Production losses can strain the capacity of households to access food and can influence dietary diversity. Additionally, changes in rainfall and temperature patterns directly impact livelihoods that depend on climate-sensitive activities, such as rain-fed agriculture and livestock rearing. Low water availability may cause sanitation problems and affect the quality of available drinking water, causing health concerns. Combined with other vector-borne infections, there is a possibility of increased malnutrition influencing food utilisation. Climate-related extreme weather events also disturb the stability of the food supply and of livelihoods. According to the IPCC (2008), the degree of climate change impacts on individual regions will vary over time and with the ability of different societal and environmental systems to adapt to change.

1.4 Adaptation Strategies

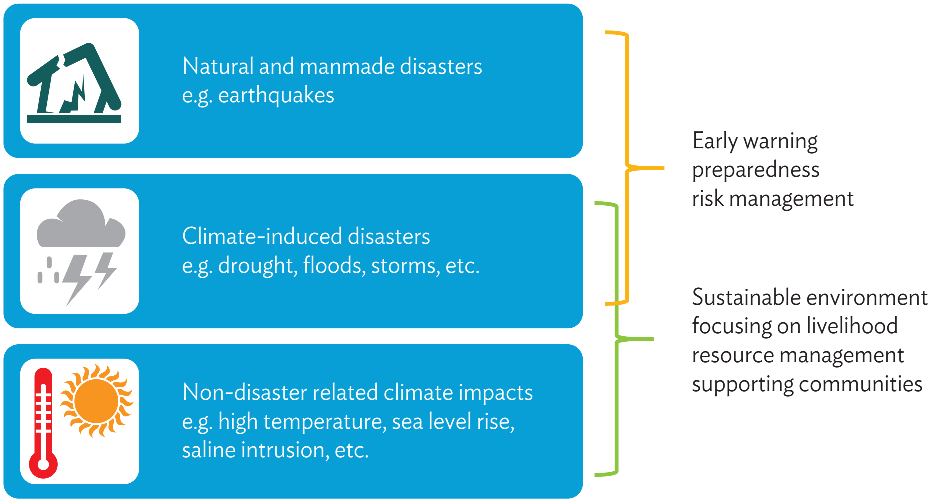
Natural disasters must be understood from a disaster risk framework. To assess the disaster risks faced by economies across Asia, each economy has been examined in the light of disaster indicators such as the frequency of intense hydrological disasters, the number of people affected by these catastrophes, the number of people killed by these events, and the corresponding indicators of meteorological disasters. The UNISDR (2009) defines disaster risk management as 'the systematic process of using administrative directives, organisational and operational skills and capacities to implement strategies, policies and improved coping capacities to lessen the adverse impacts of hazards and the possibility of disaster.' In most cases of natural disasters, prevention is not entirely sufficient, and the risk cannot be reduced to zero (World Bank, 2016). Hence, it is vital to implement decisive risk management strategies to mitigate natural disasters where risk cannot be avoided.

To date, much consideration of adaptation management has focussed on climate change initiating gradual and long-term changes on average climate conditions. However, risks from changes like extreme events and climate variability (e.g. droughts, floods, storms, coastal erosion, and earthquakes) are the most significant, requiring immediate attention. Climate change will intensify existing problems resulting from the increase in water demand, temperatures, number of extreme events, and climate variability over the next few decades.

Every year, natural disasters and climate-related extreme events result in substantial loss of life, economic damage, and social development (IPCC, 2008).

Adaptation is a major factor that will shape the future severity of climate change impacts on food production (Chang, 2007). Adaptation to climate change and disaster risk management both seek to reduce negative factors and modify environmental and human contexts that contribute to climate-related risk, thus supporting and promoting sustainability in social and economic development (IPCC, 2012). Both disaster risk reduction and climate change adaptation practices involve learning to deal with existing and projected future risk. Overlaps between these two types of practices occur when there are common concerns such as droughts, extreme heat events, floods, and storms (Figure 1.7).

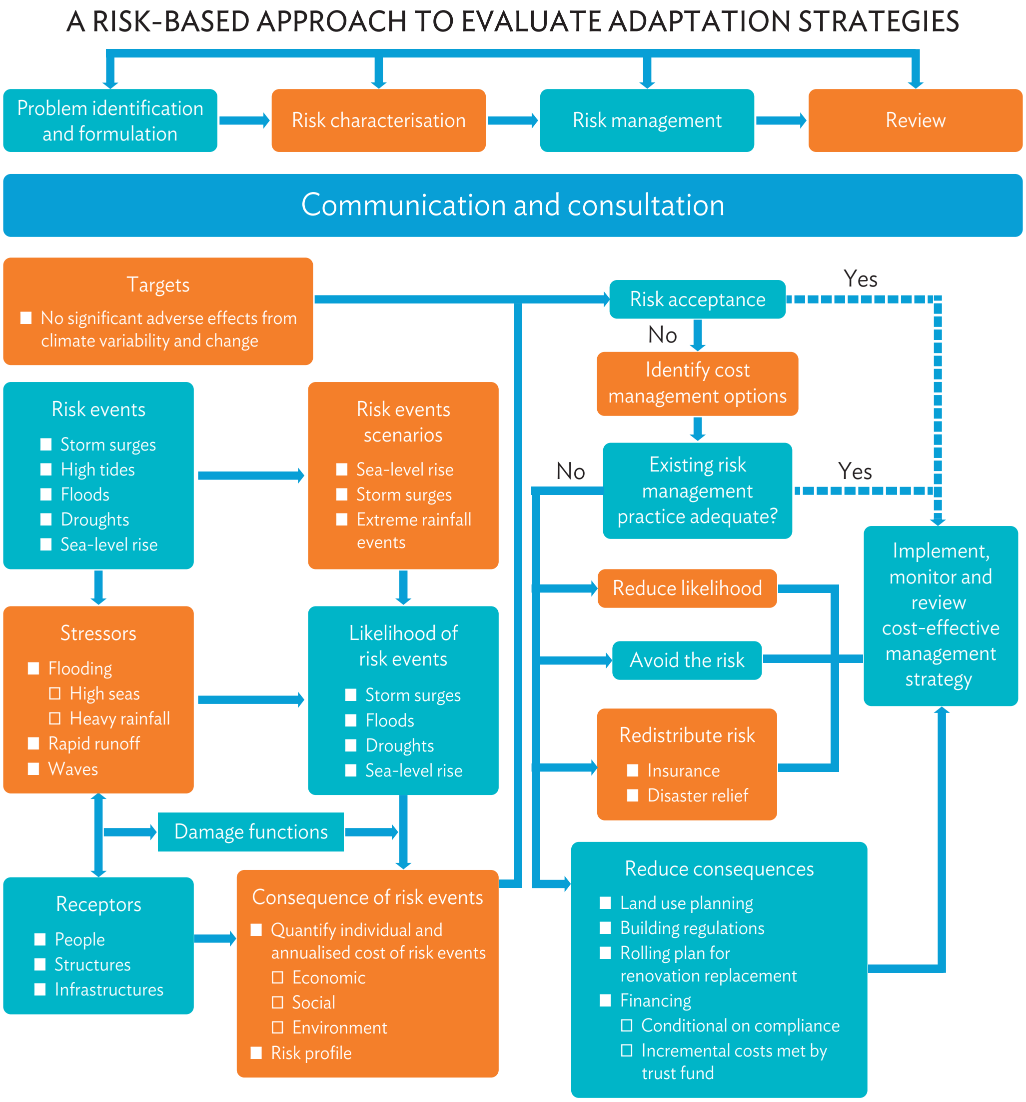
Figure 1.7: **Climate Change Adaptation and Disaster Risk Reduction Adaptation Integration**



Source: Authors.

In practice, adaptation strategies should concentrate on reducing both present and future risks related to natural disasters and climate-related extreme events. However, most current international climate change agreements and associated funding focus primarily on reducing future risks. To achieve better adaptation to address present risks and face future risks, it is necessary to (i) understand the drivers of and barriers to adaptation strategies; (ii) identify and assess adaptation options for both existing and future risks; and (iii) implement, evaluate, and monitor adaptation approaches. There are several frameworks and strategies for an integrated approach to disaster risk reduction and climate change adaptation. We discuss some of these strategies below.

Figure 1.8: Risk-Based Approach – Planned Risk Characterisation and Management Procedures



Source: Climate Change Adaptation Through Integrated Risk Reduction findings in Asian Development Bank (2005), *Climate Proofing: A Risk Based Approach to Adaptation*. Manila: Asian Development Bank. https://www.adb.org/publications/climate-proofing-risk-based-approach-adaptation (accessed 4 May 2018).

Figure 1.9: Adaptation Strategies for Disaster Risk Reduction and Climate Change

Vulnerability	Risk management	Implement food production system	Conservation of natural ecosystem	Strengthening local institutions
Identify the vulnerable groups and determine vulnerability	Risk awareness: making databases available to raise awareness of disasters and climate change	Implement food production system to balance the supply and demand for food security	Sustainable agriculture: soil conservation, environmentally friendly technologies, and farming practices to increase soil carbon	Enhance information and communication capacity among locals, and farmer to farmer knowledge transfer (indigenous knowledge)
Formulate policies to help communities to adapt	Risk preparedness: early warning and training	Agricultural technologies: resource use efficiency (water, nutrients, and pesticides)	Communal gardens, backyard gardens, and crop residue management	Improve scientific capacity and organise regional adaptation programs
Associate policy-related actions to reduce adverse effects	Risk transfer and prevention: insurance, policy planning, and implementation	Farmers support: increase support to farmers, improve their ability, and develop farmer institutions	Diversification, promoting organic agriculture, and sustainable fishery farming	Collective action and gender equality

Source: Authors.

1.4.1 | Adaptation Approaches

Adaptation has many dimensions, as it is a constant and flexible process that limits or decreases exposure to risk from natural disasters, climate change, and related extreme weather events. Risks associated with current levels of climate change and disasters typically cause severe losses to societies, economies, and the environment. Current adaptation strategies are frequently insufficient to deal with the high costs of disasters and changes in the climate. Adaptive capacity comprises two measurements: recovery from shocks, and response to changes in the climate. Resilience to risk can be achieved by reducing risk exposure and sensitivity, and enhancing adaptive capacity. Actions can be implemented across biophysical, economic, or social domains. The most suitable forms of adaptation are usually those that build on current efforts to cope with existing climate variability and extreme events, while contributing positively to sustainable economic development, environmental management, social progress, and resource use in the future.

Decision makers have various options (e.g. low- or no-regret, win-win, whole-system, top-down, and bottom-up) in planning adaptation to climate change and risk management. The most suitable choice will be determined based on the nature of the decision being made, level of risk, and understanding of the specific climate impacts. Climate risk management approaches adopted by national governments and development agencies (e.g. the United Nations Developmental Programme, United Nations Office for Disaster Risk Reduction, FAO, World Bank, ADB, and Global Facility for Disaster Reduction and Recovery) usually encourage sustainable development by reducing vulnerability to climate risks and thereby achieving resilience. Climate risk management using a 'no regrets' approach includes proactive plans to maximise positive outcomes and reduce negative effects for societies and economies in climate-affected sectors such as agriculture, food security, water resources, and health (United Nations Development Programme, 2010). Under this approach, decision makers take actions that have long-term benefits, even in the absence of climate change, by building resilience to changing economic, social, and environmental conditions. For example, in Nicaragua, researchers have managed to calculate a 'narrow niche' where it is still viable to grow Arabica coffee, but recommend switching to a different crop as temperatures increase. At lower altitudes, they suggest growing cocoa as it has the same cash value as coffee and is suited to the new growing environment. Although high altitudes are suitable for coffee farming due to the availability of water and other resources, controlling the expansion of coffee farming is recommended. The researchers also suggested ensuring that any high-elevation expansion of the crop can be achieved without harming the environment. Farmers are advised to adjust their agricultural practices based on the altitude as the climate changes, by adapting shade-grown varieties (Vermeulen et al., 2013).

In terms of climate-related extreme weather events, climate risks are very high because the risk has been intensifying over the past few decades. A risk-based climate-proofing approach to adaptation is not only desirable but also feasible. It is essential to identify the risks associated with disasters and climate change, and manage them to reduce their impacts. The risk-based approach uses the probability of climate-related effects and looks at the consequences of both existing and future conditions. This approach offers an opportunity to study a specific event only, or a combination of several events over time. The risk assessment and management approach can also be applied to other sectors besides the food sector, such as the health, financial, transport, energy, and water resources sectors. Current knowledge of disaster risk management will help decision makers and planners establish and implement the risk-based management options. Since the adaptation process usually involves many players, the framework of the risk-based approach enables coordination and cooperation, such as information sharing, amongst these various players (ADB, 2005). Based on the risk-based approach, six case studies were planned to help ADB's Pacific developing member countries adapt to existing and future climate risks by using the Climate Change Adaptation Through Integrated Risk Reduction framework and methodology shown in Figure 1.8. This approach, which proved to be very useful, can be applied at three levels: project activities, national development planning and sector programmes, and country strategies and programmes. Under the climate-proofing approach, most of the damage caused by climate change to infrastructure projects can be avoided if the right strategies are implemented at the project design stage (ADB, 2005).

1.4.2 | Principles of Successful Adaptation

The principles of successful adaptation for decision making should have the following qualities:

(i) Adaptation should be **holistic** to manage and reduce risks associated with disasters and climate change. This highlights the need to establish both disaster risk management and adaptation to climate variability and extreme events by making them integral components of national risk management strategies.

(ii) Adaptation should be **efficient** to address long-term impacts while reducing short-term effects. The benefits should also be long-term and cover all costs, making them essentially cost-efficient.

(iii) Adaptation should be **evidence-based** considering the data from the scientific community and research organisations. Adaptation largely depends on generating an information or evidence base, and an understanding of how a given system functions to inform the development of effective adaptation strategies. Awareness of the issues involved in adaptation helps in the process of risk identification. Thus, it is necessary to establish an evidence base upon which the level of risks can be analysed and evaluated to determine their significance and to avoid maladaptation.

(iv) Adaptation measures must be **monitored and reviewed** during implementation, which may require new monitoring and reporting systems.

(v) Adaptation management should consider the physical and biological features of an area, as well as the institutions and people who influence it. The interconnection of these factors helps decision makers work in an **integrated** way across sectors to address environmental, social, and economic issues.

(vi) Adaptation actions should be **flexible**. Since there is ambiguity regarding the future state of the climate, options should include decisions that maximise future flexibility.
(vii) Adaptation measures should be **effective** to reduce the risks of disasters and climate change without any adverse effects on the environment, society, and economy.
(viii) Actions should be **prioritised** based on the impacts of disasters and climate variability by focusing on areas where people are most vulnerable, the economy is at stake, and critical national infrastructure is involved.
(ix) Actions should be **environment-friendly** based on the ecosystem to enhance the capacity of natural systems and resist future climate-related extreme events.

Adaptation strategies for disaster risk reduction and climate change should be established based on the assessment and prioritisation of risks that people face as well as their ability to adapt. These strategies include early warning systems, monitoring, and evaluation for enhanced coping and adaptation (Department for International Development, 2011). The adverse effects of natural disasters and climate variability can significantly affect all four dimensions of food security. The specific implications for food security depend on whether a disaster affects food availability, physical and/or economic access to food, or both. During disasters, the extent of any shortfall in food availability depends on local food availability, access to regional food reserves, and food assistance from national and international organisations. However, when disasters damage transportation systems, people living in the affected areas usually face significant shortfalls in food availability. The principal objective of risk management should be to reduce the impact of natural disaster risks and build resilience to food insecurity by making food available to affected people. For example, the ASEAN Plus Three Emergency Rice Reserve (APTERR) was established in 2011 as a buffer against immediate threats to food security caused by disasters and market vitality associated with climate calamities. The objectives of the APTERR are to make rice available during emergencies, stabilise the price of rice, and improve farmers' income and welfare. The scheme aims to improve food security without distorting the international rice market. APTERR stocks can be released to a member state that is unable to cope with an emergency using its natural reserves alone and is unable to procure the needed supplies through regular trade (Trethewie, 2013).

Significant adaptation strategies comprise such essential elements as early warning systems, farm-level management to optimise production, related technologies, capacity building, and awareness raising to understand and undertake adaptation. We discuss some of the aspects of adaptation below (see Figure 1.9).

1.4.2.1 Vulnerability

Adaptation measures require widespread information on agricultural, environmental, economic, and social systems affected by disasters and extreme climate events, with the aim of carrying out accurate vulnerability assessments. Vulnerability assessments help decision makers understand the impacts of changes in the climate and seasonal variability on agricultural systems, and formulate policies to help communities adapt. However, agricultural production systems have their own dynamics, and adaptation especially emphasises future agriculture. The future vulnerability of the community or country depends not only on climate change but also on the type of development pathways that are adopted.

1.4.2.2 Risk Management

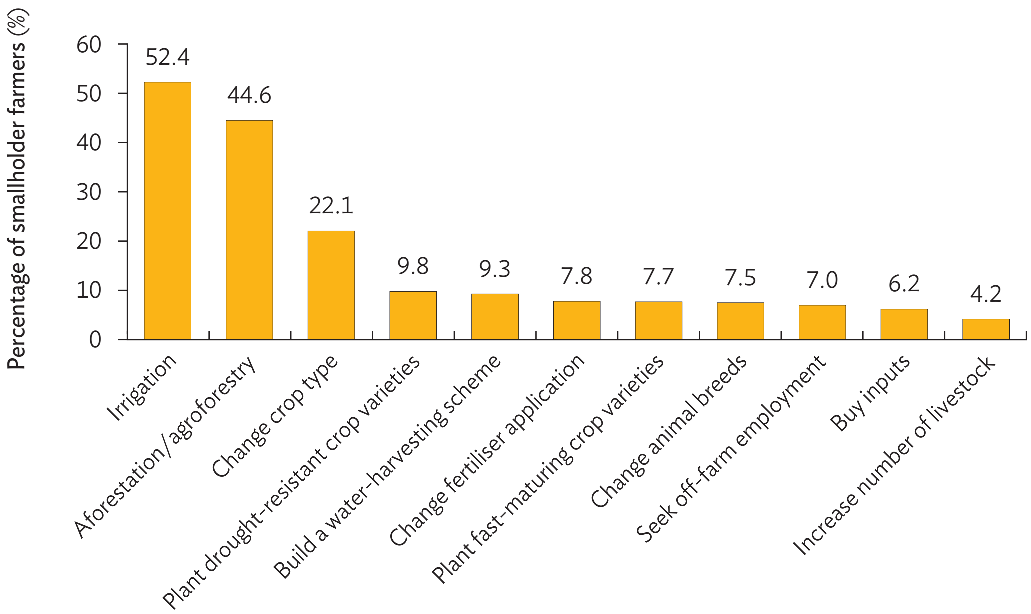
Early warning systems are very effective contributors to adaptation and risk management (FAO, 2017). Management of disaster risks depends on the source, monitoring, and dissemination of information (Eiser et al., 2012). In addition to monitoring the weather, it is essential to monitor food reserves in the case of emergencies and prepare for a disaster situation. Developing the components of an early warning system as well as the correct type of information and communications technology assists in evaluating a given situation and planning accordingly. In most situations, people adapt to climate change by modifying their behaviour according to the change or migrating to another location. An early warning system and the development of other useful technologies will make it possible for people to adapt to expected changes. Farmers can utilise hard technologies (e.g. irrigation systems and tolerant crop varieties and livestock breeds), soft technologies (e.g. insurance schemes and crop rotation patterns), or both (UNFCC, 2006). Technological improvements also help researchers disseminate information and data to the public and farmers more quickly (Toya and Skidmore, 2015). The information helps farmers make decisions about cropping schedules, variety selection, nutrient use, diseases, and water use schedules. The information is made available to farmers in developing countries through satellites, websites, mobile phones and applications, and hotline services, with the aim of reaching, warning, and preparing the farmers for extreme weather events (Kaur et al., 2015).

In addition to risk awareness and preparedness, risk transfer and sharing is another way of managing risk by distributing losses caused by extreme weather events and climate variability (Linnerooth-Bayer and Hochrainer-Stigler, 2015). Financial tools decrease the burden of loss on farmers and other affected people, as the reduction of losses by natural disasters and climate change can be expensive (Linnerooth-Bayer and Hochrainer-Stigler, 2015). Financial instruments for farmers include pre-disaster savings, post-disaster credit, and insurance, which for the poor can take the form of stockpiles of food, grains, seeds, and/or exchangeable assets that are useful in medium-risk cases. Microsaving or saving before disasters protected the economy of women's empowerment in the Philippines, including decision-making power over purchases and children's education (Ashraf et al., 2010). Microfinancing is another financial tool that can protect farmers from potential losses in crop, livestock, and fishery production due to disasters (Johnston and Morduch, 2007). Farmers receive automated insurance payouts in the event of disaster loss, encouraging them to not sell their assets (Reddy and Anbumozhi, 2017).

1.4.2.3 Implementing Food Production Systems

Farm practices such as optimising production, farming technologies, and diversification can be used to fill production gaps. Farm-level adaptation options used by farmers to improve production are presented in Table 1.3. Several knowledge-intensive forms of agriculture are available, and the necessary technology and encouragement should be offered to encourage farmers to accept and adopt them (Nelson et al., 2009). According to the FAO (2018), climate-smart agriculture involves a combination of agronomic practices for soil and water management, improved infrastructure and equipment for disaster risk management, and research and development for adapted crop seeds and technologies. These are some of the strategies recommended to optimise agricultural production and food security. Among the adaptive measures adopted by farmers in response to climate change, some of the most common are agroforestry practices, crop diversification, early planting, increased use of early maturing varieties and stress-tolerant crop varieties, wild plant gathering, and mixed cropping production systems (Altieri and Koohafkan, 2008; Verchot et al., 2007; Silvestri et al., 2012). The farmers prefer some strategies, such as irrigation, agroforestry, and crop diversification, over the others (Figure 1.10) (Silvestri et al., 2012). Agricultural diversification, including the addition of new crop varieties and livestock breeds, mixed cropping, crop rotation, and inter-cropping, is considered the best strategy for optimising production (Reddy and Anbumozhi, 2017). Diversification has very positive effects, such as reducing the effects of adverse weather conditions such as droughts and erosion, slowing the spread of pests and diseases, reducing input, and increasing yield (Fadina and Barjolle, 2018). National and international agricultural research organisations have made several varieties tolerant of drought, heat, and salinity available to farmers. Diversification improves soil fertility, boosts protein consumption, and diversifies diets (Headey and Kennedy, 2012). With regard to livestock, trying to raise new strains of livestock will help make agricultural systems more resilient.

Figure 1.10: Desired Adaptation Strategies by Smallholder Farmers



Source: Silvestri, S., E. Bryan, C. Ringler, M. Herrero, and B. Okoba (2012), 'Climate Change Perception and Adaptation of Agro-Pastoral Communities in Kenya', *Regional Environmental Change*, 12(4), pp. 791–802.

Farm practice technologies, such as new irrigation techniques to handle drier climates, are suggested to manage water resources, maximise resource use, and improve production. For example, the drip-irrigation method utilises water efficiently by supplying water frequently and in small quantities to the root zone through plastic pipes. Micro-irrigation, or low-pressure pipes equipped with water filters and smart metered solar utility models for localised areas in sub-Saharan Africa ensured the delivery of water and nutrients directly to the root zone and facilitated the efficient use of resources (Burney and Naylor, 2012). Establishing farmer institutes encourages farmers to interact with each other and share farming knowledge. Building household storage facilities such as small storage facilities, moisture-proof containers, and plastic bags is also necessary to cope with seed shortages in the event of disasters. For example, monsoon rains in Nepal (Dey, 2015) and Haiti (McGuire and Sperling, 2013) and floods in Pakistan (Doocy et al., 2013) destroyed farmers' seeds. Distributing cheap, low-oxygen grain storage bags in the event of disasters will help farmers temporarily store and save seed (Chapagain and Raizada, 2017).

Table 1.3: Options for Adaptation to Climate Change at the Farm Level

Risk	Response
Changing climate and climate variability and seasonality	• Participate in monitoring schemes when available. • Optimise planting schedules such as sowing dates (including for feedstocks and forage). • Plant different varieties, species, or cultivars of crops. • Use short-duration cultivars. • Varieties or breeds with different environmental optima, or those with broader environmental tolerances, may be required. The use of currently neglected or rare crops and breeds should be considered. • Early sowing enabled by improvements in sowing machinery or dry-sowing techniques • Increased diversification of varieties or crops to hedge against risk of individual crop failure • Use intercropping. • Make use of integrated systems involving livestock and/or aquaculture to improve resilience. • Change post-harvest practices, for example, the extent to which grain may require drying and how products are stored after harvest. • Consider the effect of new weather patterns on the health and wellbeing of agricultural workers.
Change in rainfall and water availability	• Participate in monitoring schemes when available. • Change irrigation practices. • Adopt enhanced water-conservation measures. • Use marginal and wastewater resources. • Make more use of rainwater harvesting and capture. • In some areas, increased precipitation may allow irrigated or rain-fed agriculture in places where it was not previously possible. • Alter agronomic practices. • Reduce tillage to lessen water loss, incorporate manures and compost, and employ other land use techniques such as cover cropping to increase soil organic matter and hence improve water retention.
Increased frequencies of droughts, storms, floods, wildfire events, and sea-level rise	• Participate in monitoring schemes. • General water conservation measures are particularly valuable during times of drought. • Use flood-, drought-, and/or saline-resistant varieties. • Improve drainage, soil organic matter content, and farm design to avoid soil loss and gullying. • Consider increasing insurance cover against extreme events.
Pests, weeds, diseases, and the disruption of pollinator ecosystem services	• Participate in risk monitoring and preventing schemes when available. • Use expertise in coping with existing pests and diseases. • Build on natural regulation and strengthen ecosystem services.

Source: Food and Agriculture Organization (2017), *Benefits of Farm Level Disaster Risk Reduction Practices in Agriculture*. Rome: Food and Agriculture Organization. http://reliefweb.int/sites/reliefweb.int/files/resources/a-i7319e.pdf (accessed 10 May 2018).

1.4.2.4 Conservation of Natural Ecosystems

Ecosystem-based adaptation includes several management activities to improve the resilience and reduce the vulnerability of both people and the environment to disasters and climate change. Adaptation strategies for the conservation of natural ecosystems are soil and agriculture conservation, forest conservation (such as mangrove conservation), integrated pest management, livestock and fisheries management, and coral restoration (Keys and McConnell, 2005; Pretty and Bharucha, 2014). To conserve agriculture to meet future agriculture and food security demands, it is necessary to restore natural assets by improving farmland and ecosystem management (Reddy and Anbumozhi, 2017). This also minimises the scope for maladaptation in developed and developing countries. Other ecological restoration practices include agroforestry activities such as planting trees, climate-smart landscapes, communal gardens, intercropping, and livelihood diversification in disaster-prone areas. Ecosystem restoration and development also minimise greenhouse gas emissions. Thus, the species chosen to restore communal areas must be able to meet a variety of environmental, social, and economic needs (Kumar et al., 2015). A strategic plan to improve soil health and reverse soil degradation is required to increase food production and improve food security. Organic agriculture and sustainable fisheries are other options to conserve the natural ecosystem. Active ecological restoration requires institutional frameworks to ensure that all stakeholders have fair access to benefits from the natural resources on which their livelihoods depend (Kumar et al., 2015).

1.4.2.5 Strengthening Local Institutions

As local communities are the first to respond when a disaster happens, increasing the disaster management capacity of these communities and local governments is the most effective way to improve disaster management and climate change. Efforts to build capacity for food security involve enhancing the ability of individuals, groups, organisations, and communities to meet their food security challenges sustainably. In the long run, this cannot be achieved without qualified local individuals and institutions to provide direction and motivation to manage these efforts. This requires the development of teamwork amongst farmers, extension agents, scientists, and, frequently, different government ministries and nations (Alcayna et al., 2016).

Achieving adaptation at the global, national, and regional levels requires the strengthening of the governance system to coordinate adaptation measures. Prioritising initiatives through policy support such as technologies that strengthen the resilience of farming systems to disasters at the regional level can lead to sustainable agriculture. Establishing a relationship between policymakers, the scientific community, and professionals from all food-related sectors will help in the development of new decision-support systems to improve the capacity of farmers, fishers, and forest-dependent people to adapt their livelihoods to climate change and disasters (FAO, 2017). Another important aspect that should be investigated is the dimensions of climate change impacts and adaptation patterns on gender. Climate change influences men and women differently because of differences in their access to resources and climate adaptation practices. Women are crucial actors in maintaining and improving food security in the face of climate change. Thus, it is necessary to consider women's needs for improved access to education and the labour market, and greater participation in decision making (FAO, 2017).

1.5 Recommendations to Improve Medium- and Long-Term Resilience

1.5.1 | National Level

(i) Improve information systems to provide reliable weather forecasts to farmers and public databases to educate people on disaster risk reduction and climate change adaptation.
(ii) Improve rural roads and production infrastructure, and enhance access to markets.
(iii) Enhance farm productivity through agricultural research, extension services, and post-harvest measures.
(iv) Strengthen human capacity by working explicitly with community organisations and including the most vulnerable people, particularly women.
(v) Introduce insurance and disaster mitigation measures such as crop insurance, credits, and futures contracts.
(vi) Increase food stockpiles for use during poor production years, and establish regional food reserves as a crisis management system.

1.5.2 | Regional Level

(i) Promote research and development, knowledge exchange, and capacity building.
(ii) Improve the monitoring and surveillance of agricultural production and food market conditions.

(iii) Promote trade liberalisation.
(iv) Consider mechanisms to promote price stability, such as regional food reserves.
(v) Enhance collaboration on climate change under the ASEAN Sociocultural Blueprint.
(vi) Enhance collaboration on disaster risk reduction under the ASEAN Agreement on Disaster Management and Emergency Response.

1.6 Summary

Natural disasters and extreme weather events due to climate change can cause agricultural production losses affecting food security and its components, including availability, access, utilisation, and stability. Reduced food production due to disasters and climate change raises commodity prices, affecting the ability of the population in vulnerable societies to access food markets, and influencing livelihoods. Adaptation strategies to reduce vulnerability and increase resilience are required to achieve food security in the event of natural disasters and climate change. This chapter discussed principles for better adaptation and various integrated adaptive strategies to cope with and manage natural disasters, reduce risk, and adapt to climate change to ensure food security. Principles for effective adaptation should include approaches that are holistic, efficient, sustainable, prioritised, and effective. Adaptation approaches must incorporate plans that not only target existing climate conditions, but are flexible to react to future climate conditions and address the causes of vulnerability. The strategies discussed here are to (i) address vulnerability, (ii) manage risks, (iii) implement food production systems, (iv) conserve natural ecosystems, and (v) strengthen local institutions. Each section discussed different adaptation measures, including (i) upscaling modern technologies such as conservation and climate-smart agriculture, (ii) using water and nutrients for agriculture efficiently through micro-irrigation and water-saving technologies, (iii) diversifying crops, (iv) utilising stress-tolerant crop cultivars and restoring degraded soils, (v) promoting carbon sequestration through alternate production technologies and land use, and (vi) conserving ecosystems to ensure food security. Reliable and effective early warning systems for changes in the climate, and policies to support the transfer of information can benefit farmers, agriculture-dependent industries, and policymakers by motivating them to take precautionary measures to avoid significant losses. It is also necessary to formulate both short- and long-term policies for the development, nourishment, and protection of natural resources. Capacity building through local, national, and international collaboration amongst farmers, policymakers, and the scientific community is necessary. The monitoring and evaluation of adaptation processes, investments, and results are crucial for evidence-based decision making and adaptation capacity enhancement in agriculture. Policy frameworks that support disaster risk reduction and climate change adaptation must be made robust to avoid maladaptation, taking into account the linkages of the various agricultural sectors (crops, livestock, and fisheries) with each other, as well as with additional sectors and policy domains such as irrigation, economy, gender, and social protection.

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CHAPTER 2

Evaluating the Distributional Impacts of Disasters and Climate Change, and the Development of Adaptation Roadmaps

RETHINKING ASEAN STRATEGY, POLICIES, AND ACTIONS

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ABSTRACT

Climate change is a significant threat the impacts of which are already upon us. All Association of Southeast Asian Nations (ASEAN) member states have ratified the 1994 United Nations Framework Convention on Climate Change (UNFCCC). Since then, a number of national climate-related policies have emerged in Southeast Asia. The region, however, lacks an overarching, coherent, and concrete adaptation framework for climate change adaptation. This is problematic because the ASEAN region faces its own set of climate impacts and vulnerabilities that, in turn, can worsen the distributional impacts of climate change. Distributional impacts refer to the uneven manner in which populations or groups are affected by issues, with some groups being more vulnerable than others. Such impacts can be seen in the food sector, notably food security and supply, access to food (physical and economic), and nutritional outcomes in the region. A lack of downscaled assessments of climate impacts, insufficient customised initiatives to respond to region-specific challenges, and a lack of inter-sector collaboration in mitigating the impact of climate change on certain populations further pose a hindrance to effective climate solutions. Considering the similar climate-related challenges that ASEAN Member States are facing, the regional grouping holds enormous potential for actionable cooperation that may benefit the region and increase its capacity to adapt to climate change. The study thus recommends the region to establish an ASEAN Climate Change Adaptation Centre; to develop downscaled impact assessments of climate change on food security that feed into assessments of vulnerabilities and prioritisation of initiatives, following a research road map for the region; and to complement government approaches to resilient policies with private sector participation.

2.1 Introduction

Climate change is a significant threat the impacts of which are already upon us. As many scientists have pointed out, climate change acts as a threat multiplier, generating climate-induced threats to health and the availability of resources like water and energy that amplify the scale of human insecurities and vulnerabilities in various aspects of daily life. These implications also apply to food security. Given the serious concerns brought about by the changing climate, policies addressing climate change no longer consider mitigation alone but are increasingly focusing on adaptation. While there has been much debate on mitigation and disaster risk reduction (DRR) at the global level, particularly for regions vulnerable to climate change, adaptation has become a more important consideration.

All Association of Southeast Asian Nations (ASEAN) member states have ratified the 1994 United Nations Framework Convention on Climate Change (UNFCCC).[1] Since then, a number of national climate-related policies have emerged in Southeast Asia. Despite the UNFCCC's relatively early ratification, the topic of climate change adaptation (CCA) only entered national climate change policies much later, since climate change mitigation received more attention in the earlier stages. The initial emphasis on mitigation is not surprising considering that greenhouse gas emissions are seen as a major culprit of the changing climate. Thus, it was inevitable that bringing such emissions down would be the top priority in the global climate agenda.

Due to developments that increasingly attribute disaster events to climate change, focusing on mitigation efforts alone has proved insufficient. CCA first began to enter mainstream climate change deliberation more prominently in the 2007 Bali Action Plan. Together with the formulation of the 2005–2015 Hyogo Framework for Action and the 2014 Fifth Assessment Report of the International Panel for Climate Change (IPCC) on Climate Change Impacts, Adaptation and Vulnerability, CCA has begun to make inroads into national climate change policies.

As an effective CCA strategy is critical to help states and communities deal with climate change and food security in particular, this chapter examines the nature of CCA policies in the region, at both the national and regional levels. The chapter argues that,

1 Dates of ratification: Brunei Darussalam (2007), Cambodia (1996), Indonesia (1994), the Lao People's Democratic Republic (Lao PDR) (1995), Malaysia (1994), Myanmar (1994), the Philippines (1994), Singapore (1997), Thailand (1994), and Viet Nam (1994) (UNFCCC).

while ASEAN Member States and ASEAN as a region have positive report cards on climate adaptation policies (as evidenced by the presence of climate change policies at the national and regional levels), there remains a need for more coherent and comprehensive regional CCA strategies. This is especially important when it comes to addressing food security, as this problem is essentially a cross-cutting issue and requires an ecosystem approach to address its attendant threats. The chapter argues further that more responsive policies on food security will be achieved when these are informed by an overarching regional policy and/or action plan on CCA.

2.2 Overview of National Climate Change Adaptation Initiatives in Southeast Asia

In Southeast Asia, the initial formulation of climate change policies differed between those countries that fall into the category of least developed countries (LDCs), and the rest. Three countries in the LDC category – Cambodia, the Lao People's Democratic Republic (Lao PDR), and Myanmar – received assistance in developing their national adaptation policies, as stipulated in an outcome of the seventh session of the Conference of the Parties of the UNFCCC that established a special programme for LDCs in 2001. Cambodia and the Lao PDR were the first countries to draft national climate adaptation policies known as National Adaptation Programmes of Action to Climate Change (NAPAs), with Cambodia drafting its NAPA in 2006, and the Lao PDR in 2009. Myanmar launched its NAPA in 2012.

Cambodia's NAPA identified droughts and floods as the main hazards, and formulated adaptive efforts for agriculture and fisheries in particular (Ministry of Environment of the Royal Government of Cambodia, 2006). Subsequently, Cambodia established a National Change Committee, which developed the National Climate Change Strategic Plan (2014–2023) (National Climate Change Committee of the Royal Government of Cambodia, 2013), National Policy on Green Growth Development, and National Strategic Plan on Green Growth Development (2013–2030) (National Council on Green Growth of the Royal Government of Cambodia, 2013). In addition to formulating adaptation plans in the food, water, and energy sectors, Cambodia took a more comprehensive approach by incorporating gender and health, critical ecosystems, biodiversity, protected areas, and cultural heritage sites in its adaptation agenda (National Climate Change Committee of the Royal Government of Cambodia, 2013).

The Lao PDR's NAPA highlighted agriculture, forestry, water, and public health as priority areas. Floods were identified as the top hazard, and the Lao PDR's NAPA aimed to strengthen institutional and human resources capacities on water and water resource management in particular (Lao PDR, 2009). In 2010, a year after launching its NAPA, the Lao PDR came up with its Strategy on Climate Change, which laid down more practical measures in each identified sector (Lao PDR, 2010). For example, in the agriculture sector, the strategy envisioned the development of climate- and disease-resilient crop varieties and the rehabilitation of the flood control system. On forestry and land use change, the planting of different forestry species was planned. As the Lao PDR is highly dependent on water resources for generating electricity, the country is also aiming to construct climate-proof dams and infrastructure.

Myanmar's NAPA identified eight affected sectors and categorised them into four priority areas (Republic of the Union of Myanmar, 2012). Agriculture, early warning systems, and forestry are given first priority; public health and water resources are given second priority; the coastal zone is given third priority; and biodiversity, energy, and industry are given fourth. Myanmar projects that it will suffer from increased temperatures and changes in rain intensity, leading to increased risk of floods and extreme weather events including cyclones or strong winds, floods and storm surges, intense rains, extreme high temperatures, and drought. After launching its NAPA, Myanmar drafted the 2016–2030 Climate Change Strategy and Action Plan, which details adaptation plans for the following six key sectors: (i) agriculture, fisheries, and livestock; (ii) the environment and natural resources; (iii) energy, transport, and industry; (iv) cities, towns, and human settlements; (v) health and wellbeing; and (vi) education, science, and technology (Ministry of Natural Resources and Environmental Conservation of the Republic of the Union of Myanmar, 2016).

The non-LDC Southeast Asian countries (i.e. Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam) employed their own mechanisms in formulating their national climate change-related policies. In general, they referred directly to relevant international agreements, including the 1994 UNFCCC and the 2007 Fourth Assessment Report of the IPCC, as guidelines. Thus far amongst these countries, dedicated CCA policies are only found in Indonesia and Thailand. Other countries have incorporated CCA in either their sectoral plans or their broader climate change strategies. The absence of a dedicated policy for CCA may imply that CCA is currently given low priority, although interviews with relevant officials may be needed to assess the rationale behind this absence further.

Table 2.1: Assessment of Climate-Induced Risks in Seven Areas in Indonesia

Risks	Sumatra	Java-Bali	Kalimantan	Sulawesi	Nusa Tenggara	Maluku	Papua
Decrease in water availability	M, H, VH	H, VH	L, M	H, VH	H, VH	L, M	L
Flood	H, VH	H, VH	L, M, H	L, M, H	L	L	L, M
Drought	H, VH	H, VH	L	L, M	L, M, VH	L	L
Coastal inundation	M, H	M, H, VH	M, H, VH	M, H	M, H	M, H	M, H
The spread of dengue fever	L, M, H	L, M, H	L, M	L, M	L, M	L, M	L, M, H
The spread of Malaria	L, M	L, M, H	L, M	L, M, H	L, M, H, VH	M, H	M, H, VH
The spread of Diarrhea	L, M, H	L, M, H	L, M, H	L, M, H	L, M, H	L, M, H	L, M, H, VH
Decrease in rice production	H, VH	H, VH	–	–	H, VH	–	–
Forest fires	M, H, VH	M, H	–	–	–	–	–

Note: L: Low; M: Moderate; H: High; VH: Very High.

Source: Republic of Indonesia (2013), *National Action Plan for Climate Change Adaptation (RAN-API) Synthesis Report*. Jakarta: Republic of Indonesia. p. 8. https://gc21.giz.de/ibt/var/app/wp342deP/1443/wp-content/uploads/filebase/programme-info/RAN-API_Synthesis_Report_2013.pdf (accessed 16 March 2018).

Brunei Darussalam established its National Council on Climate Change in 2011 (Knowledge Center on Climate Change, 2011). Although Brunei Darussalam does not have a dedicated policy on CCA, it has already incorporated climate change considerations in its energy, land transport, and building sectors.[2] In its intended nationally determined contribution (INDC) to the UNFCCC in 2015, Brunei Darussalam identified other sectors – including biodiversity, coastal and flood protection, health, agriculture, and fisheries – for future adaptation plans (Ministry of Development of Brunei Darussalam, 2015).

Indonesia launched its National Climate Adaptation Plan in 2013. This plan identified the risk levels of climate-induced disasters, particularly those affecting water, health, agricultural production (especially rice), and forestry in seven areas in Indonesia (see Table 2.1) (Republic of Indonesia, 2013). To boost climate resilience, Indonesia has clustered its adaptation efforts into the following five areas: economic resilience, including food and

[2] See, for example, the 2014 Land Transport White Paper, the 2014 Energy White Paper, and the 2017 Building Guidelines and Requirements.

energy security; livelihood resilience, including health, settlement, and infrastructure; ecosystem resilience; special areas resilience, including urban, coastal, and small island areas; and supporting systems (Republic of Indonesia, 2013).

Malaysia developed its National Policy on Climate Change in 2009, but has yet to create dedicated climate adaptation and mitigation plans. The national policy attempted to address climate change comprehensively by looking into multiple sectors, including agriculture and food security; natural resources and environment (water, biodiversity, forestry, minerals, soil, coastal, marine, and air); energy; industry; public health; tourism; transportation; infrastructure; land use and land use change; human settlements and livelihood; waste management; and DRR (Ministry of Natural Resources and Environment Malaysia, 2009). Despite the broad mandate called for by the 2009 National Policy on Climate Change, the national development policy known as the Eleventh Malaysia Plan (2016–2020) only focused on certain sectors (i.e. water resources, agriculture, and infrastructure) since flooding was identified as the top climate-induced hazard (Economic Planning Unit of Malaysia, 2015).

In the Philippines, climate change measures were given legal status through the enactment of the Climate Change Act of 2009 (Republic of the Philippines, 2009). Subsequently, the Climate Change Commission under the Office of the President formulated the National Framework Strategy on Climate Change 2010–2022, which was expanded in the National Climate Change Action Plan (NCCAP) 2011–2028 (Climate Change Commission of the Republic of the Philippines, 2012). The NCCAP prioritised food, water, the ecosystem, the environment, human security, industries and services, energy, and capacity development in its efforts to combat climate change. The National Framework Strategy on Climate Change 2010–2022 identified CCA as one of its objectives and identified river basins, coastal and marine areas, biodiversity, water, agriculture, health, and infrastructure as priority sectors (Climate Change Commission of the Office of the President of the Philippines, 2013).

Singapore's efforts to address climate change are reflected in its 2008 and 2012 Climate Change Strategies and 2016 Climate Action Plan. Flooding, coastal land loss, water resource scarcity, heat stress, increasing energy demand, climate-induced diseases, and impacts on island and marine diversity were identified as the main threats (Singapore National Climate Change Strategy, 2008). Singapore's CCA efforts have generally focused on infrastructural solutions such as improving drainage systems, erecting hard walls or stone embankments along sections of its coastline, and increasing the minimum level of reclamations

(National Climate Change Secretariat of the Republic of Singapore, 2012). In terms of health impacts, Singapore has looked into the possibility of using Aedes mosquitoes to control its mosquito population in a bid to anticipate the increasing prevalence of dengue brought about by the changing climate.

Thailand's climate change policy processes began with its National Strategy on Climate Change, 2008–2012 (Kraisoraphong, 2010), which was followed by the Climate Change Master Plan, 2012–2050. A dedicated policy on CCA was formulated later, as reflected in the National Adaptation Plan 2015–2023. This plan identified the following priority concerns: floods, drought, and water management; agriculture and food security; tourism; public health; natural resources; and human settlement and security (Sakhakara, 2016).

Viet Nam has no dedicated policy on CCA although a number of climate change-related policies incorporate adaptation.[3] The threat of sea-level rise, which increases the risks of flooding and salinity intrusion, seems to be at the top of the agenda, with agriculture as the most vulnerable sector. Consequently, adaptation efforts focus on coastal zones, water resources, and the agricultural sector.

In summary, most ASEAN Member States already have national climate change policies in place, although they have only commenced development in the last decade. Cambodia, Indonesia, the Lao PDR, Myanmar, and Thailand have dedicated CCA policies, whereas Malaysia, the Philippines, Singapore, and Viet Nam incorporate CCA in their larger climate change policies. Brunei Darussalam addresses climate change concerns in its sectoral policies. The country adopted a holistic perspective that considers multiple sectors, although the risk of flooding remains the main common threat and its implications for agriculture and food security are the main common concern.

[3] These include the Central Party Committee's Resolution 24/NQ/TW (2013) on Responding to Climate Change (Central Executive Committee, Vietnam Communist Party, 2013), National Climate Change Strategy 2011 (The Prime Minister of Vietnam, 2011), National Action Plan on Climate Change 2012–2020 (The Prime Minister of Vietnam, 2012b), National Green Growth Strategy 2012 (The Prime Minister of Vietnam, 2012a), and National Action Plan on Green Growth 2014 (The Prime Minister of Vietnam, 2014).

2.2.1 | Regional Climate Change Initiatives

Parallel to national initiatives, ASEAN Member States have collectively expressed their commitments to addressing climate change at the regional level through the following declarations: the ASEAN Declaration on Environmental Sustainability (13th ASEAN Summit in 2007); ASEAN Declaration on Conference of the Parties-13 to the UNFCCC and Conference of Parties serving as the Meeting of Parties-3 to the Kyoto Protocol (13th ASEAN Summit in 2007); Singapore Declaration on Climate Change, Energy and the Environment (3rd East Asia Summit in 2007); Joint Ministerial Statement of the First East Asia Summit Energy Ministers Meeting (2007); Ministerial Statement of the Inaugural East Asia Summit Environment Ministers Meeting (2008); ASEAN Joint Statement on Climate Change to Conference of the Parties-15 to the UNFCCC and Conference of Parties serving as the Meeting of Parties-5 to the Kyoto Protocol (15th ASEAN Summit in 2009); Singapore Resolution on Environmental Sustainability and Climate Change (11th ASEAN Ministerial Meeting on the Environment [AMME] in 2009); ASEAN Action Plan on Joint Response to Climate Change (12th AMME in 2012); Declaration on Institutionalising the Resilience of ASEAN and its Communities and Peoples to Disasters and Climate Change (26th ASEAN Summit in 2015); and Declaration on ASEAN Post-2015 Environmental Sustainability and Climate Change Agenda (27th ASEAN Summit in 2015) (ASEAN Cooperation on Environment, 2018).

Institutionally, the ASEAN climate change cooperation brings together environment ministers and senior officials on the environment (see Figure 2.1) for regular meetings to discuss the implementation of environment-related strategies and plans. The AMME meets biennially, whereas the ASEAN Officials on the Environment (ASOEN) meet annually. The ASOEN are assisted by seven subsidiary bodies: the ASEAN Working Group on Climate Change (AWGCC), the ASEAN Working Group on Environmentally Sustainable Cities, the ASEAN Working Group in Chemicals and Waste, the ASEAN Working Group on Nature Conservation and Biodiversity, the ASEAN Working Group on Coastal and Marine Environment, the ASEAN Working Group on Water Resources Management, and the ASEAN Working Group on Environmental Education. The ASEAN Secretariat's Environment Division under the ASEAN Socio-Cultural Community (ASCC) pillar handles the workings of the cooperation and reports to the ASOEN.

Figure 2.1: Institutional Framework of the Association of Southeast Asian Nations Cooperation on Environment

ASEAN = Association of Southeast Asian Nations.

Source: ASEAN (2017), ASEAN Cooperation on Environment – At a Glance. http://asean.org/storage/2018/02/50.-December-2017-ASEAN-Cooperation-on-Environment-At-A-Glance.pdf (accessed 16 March 2018).

Climate change was one of the 11 priority actions on which the Environment Division was working, based on the environment-sustainability agenda of the 2009–2015 ASCC Blueprint (ASEAN, 2009). This agenda, which identified the need for climate mitigation and adaptation measures, listed 11 priority actions, including the development of the ASEAN Climate Change Initiative, and information exchange on research and development, technology, and best practices. However, the identified priority actions appear to serve more as guidelines than as operational imperatives. This is despite acknowledgment that cooperation needs to be enhanced to address climate change impacts in different sectors, such as the environment, agriculture and forestry, disaster management, science and technology, health, human development, the economy, energy and transportation, and political and human security. With the AWGCC at the helm, the ASEAN Climate Change Initiative was envisioned as the primary platform to collaborate on formulating climate change policy and strategy, sharing information, building capacity, and transferring technology. The AWGCC holds an annual meeting, the latest one being held in Jakarta in 2019.

Although the AWGCC has been carrying out its role as an information-sharing and confidence-building forum, it is unclear whether it has produced regional CCA plans and guidelines that may lead to collaborative efforts amongst ASEAN Member States. Indeed, aside from several donor-funded, ad hoc projects that engaged ASEAN Member States, there are limited tangible examples of cooperation on the environment amongst the ASEAN Member States themselves.[4]

Following the ASCC Blueprint 2009–2015, CCA featured more prominently in the subsequent ASCC Blueprint 2025, which laid down the vision of an ASCC that 'engages and benefits people, and is inclusive, sustainable, resilient, and dynamic' (ASEAN, 2016b). The ASCC Blueprint 2025 was accompanied by the ASEAN Strategic Plan on Environment, which listed climate change as one of its seven strategic priorities. Under the envisioned characteristic *resilient*, this plan listed DRR and CCA as two of its envisioned key results. Although these issues are receiving increasingly more attention, the strategic measures formulated to attain this vision are still seen as guidelines that individual member states should target. A framework for workable regional cooperation initiatives for CCA and DRR is still missing.

In addition to dedicated environment-related processes, the broader concepts of DRR and CCA are also found in other sectors. The AADMER Work Programme (2016–2020), for example, explicitly incorporates DRR and CCA in one of its priority programmes. This priority programme is designed somewhat like a roadmap as it details the components, outputs, key activities, implementing agency, and timeframe to support the achievement of 'a disaster resilient and adaptive ASEAN community' (ASEAN 2016a).

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4 See, for example, the 2002 ASEAN Agreement on Transboundary Haze Pollution and the ASEAN Centre for Biodiversity established in 2005.

As previously observed in the ASCC Blueprint, the proposed activities in the relevant AADMER Work Programme generally aim to build national capacity for climate resilience. In the few instances where regional mechanisms are mentioned, their purpose seems restricted to sharing information and building confidence. Although the AADMER Work Programme calls for DRR and CCA, in practice, the ASEAN Coordinating Centre for Humanitarian Assistance on Disaster Management (AHA Centre), which is the main operational regional body working on disaster-related matters, has yet to work on this preventive aspect fully, as it is still very much focused on disaster response (Faisal, 2017–2018).

Other sectors also incorporate climate change considerations (Letchumanan, 2010). In the energy sector, ASEAN has collectively set targets for energy intensity reduction and renewable energy share. In the transportation sector, ASEAN has, with donor support, embarked on a number of initiatives such as the ASEAN-Japan Action Plan on Environmental Improvement in Transport Sector, Energy Efficiency and Climate Change Mitigation for the Land Transport Sector, and the ASEAN Air Transport Integration Project. In the agriculture and forestry sector, the 'ASEAN Multi-Sectoral Framework on Climate Change and Food Security' was endorsed in 2009 to promote coordination and cooperation on adaptation and mitigation measures.

At this juncture, the extent of climate change-related policies and mechanisms in ASEAN Member States and in ASEAN as a regional institution is clear. Some countries have even established specialised climate change bodies. However, it is important to note that individual ASEAN countries were able to proceed to introducing national climate change policies without referencing regional climate change policy, as this suggests that their approach to addressing climate change is dispersed and not integrated. Despite a lack of a comprehensive regional policy, individual countries' adaptation policies had already integrated strategies in various sectors, including agriculture and food production. The convergence of concerns in agriculture and food security necessitates an examination of the distributional impacts of climate change on food security and an investigation of potential gaps in current approaches to CCA. Such assessments are particularly important considering that the region is highly integrated and interconnected, with, for example, some countries being food exporters and others being food importers. It is also important to note that food security functions within an ecosystem rather than in isolation. Thus, food security challenges cannot be dealt with separately from responses to and/or strategies for CCA. The symbiotic relationship between climate change and food security is discussed further below.

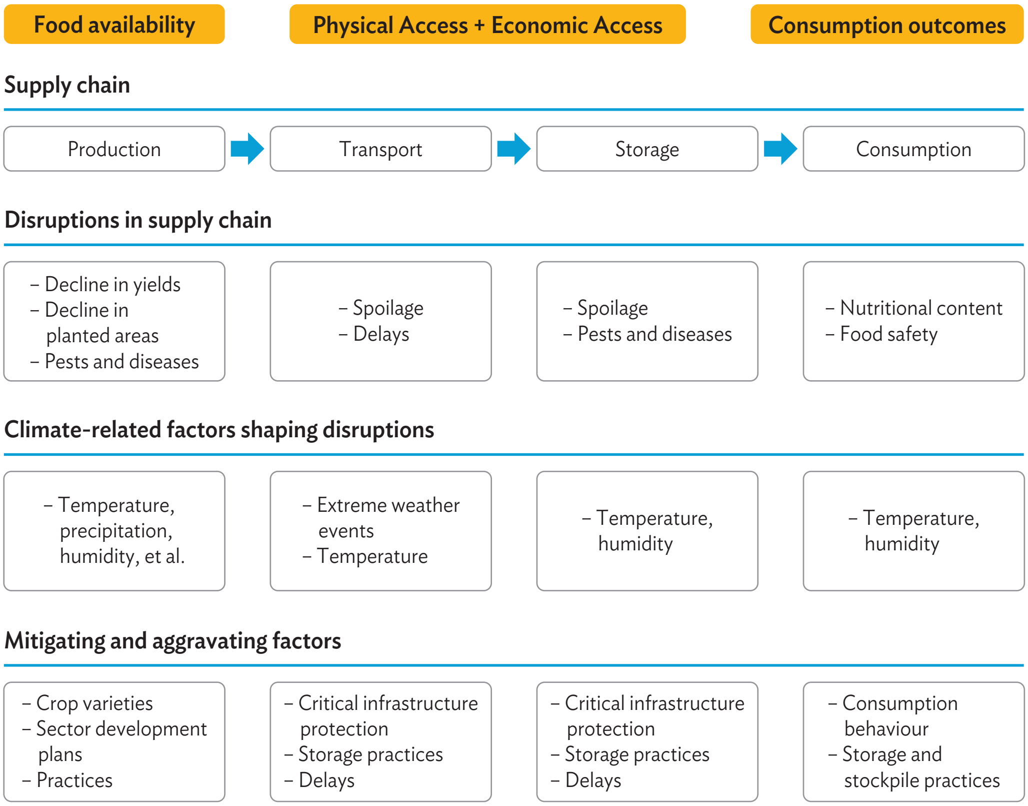
2.3 Distributional Effects: How Climate Change and Disasters Affect Food Security

Distributional effects refer to the uneven manner in which populations or groups are affected by issues, with some groups being more vulnerable than others. Regarding the interlinked issue of climate change impacting food security, assessing distributional effects is complex. To appreciate this, it is first necessary to recognise the multifaceted nature of food security. The United Nations Food and Agriculture Organization (FAO) defines food security as '(having) at all times ...physical, social and economic access to sufficient, safe and nutritious food which meets...dietary needs and food preferences for an active and healthy life' (FAO, 2002). This means that a population is not considered food secure if it consistently falls short in any of these aspects, that is to say, (i) if it is consistently unable to meet its consumption needs through both production and imports (food availability); (ii) if it is vulnerable to disruptions that prevent physical access to food (physical access); (iii) if food is so expensive that it is unaffordable for some segments (economic access); or (iv) if consumption habits as well as a high incidence of food-borne diseases lead to poor health and nutritional outcomes (food utilisation/consumption outcomes). The phrase 'at all times' in the FAO definition implies that stability is also an important component, and applies to the four aspects outlined above.

Following this definition, the distributional impacts of climate change on food security are captured in Figure 2.2, which shows that analysis of these impacts is multi-layered. First, it is necessary to look at the affected point in the supply chain, whether it is food production, transport, storage, or consumption. Disruptions along the supply chain can take different forms, such as a decline in yields and planted areas, incidence of pests and diseases that affect food production; spoilage and delays that affect transport; spoilage, pests, and diseases that affect storage; and nutritional content and food safety, affecting utilisation or consumption outcomes. Climate change can increase the likelihood of these disruptions, due to changes in temperature, humidity, or precipitation, or to extreme weather events. Finally, human intervention may either mitigate or aggravate the impacts of these climate-induced disruptions on populations.

The impacts of climate change on the supply chain are discussed further below.

Figure 2.2: How Climate Change and Disasters Affect Food Security



Source: Authors.

2.3.1 | Impacts on Food Production and Supply

The first impact of climate change is on production and food supply and availability. Extreme weather events (e.g. droughts and floods) may destroy entire batches of crops prior to harvest. For example, the region suffered significant losses in 2015 alone when droughts impacted 492,000 hectares (ha) of cropland, and floods 81,000 ha (ASEAN Plus Three Food Security Information System, 2016). Longer term changes in environmental conditions (e.g. temperature, precipitation, and humidity) make environments less conducive for agricultural production. For instance, fish catch in Southeast Asia has been projected to fall by as much as 40%–60% of fish-catch potential due to climate-induced fish migration, while dry-season rice yields in the Philippines could fall by 10% due to a 1% increase in nighttime temperatures during the dry season (Portner et al., 2014; Peng et al., 2004).

A number of human-induced factors can also mitigate or aggravate the impacts of climate change on food production and supply. Choice of crop varieties is important, as yield reductions can be worsened if the types of crops utilised by farmers are more vulnerable to temperature changes, extreme temperatures, droughts, and submergence. Norms of fertiliser use are important too, as these influence soil quality, while overuse may lead to excessive amounts of nitrogen in the soil, and the growth of invasive weeds and grass that steal needed water and nutrients (e.g. nitrogen and phosphorous) from the planted crops (Settele et al., 2014). On the other hand, having too little of these nutrients may prevent plants from properly absorbing the nutrients and photosynthesis from happening efficiently (Brevik, 2013). Pests and diseases should also be factored in, as changes in temperatures and humidity may make certain areas more conducive to pest growth and the spread of diseases. Alternative scenarios can be configured, taking into account the effects of fertilisation, where increasing the amount of carbon in the soil can actually boost plant growth (Nakagawa et al., 1993). Finally, competing demand for scarce resources is another factor that could mitigate or aggravate the impacts of climate change on production. Given land scarcity, competing uses of land could lead to agricultural land being appropriated for urban or industrial uses. Similarly, there are competing demands for water from the manufacturing, electricity, and domestic water use sectors (Organisation for Economic Co-operation and Development, 2012).

2.3.2 | Impacts on Access to Food (Physical and Economic)

Next, we consider the impacts of climate change and disasters on physical access to food. Extreme weather events may delay the transport of food products, while long-term changes in temperature and humidity may cause food to spoil in transit unless proper transport and storage practices are in place. In combination, long-term climate impacts and extreme weather events may increase losses in food production, transport, and storage. This impacts economic access to food because disruptions in food production, transport, and/or storage cause food prices to increase, making food less affordable.

In addition, a number of human-induced factors can mitigate or aggravate the impacts of climate change on transport and storage. Critical infrastructure protection implies safeguarding vulnerable points in food transport and storage (Department of Homeland Security, 2007). Transport and storage practices also require cooling or heating mechanisms to maintain the appropriate temperatures to avoid spoilage, sterilise food, or extend the shelf-life of the food product (Miks-Krajnik et al., 2015).

2.3.3 | Impacts on Consumption and Nutritional Outcomes

The factors discussed above can reduce food consumption significantly, resulting in detrimental health and nutrition outcomes especially for the poor. For example, increased food prices during the 2007–2008 food price crisis, together with the price inflation that occurred from June to December 2010, caused an increase in the number of people suffering from hunger (Ivanic, Martin, and Zaman, 2011).

The impacts on consumers can vary depending on the presence of human-induced factors that can mitigate or aggravate the impacts of climate change on food utilisation and consumption. One of these factors is the total food reserves available, considering in particular the stockpile policies adopted by countries or areas within those countries. For example, India's food policy regime enables the country to mandate higher crop production targets and to store the resulting yield in preparation for emergencies (Chand, 2005). Another important factor is population income levels relative to food prices, and the corresponding food subsidies provided by governments. This is because during disruptions, when food becomes scarcer, prices may increase until food becomes unaffordable for many poorer people. Consumer practices, such as certain forms of subsistence farming and food storage in preparation for contingencies, are also important. This final factor may be influenced by the rapid rate of urbanisation, as well as the prevailing view that food production is for rural, not urban areas.

Based on this analysis, the distributional impacts of food depend on the balance between the presence of climate-related factors that can lead to disruptions, on the one hand, and the effectiveness of food- and agriculture-related adaptation mechanisms that can mitigate the impacts of climate on food security across the supply chain on the other. For instance, the urban poor may be worst hit when domestic and international food prices increase. A potential mitigating measure is to allocate space and provide opportunities for subsistence farming to create alternative food sources; however, this measure may not be viable in some cities where the opportunity cost of land is high. Similarly, farmers in drought-affected areas may suffer crop losses and loss of income as a result, thereby reducing their economic access to food. Implementing drought-resistant crop varieties and irrigation facilities in these areas could make farmers more resilient to droughts. Potential challenges to these measures include limited access to drought-resistant varieties, or under-investment in needed irrigation infrastructure; in the presence of one or both these factors, the population will suffer more from droughts. Individuals in other sectors (e.g. processing, exporting and importing, and retail) may be directly affected by extreme weather events, and may also be indirectly affected by climate impacts on production unless appropriate measures are taken. Net food-importing countries (especially of staple products) are likewise vulnerable to climate impacts on production, as well as on transport and storage.

As these examples show, in light of the potential for changes in climate-related factors, it is necessary to qualify vulnerability and resilience, as well as levels of community preparedness and their ability to implement appropriate measures to reduce the impact of climate change on food security.

2.4 Gaps at the Regional and Country Levels in Addressing the Distributional Impacts of Climate Change on Food Security

Thus far, we have described the multifaceted nature of food security, as well as the different factors that come into play in assessing climate change's impact on food security. Our earlier discussion of the state of CCA at the regional and country levels is particularly useful in assessing how this influences the distributional impacts of climate change on food security. This will feed into the recommendations moving forward.

2.4.1 | Lack of National Initiatives that Encompass All Sectors Within Countries

It has been observed that CCA activities are not addressed at the national level in most ASEAN countries, but instead are only given focus in selected sectors. This introduces the challenge of a lack of inter-sector collaboration in mitigating the impact of climate change on certain populations. In particular, it is necessary to give more thought to food transport and storage.

While some regions have highlighted agricultural production as a point of focus and intervention, our analysis shows that distributional impacts go beyond food production. For example, even when sufficient food is produced or ordered for import, food shipments can get stuck at chokepoints while being transported within or amongst countries.
Yet, ASEAN strategies for mitigating climate impacts on food security do not include the protection of critical infrastructure, which is useful in safeguarding these chokepoints or providing alternative routes. To address this, it is necessary to secure the cooperation of food traders, as well as those in the shipping, air-freight, and other transport industries.

Similarly, food storage requires technologies that can better protect stored food from microbes that cause spoilage. Research is needed to identify ways of preventing food contamination by these microbes, thereby extending the shelf-life of products. This will also require collaboration with other sectors, such as the health sector, and the chemical and microbiological industries.

2.4.2 | Lack of Downscaled Assessments of Climate Impacts

In addition to considering the different impacts of food security beyond production, countries should consider the distributional impacts across subnational areas. It was earlier observed that present-day initiatives in ASEAN are primarily information-sharing and confidence-building platforms, rather than platforms for concrete action. It was also highlighted that countries are more operationally aligned with the global climate change agenda rather than the regional agenda, through country-level commitments (i.e. the NAPAs of most ASEAN countries).

The problem with aligning only with global-level climate change initiatives is that this makes it difficult to customise initiatives to different countries' circumstances. Studies conducted by the IPCC (in either the Fourth or Fifth Assessment Report) mostly take place at the regional or country level. However, even within countries, the impacts of climate change are not geographically uniform, as some areas are more likely to suffer severe yield reductions than others. For instance, in Thailand, the world's second largest rice exporter, yields are predicted to improve in some areas and decline in others. Moreover, the size of land plots allocated for growing crops differs across areas, such that even if yield reductions are only moderate, the impact on overall production could still be large if the planted area is large.

Since global initiatives do not go deeper than region- and country-level climate assessments, ASEAN Member States will need to fill this gap and generate their own subnational assessments, referred to as downscaled assessments of climate impacts. These should include factors such as temperature, precipitation, and humidity, as well as the biological impacts of these factors on plant growth and development, and how they feed into crop losses. Without such assessments, ASEAN countries will lack foresight on the specific impacts of climate change within countries.

In the absence of an ASEAN initiative focusing on downscaled assessments, such assessments are currently rather sparse and ad hoc in nature, and rarely treated as a national initiative. In fact, only Singapore has developed an encompassing study on downscaled climate change projections, and these have not yet been translated into the impacts on food production in the city-state (National Environment Agency, 2018). This may be due to high computing costs for conducting these assessments; for example, when Singapore was building its downscaled model, it was deemed financially unfeasible to look at all 40 available climate models (although this was also deemed undesirable as not all models were meaningful when downscaled) (Marzin et al., 2014).

Based on country commitments to the UNFCCC, in which areas requiring support were identified, it was also found that ASEAN countries (especially Myanmar, the Philippines, Thailand, and Viet Nam) need support in developing downscaled assessments of this nature (Marzin et al., 2014). Even worse, the need for downscaled studies in other countries has not been recognised. This raises the question of whether other countries recognise the need to go beyond the IPCC study assessments and develop downscaled assessments.

Beyond downscaled assessments of climate impacts on agriculture production, there are even fewer coordinated studies that trace impacts on food security outcomes of affected communities, taking into account farmer practices and government support policies.

This has several implications for the region's resilience to climate change impacts, including low or slow take-up of climate-adaptive technologies, and limited availability of financing and insurance options for farmers. Governments remain hesitant to take up certain relevant technologies, such as climate-smart crops. A lack of downscaled assessments hinders an appreciation of the urgency of implementing these technologies. Instead, governments may hold on to dogmatic interpretations of international biosafety provisions, resulting in delays in the approval of new crop varieties that could help them more effectively manage larger uncertainties in relation to climate impacts on agricultural production (Kent, 2004).

In the absence of downscaled assessments, governments and the private sector have insufficient basis for developing their own financing and insurance support policies for farmers. This is because such policies require information on the type of risk that farmers face. In the absence of this information, the government or the private sector may suffer financial losses, making financing and insurance a highly uncertain and potentially unviable enterprise. Yet, farmers are in dire need of this support. Whenever farmers suffer crop losses, the impact can be severe in the absence of crop insurance policies provided by firms.

Similarly, the lack of financing support, given the uncertainty of farmers' ability to pay back loans, means that farmers are unable to invest in new technologies that can boost yields, worsening the distributional impacts of climate change on farmers in both the short and long term.

2.4.3 | Initiatives Are Not Sufficiently Customised to Region-Specific Challenges

It was observed above that the region lacks an overarching, coherent, and concrete adaptation framework for CCA. This is problematic because the ASEAN region faces its own set of climate impacts and vulnerabilities that, in turn, can worsen the distributional impacts of climate change.

First, some countries in the region face disproportionate exposure to disasters. For instance, in 2015, three of the top 10 countries in terms of number of disasters reported per country were ASEAN members (Indonesia, Myanmar, and the Philippines), with the most frequent type of disaster faced that year being floods (Htet, 2015). From a distributional perspective, people in these countries will require additional support in such areas as infrastructure, and the use of flood-resilient crop varieties.

Next, the interconnected nature of food security, given trade in agricultural products within the region, makes the region less resilient to crises. For instance, as the Philippines is a net importer of rice, it could disrupt regional trade networks by importing a large quantity of rice. This is reminiscent of the chain of events that led to the food price crisis in 2007–2008, when the Philippines panic-purchased from Viet Nam, contributing to the rapid inflation of food prices.

Furthermore, policies may not be aligned with a unique trait of the region, such as the persistence of smallholder farmers while the rest of the world is seeing the advent of larger farms. The mean size of Southeast Asian farms in the 1990s was 1.8 ha, compared to 4.9 ha in West Asia and North Africa, and 178.4 ha in the United States; in fact, a downward trend was found in mean farm size in countries like China, Indonesia, the Republic of Korea, the Philippines, and Thailand (Rigg, Salamanca, Thompson, 2016). Due to the small size of their farms, ASEAN farmers may be unable to invest in better crop varieties, inputs, and farming practices.

Thus, it is clear that the region has specific requirements that can be attended to more directly at the regional level.

2.4.4 | Gaps in the Association of Southeast Asian Nations Economic Community and the Region's Socio-Cultural Community 2025 Blueprints

Another earlier observation was that CCA activities are not addressed at the national level in most ASEAN countries, but instead are only focused on in selected sectors. This introduces the challenge of a lack of inter-sector collaboration in mitigating the impact of climate change on certain populations. This is reflected in the fact that the ASEAN Economic Community (AEC) and ASCC blueprints address aspects of this challenge separately. While both blueprints saw significant improvement in linking their agendas to climate change adaptation and food security, there is still room for improvement (Caballero-Anthony et al., 2015).

The Strategic Plan of Action on Food Security in the ASEAN region which falls under the AEC's ambit, aims to ensure long-term food security while focusing primarily on production (including production inputs and reducing post-harvest losses), trade, and food reserves. The strategic plan has been critiqued as not focusing explicitly on CCA, although the updated 2016–2025 AEC Blueprint now states that one of its objectives is to, '[increase] resilience to climate change[,] natural disasters and other shocks' (item 57.iv., C.5, Food, Agriculture and Forestry [FAF]). This line was written in the context of 'promot[ing] deeper integration of the FAF sector in the region and the world' (item 57, C.5, FAF). As such, the blueprint is overly focused on production, and does not yet capture impacts on poorer populations, despite its use of the term 'inclusive' in the vision for the FAF sector.

Moreover, the focus on production practices can be improved by a greater focus on climate uncertainties. The AEC can leverage certain opportunities to help adapt food production to climate change more effectively. For instance, under goal B.8, 'Sustainable Economic Development,' the strategic measures indicated 'reduce post-production losses' (item 41.v), which is obviously impacted by climate change; thus, this requires proper linkage with climate impacts.

Another step towards climate resilience is the integration of climate change with food security impacts with other sectors. The integration of information and communication technology (item C.2, AEC 2025 Blueprint) can still be better harnessed in boosting resilience, and small farming enterprises can also be better supported through private sector involvement.

Similarly, the ASCC, with its 'people-centred' focus, includes a social welfare and protection clause, with an explicit food security objective that emphasises food safety and sufficient access to food.

Previously, the linkage between food access and food production, which is a driver of food access, was not obvious. Climate change fell under the clause on 'ensuring environmental sustainability' in general, and mitigating climate impacts on agriculture; yet, related initiatives have largely been carried out through ad hoc projects. This issue was addressed to some extent in the ASCC 2025 Blueprint, under the banner of 'social safety nets,' which mentioned measures 'to ensure food adequacy and accessibility at the household level, especially vulnerable households, and ability to cope with disaster, food price shocks and scarcity by developing adaptive mechanisms and strategies' (item i, D.5, Enhanced and Optimised Financing Systems, Food, Water, Energy Availability, and other Social Safety Nets in Times of Crises by Making Resources More Available, Accessible, Affordable and Sustainable).

Nevertheless, challenges remain. The safety-net approach to addressing food insufficiency (i.e. in times of crises) is still not the optimal approach. This can be complemented by efforts to reduce the likelihood of such a 'food disaster.' Another, more proactive approach is to address this issue early on in the supply chain, at the production stage. While the approach in the ASCC 2025 Blueprint (item D.5) reflects to some extent our suggestion to link food security outcomes to climate, it only does so in times of climate-related disasters, and at the time of the disaster. While this relates to issues at the distribution stage of the supply chain, it could be improved by beginning at the production stage.

As such, there should be a move towards the ideal approach proposed in our second recommendation (see below) to downscale climate impacts on food production in specific areas while integrating human-induced factors as a means of preventing food insufficiency through the production phase. While climate impacts on food security are more salient during disasters, adaptation measures should not focus on these alone, as seen in the present form of the ASCC 2025 Blueprint.

Finally, the approach of addressing climate impacts on agriculture only in terms of water resource management (through irrigation facilities) is deserving of some criticism (Caballero-Anthony et al., 2015). This again raises the urgency of downscaled assessments, as these would allow a more nuanced appreciation of the different types of climate impacts, beyond flooding.

In brief, this assessment finds that the present state of CCA at the regional and country levels, as highlighted in the early sections of this chapter, introduces specific challenges that prevent countries from addressing the distributional impacts of climate change on food security. Thus, these present opportunities to make communities more resilient to climate change impacts through (i) better regional engagement that addresses the unique constraints faced by the region, (ii) better inter-sector collaboration within countries, and (iii) the updating of the ASCC and AEC blueprints in accordance with these insights. These inform the recommendations below.

2.5 Conclusion and Way Forward

From the discussions above, it is apparent that ASEAN Member States have taken measures to adapt to climate change. The formulation of their national climate-related policies is generally modelled after international initiatives as opposed to regional processes. A lack of reference to regional measures in national climate policies may be attributed to the current nature of this cooperation, which mainly takes the form of collective statements (i.e. leaders' statements and declarations, information sharing, and confidence-building exercises). The 2017 Fifth ASEAN State of the Environment Report suggested that ASEAN needs to show the 'responses that ASEAN has taken to confront such [environmental] challenges' for it to 'be perceived as truly doing something beneficial to solving the myriad of critical environmental problems facing the region' (ASEAN, 2017b: 236). Indeed, considering the similar climate-related challenges that ASEAN Member States are facing, the regional grouping holds enormous potential for actionable cooperation that may benefit the region and increase its capacity to adapt to climate change.

Based on these developments, we offer the following recommendations.

(i) Establish an ASEAN Climate Change Adaptation Centre.

ASEAN has a reputation as a norm-builder regional entity. However, the experience of establishing and operationalising the AHA Centre proves that ASEAN can move beyond this reputation. As the concerns posed to this region by climate change become increasingly pressing, and given the distributional impacts highlighted earlier, it is time to found a regional ASEAN Climate Change Adaptation Centre that addresses CCA, with comprehensive coverage of distributional impacts on food security.

The proposed centre should be mandated to do the following:

(a) Formulate and implement CCA policies based on an ecosystem approach, especially in areas where ASEAN Member States share land, water, air, and maritime borders. This would complement the current inward-looking approach employed by ASEAN Member States in their policy-making processes. While understanding and finding solutions to climate-related concerns within domestic boundaries is clearly desirable, it is important to remember that nature knows no boundaries. The protection of the marine environment, forests, and rivers along borders, for example, will arguably be more effective through regional ecosystem-based policies and responses. Similarly, given that ASEAN countries are interconnected in the food and agriculture trade, the centre will encourage collaboration in protecting critical transport infrastructure, and other aspects of the food supply chain. These insights should be fed by the centre to ensure that the ASCC and AEC 2016–2025 blueprints sufficiently address climate change and its impacts on food security, as highlighted in the previous section.

(b) Pool regional resources and develop customised technological solutions to increase climate resilience in the region. Technological and infrastructure applications to respond to the changing climate have been called for in numerous forums and international agreements. Since these solutions mostly hail from developed countries, technology transfer is regarded as a way to enable the use of such technologies. While technology transfer generally takes place directly between technology providers and individual countries, regional frameworks and processes can be set up to facilitate the spin-offs of such transfers. Moreover, considering the region's technological know-how and experience in dealing with CCA, collaborations amongst regional experts may lead to innovative technological solutions that suit the region's needs better and may also cost much less.

The establishment of an operational centre entails special, often political processes within ASEAN. Further studies should be conducted to examine the success factors behind the establishment of the AHA Centre, as well as the challenges in setting up the proposed ASEAN Coordinating Centre for Transboundary Haze Pollution Control (this is yet to materialise as of time of writing). ASEAN Member States need to be part of these consultative processes, and the ASEAN Secretariat will likely be required to facilitate the establishment of the proposed ASEAN Climate Change Adaptation Centre.

(ii) Develop downscaled impact assessments of climate change on food security that feed into vulnerability assessments, following a research roadmap for the region.

As shown earlier, the distributional impacts of climate change are multilayered, requiring analysis not only of environmental changes amid climate change, but also of the affected part of the supply chain, and the affected aspect of food security (availability, physical access, economic access, or utilisation and consumption). Moreover, these impacts vary within countries. One initiative that could be taken up by the proposed centre is the conducting of downscaled assessments of climate change impacts.

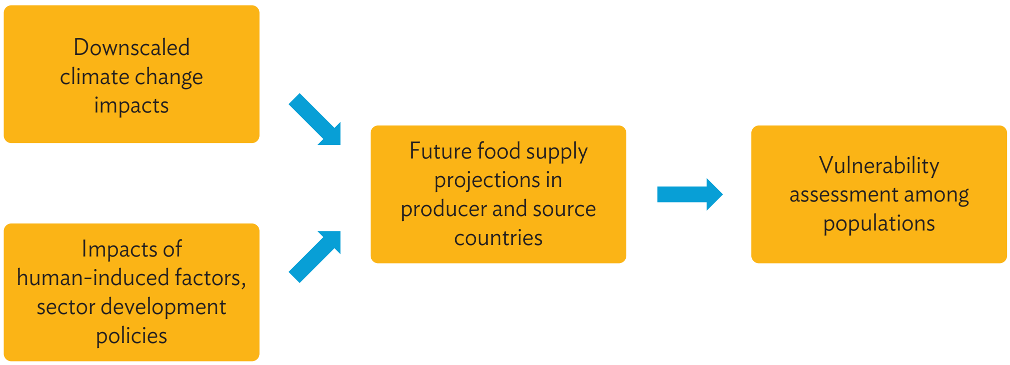
This can serve as the starting point for a more comprehensive vulnerability assessment of ASEAN countries, which can translate climate impacts into risk assessments on the actual impacts on consumers. This is strategic from the point of view of developing a coherent regional climate change framework along with a concrete, concerted regional push to deal with CCA.

Conducting such assessments allows the region to overcome information barriers that prevent governments from realising the potentially acute impacts of climate change on specific subnational areas. These can in turn allow for greater government support for CCA commitments, and a greater likelihood of them being put into action. As highlighted earlier, recognising these vulnerabilities can help governments appreciate the need for climate-smart crop varieties. It can also enable both the government and the private sector to provide financing and insurance to farmers in a viable manner, since risk plays an important part in pricing and implementing financing and insurance policies, as highlighted earlier.

(a) Develop a research roadmap. An immediate imperative for countries is to draw up a research roadmap to assess what research gaps exist across ASEAN countries that prevent them from initiating and fully utilising the downscaled assessments. Figure 2.3 illustrates the steps required for downscaled assessments to be converted into research outcomes of value to governments, in line with the framework adopted in this chapter that looks at the distributional impacts of climate change on food security.
(b) Develop research capacity in ASEAN governments for downscaled assessments, building on IPCC expertise and financial support from higher income countries that import from the region. The vulnerability assessment described above will require substantial capacity development assistance amongst ASEAN countries. Technical assistance focusing on this should be imperative across all countries.

A potential way forward is to push for the next rounds of IPCC assessment to integrate downscaled assessments. It will also be important to obtain sufficient financial support, especially for higher income countries that depend on regional exporters as food supply sources, given the high computational costs of conducting downscaled assessments.

Figure 2.3: Research Roadmap for Assessing Climate Impacts on Vulnerability and the Distributional Impacts of Climate-Induced Food Disasters



Source: Authors.

This initiative can be implemented through collaborative efforts between sectoral ministries and academia. The research roadmap may then be implemented through the proposed centre.

(iii) Complement government approaches to resilient policies with private sector participation.

Finally, approaches to address the distributional impacts of climate change may need to leverage available sources of knowledge and expertise more effectively. Another way forward is to complement present approaches with private sector involvement in order to boost resilience to disruptions in food security arising from climate change. This is because a long period of time may be needed to conduct the encompassing downscaled studies proposed above, while the need for action is clearly urgent.

The 2017 World Agricultural Forum, co-hosted by the S. Rajaratnam School of International Studies, Nanyang Technological University, provided a few examples of how this can be done (S. Rajaratnam School of International Studies, 2017).

(a) The injection of technologies, such as digital crop monitoring, can help farmers know when to plant and when to postpone planting, to avoid losses and sustain yields amid climate change uncertainties. This type of private sector intervention allows farmers to act preemptively, even in the absence of government assessments of climate change impacts. A devolved approach to climate change, which allows for complementation by the private sector, thus seems an ideal approach. Private sector involvement can also strike a balance between climate-adaptive products, on the one hand, and the need to ensure that consumer preferences are also considered, on the other.
(b) Crop insurance is another private sector solution, and is related to the lack of viable insurance coverage for farmers. The private sector should develop new assessment methods with regard to the extent of insurance coverage, and the ability to customise crop insurance policies according to the requirements of the farmer (Khoo, 2017).
(c) Partnerships for improving farming practices is another potential private sector contribution. CCA practices have been promoted by the nonprofit United States Soybean Export Council (Loh, 2017), while partnerships that upgrade processes across the rice production value chain have been promoted by the Better Rice Initiative Asia project of the international organisation Deutsche Gesellschaft für Internationale Zusammenarbeit (Vichitlekarn, 2017).

Thus, the role of sector agencies is to increase public awareness of these initiatives, and to promote greater cooperation between the public and private sectors to increase resilience to climate change.

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CHAPTER 3

Addressing Disaster Risk, Climate Change, and Food Security Through Successful Structural and Non-Structural Measures in Country Adaptation Roadmaps

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ABSTRACT

The aim of this chapter is to support the development of adaptation roadmaps for Association of Southeast Asian Nations (ASEAN) countries and to address three challenges—disaster risk reduction, climate change adaptation, and food security—simultaneously. The discussion distinguishes amongst structural, non-structural, control, and improvement measures, and provides examples of these measures from Austria, the rest of Europe, and other parts of the world. Finally, a sample adaptation roadmap for ASEAN countries targeted to 2030 is proposed.

3.1 Introduction

Disaster resilience, adaptation to climate change, and food security can be achieved through a combination of planning and measures. By combining separate plans or legal frameworks for disaster resilience, food security, and climate change adaptation (CCA), it is possible to establish national frameworks that are more than just the sum of all three separate approaches. The aim is to decrease vulnerabilities and increase resilience to all three threats simultaneously. Vulnerabilities vary due to environmental properties, risk exposure, landscape features, population pressures, and the educational background of the concerned people, amongst other factors. Resilience is the ability to cope with threats and relates to the endogenous power of people from within the region. This depends widely based on their wealth or disposable income as well as their power to organise relief from within the region.

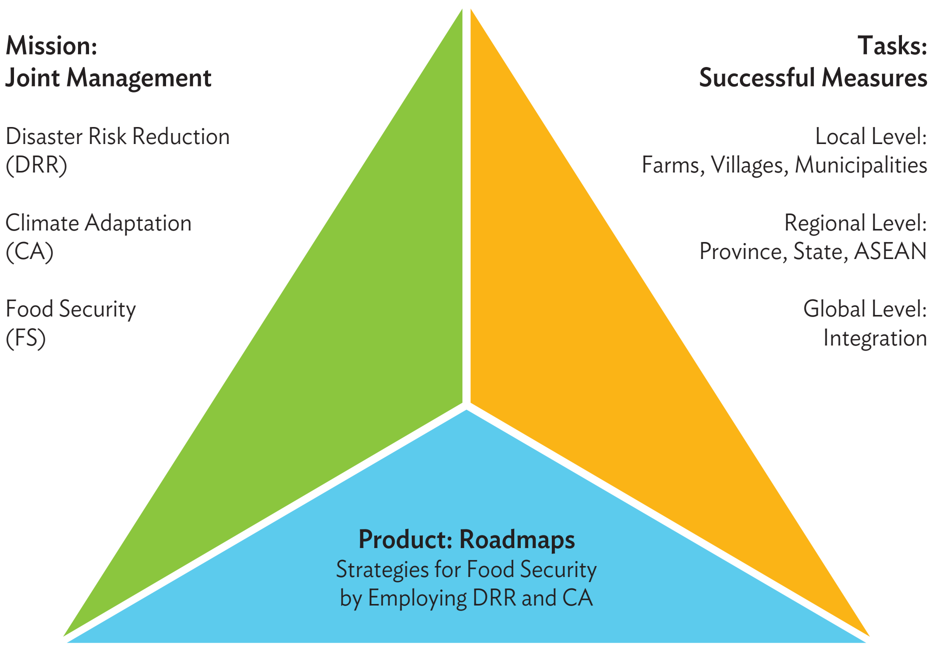
Climate change and the consequences of disasters are costly. The Stern report (Stern, 2006) argued that if countries fail to act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global gross domestic product (GDP) each year. If a wider range of risks and impacts is taken into account, damage estimates could rise to 20% of GDP or more. As such, climate change and the increased frequency of disasters will become a hindrance to development. This contrasts with the successful economic growth thus far in Association of Southeast Asian Nations (ASEAN) countries that has led to increased wealth and food security. During 2007–2015, the average annual real growth rate was 5.3% collectively for all countries (ASEAN, 2017). Hunger is no longer a major threat in ASEAN. In 1992, hunger reached levels that were serious in the Philippines and Thailand; alarming in Cambodia, Viet Nam, and Indonesia; and extremely alarming in Myanmar and the Lao People's Democratic Republic (Lao PDR). As of 2017, hunger was still a serious problem in Cambodia, Indonesia, the Lao PDR, Myanmar, and the Philippines (Welthungerhilfe et al., 2017); however, if the industrialisation of agriculture and food production continues at the same rate as in the last 25 years, hunger in the region is expected to disappear.

Although ASEAN countries are experiencing opposing trends, they currently have an opportunity to take more control over environmental decline and safeguard economic growth at the same time. Financial reserves and good infrastructure are crucial to achieve food security and eradicate hunger in an era facing ever more frequent and major disasters and damage. More structural and non-structural measures on local or regional food production and food consumption scales are required to reduce vulnerabilities and boost the resilience of ecosystems. Countries need to expand physical infrastructure such as storage facilities to minimise food loss after harvests and roads to accelerate food transportation systems, while supporting ecosystems with green infrastructure to cope with increased levels of environmental stress of all kinds. Countries should also safeguard an enlargement in institutional capacities and enhance the efficiency of public administration while implementing public awareness measures and encouraging broad business involvement. Many targeted measures will be required to oppose a possible reverse of the success observed in the area of food security.

For this reason, ASEAN countries will produce adaptation roadmaps to implement joint measures of disaster risk reduction (DRR), CCA, and food security, with the aim of uniting these three separate frameworks into a common framework. The task is to identify successful structural and non-structural measures and collect advice as to how far these measures can be optimised and controlled.

Prompting the broad involvement of government officials, extension offices, and learning institutes will guarantee broader and more targeted participation by businesses involved in agricultural production and food processing and by the public. It is also necessary to outline the necessary steps and timing for the implementation of the measures. Economic considerations to reduce costs and avoid duplication by independent teams working on separate plans are a key concern here. Figure 3.1 describes the mission, tasks, and product outcome of this process. This chapter draws from an Economic Research Institute for ASEAN and East Asia (ERIA) workshop held in Singapore on 25–26 May 2018, that involved government officials and experts from the ASEAN region (ERIA, 2018).

Figure 3.1: Process of Designing Country Adaptation Roadmaps in the Association of Southeast Asian Nations



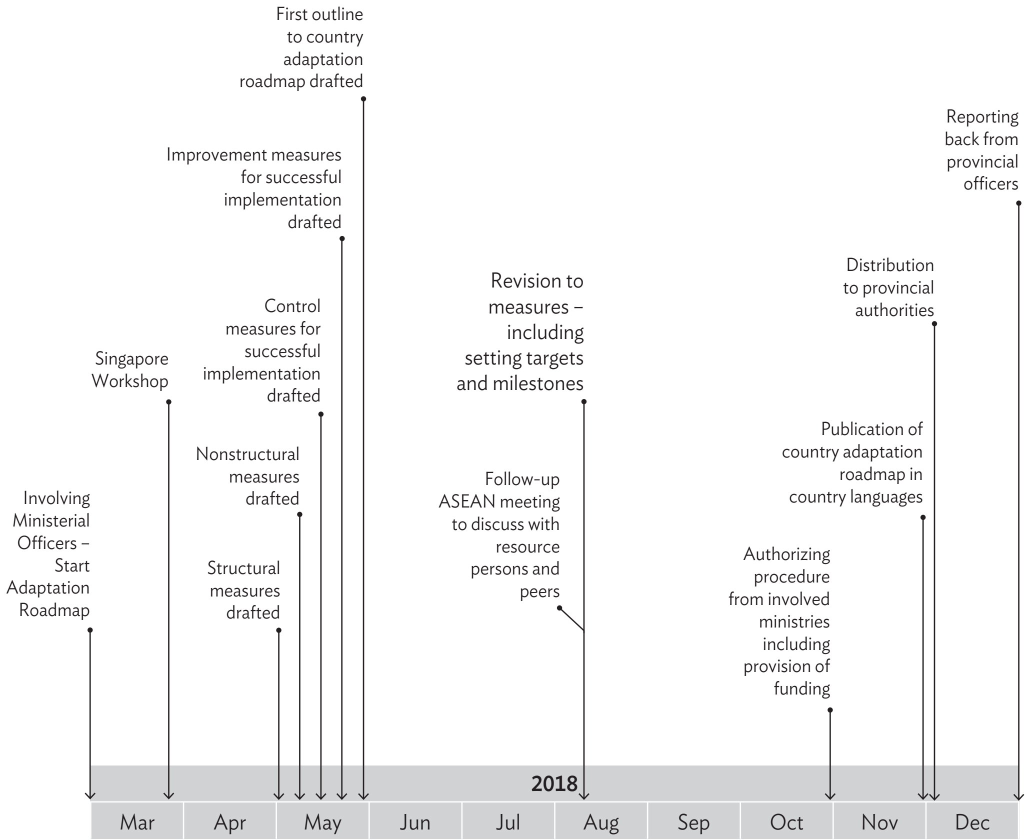
ASEAN = Association of Southeast Asian Nations.

Source: Economic Research Institute for ASEAN and East Asia (2018), Memorandum of the CCA Roadmap Workshop on Evaluating the Distributional Impacts of Disasters and Climate Change. Singapore. 25–26 March 2018.

There is a close space–time relationship connecting planning at the regional (ASEAN) level, at the national level for each of the 10 member states, and at the local level for the many individual areas in the ASEAN region. The roadmaps encompass immediate or short-term local measures and decision making, as well as long-term national policies, and shall provide a timeline as to how and when these measures are planned to be implemented. The declared interests of food security, DRR, and CCA can be formulated as territorial or sector plans and regulations for agriculture, the food industry, retailers, or consumer protection and health standards.

Ideally, a national adaptation roadmap will be embedded in an ASEAN region adaptation plan, and will consist of several smaller subregional or provincial adaptation plans highlighting particular disaster risks and climate threats. This makes it possible to recommend more specific measures to counter disaster threats. In dealing with the 'scaling issue,' that is, selecting the local or regional area of concern, it is very important to judge whether the issue is an immediate threat to local people or will be a longer-term regional problem in the future. To assess this, the 'local' scale can be broken down further into the farm (or firm), village, and municipal scales (with each larger scale comprising the smaller ones). Similarly, the 'regional' scale can be broken down into the province, nation, and ASEAN as a whole. It can be challenging and demanding to transition smoothly from the national scale down to the appropriate local scale, and remote, sparsely populated locations in particular are often considered to be largely unimportant to regional decision making. Subsistence agriculture and limited or nonexistent value chains prevail in such areas. Damage caused by disasters to traditional agricultural systems can be managed on this scale if local societies remain vital. However, remote areas are endangered even in the absence of disasters as young people in particular emigrate to find higher incomes and a better education for their children. No reactions at the local scale despite initially low values at risk are likely to accumulate over time to become a larger regional problem. Therefore, it is best to solve local challenges immediately to achieve higher regional resilience as a result. If all ASEAN countries can reach a significant number of stakeholders at ever smaller scales, the region will be able to achieve a combination of high disaster resilience, effective protection from climate change, and an optimal level of food security. This will simultaneously address the aims of international frameworks like the Sustainable Development Goals 2030 (United Nations [UN], 2015), the Paris Accord (UN Framework Convention on Climate Change, 2015), and the Sendai Framework for Action (UN, 2015); and will contribute further to overall global sustainability.

Figure 3.2: Timeline of Designing Country Adaptation Roadmaps in the Association of Southeast Asian Nations



ASEAN = Association of Southeast Asian Nations.

Source: Author.

The process of establishing DRR, CCA, and food security country adaptation roadmaps depicted in Figure 3.2 differs from the final country adaptation roadmap presented at the end of this article (Figure 3.5). The establishing process is an urgent issue that must be completed within 2019. The process involves key decision makers from ASEAN government institutes and resource persons from scientific research institutes and universities under the initiative of ERIA (2018). It is assumed that a small, efficient team can initiate a much broader implementation process of the final product, a national country adaptation roadmap.

The actual roadmap has a much longer medium- or long-term time horizon, being targeted toward 2030. The adaptation roadmap should mark validity and responsibilities for a given territory or sub-territory, and demarcate the locations, timelines, and interests to be considered at the beginning. The plan must determine deadlines for reaching certain goals, assign responsibilities for actions (in light of the fact that the venture has many stakeholders), and set realistic milestones. Urgent projects require consideration, reactions, or measures within a year. The 'short term' may be considered within a slightly longer perspective (2–3 years), while 'medium term' generally involves a 5-year horizon but can extend to a maximum of 10 years. Long-term planning relates to actions that require more than a decade to implement. It might also be necessary to revise the adaptation roadmap after several years. A revision every 6–7 years should be targeted, a timeframe similar to that used in the European Union (EU) budget or the update frequency of Intergovernmental Panel on Climate Change reports. Long-term planning visions may be valid for twice as long.

Below we discuss four categories of measures for establishing national adaptation roadmaps: structural measures, non-structural measures, control measures, and the improvement of established adaptation measures. This discussion is based in part on discussions held during the 2018 ERIA workshop in Singapore, an analysis of similar government documents from outside the ASEAN region, and the findings of scientific papers.

3.2 Structural Measures

Structural measures are primarily local measures and refer to any physical construction to reduce and avoid the possible impacts of hazards, or the application of engineering techniques to achieve hazard resistance and resilience in system structures. Some examples include dams, flood levees, ocean-wave barriers, earthquake-resistant construction, and evacuation shelters. Technical measures generally include substantial investments and regional financing, and therefore go beyond the local scale and require intensive cooperation between local and regional stakeholders. Only very important places from a value chain perspective—such as densely populated urban areas, traffic nodes, or hubs—will receive the funding required to realise such projects. Less important places from a value chain perspective (usually less populated and rural areas) must implement inexpensive structural measures to improve the resilience of their environment.

A good example of rather inexpensive structural measures is green infrastructure. Green infrastructure is based on the principle that 'protecting and enhancing nature and natural processes are consciously integrated into physical planning and territorial development' (European Union, 2013). It requires significantly less investment than other structural measures. In Europe, several regions, cities, and rural areas are promoting strategies defining green infrastructure as 'a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services' in both rural and urban settings (European Environment Agency, 2015). Green infrastructure plays a key role in achieving a variety of interconnected environmental areas such as biodiversity conservation, territorial development and cohesion, climate change mitigation and adaptation, agriculture, and forestry management. In the following section we recommend specific structural measures based on green infrastructure, as they contribute best to achieving the desired combination of DRR, CCA, and food security in the targeted ASEAN country roadmaps. In particular, we highlight several feasible methods—the provision of agricultural land for the urban poor, urban gardening, agro-forestry, alleys and hedges, increased organic content in soil, traditional water management for rice cultivation, and wetland restoration—that can enhance the desired ecosystem service performance with limited investments.

Disasters that affect cities and urban areas cause particularly extensive damage. The resilience of urban and metropolitan areas to disasters can be increased considerably by planning garden villages—consisting of a mosaic of small gardens—during early stages of development when public land is still available or can be bought at modest prices. For example, Graz, the second largest city in Austria, is implementing a roadmap called 'Smart Food Grid Graz' in an attempt to double local food production (within a diameter of 30 square kilometres) from its current level of less than 15% to 30% in 2030 (Seebacher et al., 2017). An extended green area with many small private gardens is considered to fall under the umbrella of climate mitigation and abatement, as the food is not transported and greenhouse gas emissions are negligible, while the dense net of green infrastructure offers protection from extreme rain and storms. In addition, run-off water stays in the green infrastructure and does not run directly into urban canals.

Green infrastructure in cities will substantially limit damage from disasters. Municipal and local governments should consider buying or arranging land areas for urban green belts (Amati, 2008) or green nets with small plots of agricultural land for gardening and food production. This land should provide a food reserve for the urban poor and can be leased out for limited periods and at moderate prices. At the same time, the connected green nets and/or rings will serve as a protective measure in the case of extreme disaster events. Vienna, the Austrian capital, offers a successful example of providing such opportunities for urban dwellers (Vienna Municipality, 2013). When refugees returned to the city after the First World War, 100 years ago, the country was seriously damaged with no financial reserves, and people's employment and activity options were limited. However, as there were land reserves available, the city bought some extra land and allotted it to eligible people with a low income and no property in the town. These citizens used the plots to cultivate fruit and vegetables, considerably reducing living costs. As the plots were small, and impossible to sell or speculate with (since they were not owned by the occupants), dozens of urban garden conglomerates with their holders organised into small garden associations known as *Kleingartenverein*, which helped contribute to a very high quality of life considering the comparably modest consumption of resources. Even today, some of the food consumed by the public comes directly from these plots. Initially, only cottages, not houses, could be established on such plots; however, 30 years ago, the municipal government permitted holders to build small houses not exceeding 50 square metres (m^2) on these plots. Although the gardens are relatively small (200 m^2–600 m^2) and do not include room for parking cars, they can contribute to food security in periods of crisis as was continuously the case during the wars.

Urban gardening is not restricted to small garden associations, but is also found in contemporary forms. The municipality of Vienna owns one of the largest organic farms in Austria. Its ecological performance is its most important function and, as all workers are employed by the city, the economic pressure of farming is largely reduced. In addition, several research projects on organic farming are carried out here. At several new housing projects currently planned in Vienna, new settlers can rent small garden plots 20 m^2–60 m^2 in size for approximately €100 per year in adjacent areas. A contract farmer prepares the land according to organic principles each spring with his machinery and arranges plots for urban gardeners. In some cases, a set of common vegetables is already planted. The urban plot holder simply plants and cares for the desired crops, vegetables, and fruits during the growing period. After the harvest, the contract farmer will prepare the land for the next growing season (Selbsternte, 2018). Another form of urban gardening is so called guerilla gardening where inhabitants use public plots for gardening. While this is not necessarily legal, municipalities sometimes do not mind their citizens actively greening underused urban plots (Howard, 2014).

Agro-forestry is a method of land management involving the simultaneous cultivation of farm crops and trees. Agro-forestry ensures a continuous food supply and some continuous economic returns, avoids soil degradation, offers higher resistance against storms and floods, and accordingly lessens damage from disaster events. However, they require a high level of manual work by the farmers in exchange for the avoided investment, and will be challenged if income levels in ASEAN countries increase, enticing young farmers to look for better income opportunities outside agriculture. Systems that have been working properly can continue for some decades due to the input of labour by the elder generation; however, as farmers increasingly lack time to work on agro-forestry farms, the performance of these systems can deteriorate.

Alleys and hedges along roads can protect rural transportation routes in particular from wind and extreme weather. They also hold back and store rainwater in their leaves, allow the infiltration of rainwater, and retain excess water with their roots. In addition, these elements provide shade for pedestrians and animals in temperate local climates.

Increasing the organic content of soils will make them more productive and resilient to soil erosion and disaster impacts. Green manure and animal waste can be used to boost the organic content of soil. Another way to increase the organic content of soil artificially is to breed earthworms and apply them on fields. In Austria and the rest of Europe, certain companies are selling earthworms to improve soil (Vermigrand, 2018).

Water ponds and channels for rice fields that are built from natural materials must be well maintained to keep or enhance their protective function against increased disasters. As the number of young people declines in many areas, many local irrigation systems cannot be maintained and will lose their protective function in the near future. The renovation of traditional systems and their protective function are still working well in a few cases, such as the rice terraces in Bali (United Nations Educational, Scientific and Cultural Organization, 2018), and landscape maintenance is also financially rewarded through tourism. However, in many other places where tourism is not as pronounced as in Bali, financial resources to renew such traditional systems are lacking.

The creation of more wetlands and additional forest areas offers good protection against floods. Wetlands act as sponges that soak up moisture, and wooded areas can slow water loss when rivers overflow. These areas are often destroyed to make room for agriculture and development. Halting deforestation and wetland drainage, reforesting upstream areas, and restoring damaged wetlands could significantly reduce the impact of climate change and extreme weather events. Groups in ASEAN are already actively pursuing this aim. The Indonesian Peatland Restoration Agency is implementing government plans and actions to restore 2.4 million hectares of peatland by 2020 (Wetlands International, 2017). Avoiding shifting cultivation and the burning of forest land is another means of increasing resilience to DRR and CCA.

Another action area is the construction of storage facilities. Modified climate patterns are creating a higher degree of uncertainty surrounding what was considered reliable in the past. Water storage facilities built to collect rainwater can help overcome dry periods by providing additional irrigation water. Small-scale harvest and conservation silos are particularly valuable in remote rural areas with poor distribution systems, and can reduce food insecurity substantially (Yusuf and He, 2011).

Smart farming methods and plant factories are using advanced technology in agriculture and are producing an increasing amount of data (Wolfert, Verdouw, and Bogaardt, 2017). In urban areas in particular, ever larger amounts of food like tomatoes, cucumbers, paprika, and other vegetables are being produced in partly or completely artificial environments. They use limited space and can produce at world market prices, but depend economically on cheap long-term contracts with energy supply companies, and require high initial investments. Plant factories produce certain vegetables in closed chambers under a controlled environment. All in all, the old and new methods of urban farming both considerably reduce vulnerability to disasters by providing a buffer against their adverse effects.

Smart-farming methods in rural areas use sensors that detect characteristics in weather patterns and warn farmers of unfavourable weather conditions. Although these kinds of technologies are currently too expensive to be used broadly, they contribute to new knowledge and allow for easier adjustment to unwelcome or extreme weather phenomena. Over the next few decades, these technologies will advance even more and become much cheaper.

The transfer and use of inadequate, unsustainable, or unsafe technologies for adaptation must be avoided. Technology recipients should be able to identify and select ‘sustainable technologies’—i.e. those that are climate-smart, economically viable, and socially acceptable—appropriate to their actual needs, circumstances, and capacities.

Some approaches to coastal protection have proven inadequate, for example when the weight of rocks making up a breakwater is insufficient relative to the energy of the significant wave. Sea walls often accelerate erosion for adjacent, unprotected areas of the coast, and seawater can breach coasts near aquifers and limit possibilities for agriculture. The use of coastal mangrove forests for lobster breeding was perceived to be a particularly bad practice for both the environment and workers (Environmental Justice Foundation, 2013), and the EU banned shrimp imports from Thailand in 2014 due in part to bad environmental practices. However, in recent years initiatives have begun to afforest mangrove forests (Villadiego, 2016).

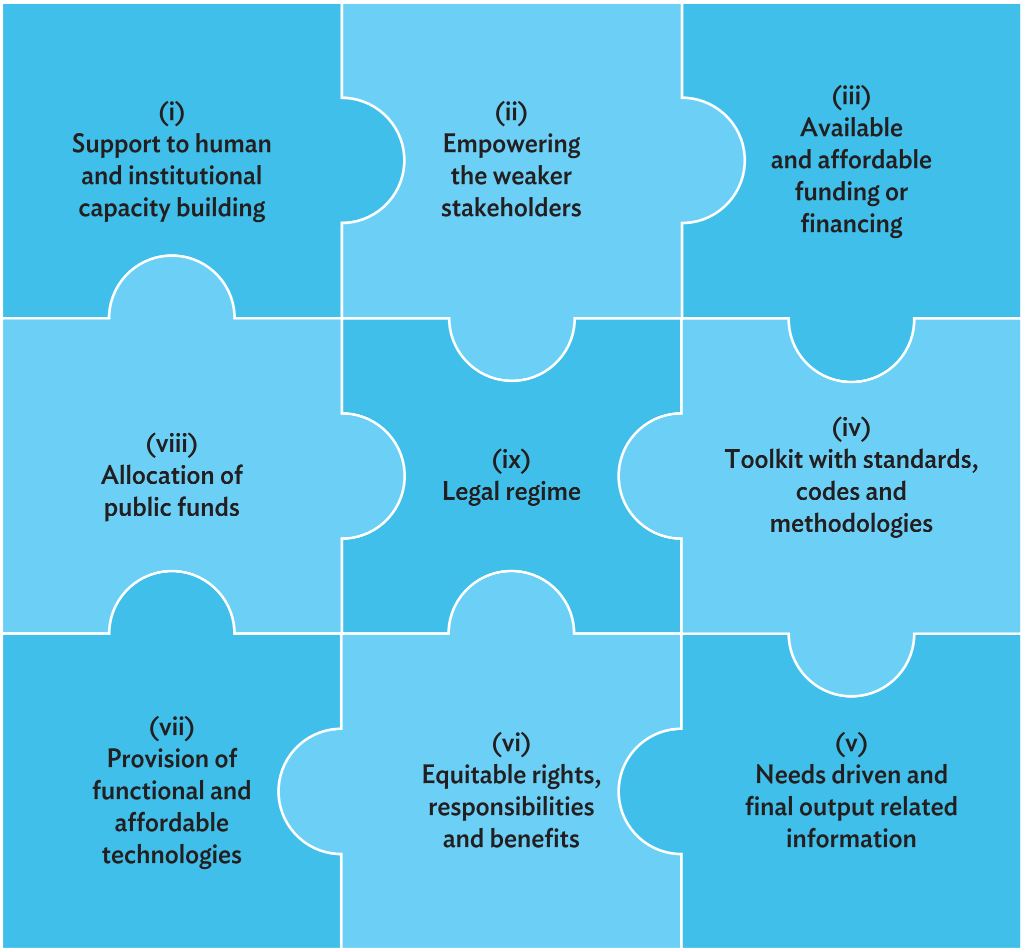
There are unfortunately several negative examples of environmental impacts, such as the depletion of groundwater resources to produce low-priced agricultural products, instead of conserving this resource. Salinisation and seawater intrusion present a particular problem; when formerly suitable agricultural land is salinised it becomes more vulnerable to heat and flood disasters, as less water can infiltrate the soil and the soil in turn cannot hold this water. For example, case studies from the Republic of Korea indicate that a combination of pig manure and seawater intrusion in the volcanic island of Jeju have widely limited resource values and potential for further economic development (Kim et al., 2003). Another case from China (Han et al., 2014) identifies saltwater intrusion as a consequence of brine extraction that began in the 1990s. New and more intensive uses of resources combined with an increase in the frequency and scale of climate-related disasters widely decreases the resilience of areas and calls for counteractions.

3.3 Non-Structural Measures

Non-structural measures are those that use knowledge, practice, or agreement to reduce risks and impacts, in particular through policies and laws, awareness creation, disaster preparedness training and education, the compilation of data and research, land use planning, and insurance.

Adaptation roadmaps reach many stakeholders at the practical, applied level. They aim to create and strengthen an enabling environment for adaptation, and to integrate adaptation planning and implementation into new and existing development policies, plans, frameworks, and practical actions. This includes the following requirements (see Figure 3.3): (i) support human and institutional capacity building; (ii) empower weaker stakeholders in particular and give them a voice in the mainstreaming process; (iii) identify available and affordable funding or financing for benign actions; (iv) collect a toolkit with relevant and applicable standards, codes, and methodologies; (v) provide needs-driven and final output-related information; (vi) allocate equitable rights, responsibilities, and benefits; (vii) provide functional and affordable technologies; (viii) allocate public funds along with favourable macroeconomic conditions; and (ix) stipulate robust and responsive legal regimes.

Figure 3.3: Diagram of Requirements for Successful Adaptation Roadmaps



Source: Economic Research Institute for ASEAN and East Asia (2018), Memorandum of the CCA Roadmap Workshop on Evaluating the Distributional Impacts of Disasters and Climate Change. Singapore. 25–26 March 2018.

It is essential to document major risks to the economy and society from disaster events and climate variability. It is also necessary to characterise the probability of these events occurring with respect to location, time, and the associated social and ecological consequences concerning prevailing economic interests.

Regions (e.g. nations or provinces) must analyse the extent to which their food security has been challenged in recent decades (at least twice as far back as the prognosis horizon); for example, if a country is looking to assess the situation in the next 10 years, it should take the past 20 years into consideration. In particular, countries should consider the frequency of droughts, floods, cyclones, extreme temperature events, and shifts in regular or usual weather patterns (e.g. changes in the arrival of monsoons) during this period; the (prize) effects on the supply of the most important agricultural inputs like energy, fertiliser, pesticides, and agricultural machinery; and damage and loss impacts, if any, on pre-harvest, harvest, and post-harvest processes. The analysis should describe the economic challenges faced by the food processing industry and retail chains by quantifying damage and loss due to different kinds of disasters, as well as consumer difficulties such as electricity failures related to disasters and consequent damage to food (such as the unintentional thawing of frozen food). All conceivable damage in the context of food production can be quantified and put into perspective based on the general income level of the area. The smaller the chosen local area, the greater the deviation from the regional or global average may be. Therefore, the impact and related cost of disasters, even if limited in scale in general, are likely to be less in larger areas and especially high in small areas directly affected by the disaster. Another difference in impact can be seen if a disaster hits a highly urbanised area or a lightly populated rural area. Agricultural production is relatively more important in remote areas that lack other income sources, and poor, less developed countries depend economically much more on agriculture. The United Nations Food and Agriculture Organization (FAO) found that agriculture-related damage from disasters is particularly extensive, reaching 25% of agricultural production value (FAO, 2015).

The motivations driving various stakeholders to engage in the adaptation process, and to replicate these motivations in other players are supported by specific schemes. EU programmes and the region's common agricultural policy are an important motivation for DRR and CCA. These are ecologically minded, primarily voluntary programmes to make the local resource base more resilient. An investigation of wine farming communities in Austria found that farmers were primarily motivated to participate in such programmes by economic incentives (Kieninger et al., 2018). Similar experiences were recorded for other agricultural commodities and other countries in Europe.

Land use planning is a key component. For example, it is crucial to create water retention areas to minimise flood damage. Local and regional hazard maps have to be citable at various scales to understand the risks to the population concerned. With regard to flood and avalanche disasters, each district in Austria has produced a hazard zone plan that forecasts catastrophic risks by demarcating red zones that indicate the likelihood of the appearance of a 150-year disaster event and yellow zones indicating the regular occurrence of extreme events causing severe damage in certain years (Federal Ministry of Sustainability and Tourism, 2018).

Education is key to abate successfully an increasing number of disasters that are causing ever more damage per event, on average. It is also necessary to build the willingness and ability of communities to adapt continuously to new circumstances and challenges, and to realise an increased potential for risk abatement. High levels of awareness, motivation, and empowerment within the public and private sectors and in civil society will help people, communities, and the wider society adapt in this way. However, this requires a long-term approach to developing and delivering comprehensive and targeted awareness-raising and educational programmes. Education was identified as key to decrease the vulnerability of various countries with regard to different kinds of natural disasters (Muttarak and Lutz, 2014). Two case studies from Thailand confirm this. During the droughts and floods of 2010, the educational attainment of rural villages played an important role in reducing economic vulnerability (Garbero and Muttarak, 2013); similarly, during the Indian Ocean earthquake of 2012, villages where more individuals and households had a higher level of educational attainment were better prepared for earthquakes and disasters. The study also found that villages where a large percentage of women had a secondary education were more resilient than those villages where women only had a primary education (Muttarak and Potisiri, 2013). Although education is a long process, the higher the educational level of the resident population, the more awareness, motivation, and empowerment can be expected in both the public and private sectors and in civil society. In addition to normal schooling and university courses, specific educational programmes for adults and the elderly should be considered.

The present reluctance of banks and other lending institutions to finance adaptation and resilience activities due to the perception that they involve longer term, high-risk projects should be addressed. This barrier can be reduced by promoting institutions, arrangements, and mechanisms that can provide innovative financing, including microfinance, crop insurance, green finance, secured loans, leasing arrangements, and public–private partnerships, thereby allowing adaptation to proceed without government intervention. Insuring against climate risks has become a rather controversial issue in Austria as private farmers are partly insured against climate risks through public financing (Sinabel, 2017). A premium support can be a hidden subsidy to the insurance company and might not reflect the objective level of risk. These programmes must also accord with disaster relief programmes and the national disaster relief fund.

An interesting example of avoided deforestation and therefore DRR and CCA is the so-called Rainforest of the Austrians, where 40 square kilometres of land were bought and enlarged through private microfinancing and individual sponsorship in Costa Rica (Regenwald der Österreicher, 2018). Here we see an NGO that understands the cultures and background of two diverse countries acting as a mediator between the countries. Another kind of funding targets public–private partnerships, and a national fund provides a certain amount to support climate-benign projects each year. In Austria, government agencies commission certain institutions to support and evaluate climate-benign projects, with benignity a precondition to obtaining public funding (Kommunal Kredit Public Consulting, 2018). Projects within the country are primarily supported with goal of defraying costs that exceed the cheapest variant in relation to the climate-benign design. In some cases, projects outside Austria, especially in least developed countries, can be supported to compensate for carbon dioxide emissions in the country.

Another possibility for DRR and CCA are targeted programmes similar to those developed in the EU. These programmes generally need an additional 5%–15% of public cofinancing from local governments. They are often designed for disfavoured regions or locations with considerably less per capita income than the average within the EU. Other variants of the programme are prepared for businesses that can count on public support if they follow certain rules.

The EU and its member states have developed several programmatic approaches founded in EU directives that cover the entire territory of the EU and are often overtaken by neighbouring countries. For example, the EU Water Framework Directive was enforced in 2000 (EU, 2000), and the EU Flood Directive of 2008 was introduced as an addition to this document. Some challenges regarding the mapping of flood risk areas and intergovernmental exchange between ministries were described (Alphen et al., 2009). Previously established directives relevant to farming include the Habitats Directive (1992) and Nitrates Directive (1991). Efforts to establish a comprehensive soil directive in the past decade were not realised. In 2016, the EU Directorate published an action plan on the Sendai Framework for Disaster Risk Reduction 2015–2030 (EU, 2016).

Successful adaptation to climate variability and disasters requires programmatic approaches that provide institutional and operational support for individual projects. A sound economic analysis will help minimise the limitations resulting from the short-term and narrow nature of projects. Reducing administrative and related burdens will provide much more control over the direction taken by individual projects. These approaches also increase the possibility of sustaining the benefits of a project, even after funding has ceased, and expedites the proposal development and approval processes, as well as implementation.

3.4 Control Measures

The enabling environment for adaptation roadmaps must be enhanced, the legislation and regulations that facilitate DRR and CCA made more powerful, and the capabilities of relevant regulatory agencies improved. It is also necessary to implement compliance monitoring (including naming the relevant agencies or bodies in charge), and strengthen enforcement capabilities. Policymaking, planning practices, and industrial development activities should ensure that all future generations are able to enjoy every important aspect of life, including peace and security, a healthy environment, a low risk of preventable catastrophes, conservation of knowledge, stable governance, a good life for children, livelihood opportunities, gender equity, and justice.

Ensuring macroeconomic conditions that favour successful adaptation activities include those that foster economic transparency. Such conditions are needed to ensure that disaster and climate-related risks are not masked or compensated for by hidden subsidies and thereby transferred to the wrong parties. The involvement of the private sector (e.g. investors and other players in the finance sector) in adaptation will be encouraged by macroeconomic conditions such as low inflation, stable and realistic exchange and interest rates, pricing that reflects the true marginal and fully internalised costs of materials, energy, labour and other inputs; deregulation; the free movement of capital; operation of competitive markets; open trade policies; trade facilitation; and transparent foreign investment policies.

A particular problem influencing food insecurity in remote rural areas is the absence of markets or the difficulty of accessing markets. Even when harvests are good, excess produce often cannot be sold due to a lack of transportation infrastructure, political conflicts, or, in the worst case scenario, civil wars, while bad harvests rapidly lead to emergency situations.

A lack of trade communications imposed by natural or manmade disasters is a major hindrance to development. If more central zones or entire countries or regions are affected by an adverse development, this will lead to inflation, high interest rates, black markets for food commodities, no investments, and a lack of resources, such as energy to operate agricultural machinery.

Corruption is a serious threat to economic transparency. Structural DRR and CCA measures in particular can be used to mask illegal transfers. The World Bank has developed a country policy and institutional assessment indicator (based on 20 criteria; made accessible via their website) that assesses the overall economic policy and related institutions of a country (World Bank, 2018).

Emphasis must be placed on coordinating activities—e.g. taking advantage of synergies, minimising duplication, and avoiding redundancies—to complement other development efforts. Priority should be given to adaptation activities that deliver tangible and visible benefits, rather than on exploratory studies, that is, activities that deliver outputs and outcomes whose relevance and value is at least equal to that of those provided by mainline ministries. This can help offset the fact that climate change is often perceived as a longer term issue, while other challenges, including disaster recovery, food security, human settlement, infrastructure, water supply, sanitation, education, and health care, require more immediate attention.

Mediators are needed to explain the interdependence between DRR, CCA, and food security. Ministerial officers can do this job on inter-ministerial boards, while special advisors and agricultural extension officers can raise awareness amongst stakeholders. Large industries in particular need to understand their role in contributing solutions for problems. In addition, the public needs to have the opportunity to understand the complexity and interdependence of joint implementation. Many people in ASEAN countries are now aware that the climate has changed. For example, if heavy rainfall disturbs the dry season, small-scale producers feel the impact. During a study tour of Bali in July 2016, farmers reported that 70% of the value of the dry-season harvest had been ruined by heavy rainfall. Fungi had affected the onions and coffee beans, and smallholder farmers lost important parts of their income. What was lacking was a climate-related communication offering advice as to how to protect a larger share of the harvest.

A good example of regular information on and explanations of CCA and DRR is the Yale Climate Connections group, which consists of academics who make sometimes complex information easier to understand (Yale Climate Connections, 2018). They produce several articles a week to supply an interested public with up-to-date information on climate issues.

A commitment should be made to the ongoing practice of monitoring, reviewing, and strengthening the Sustainable Development Goals (SDG) 2030 targets and their inter-linkages with DRR, climate change, and food security. Monitoring and reporting methods should emphasise transparency, consistency, and accountability, as well as continuing to improve the efficiency with which outcomes are delivered, as their contribution to sustainable national development.

Any risks that present generations find unacceptable should not be imposed on future generations. The discussion on sustainable development above primarily addresses resource use and the depletion of the resource base. In 1970, the Club of Rome (Meadows et al., 1972) published 'The Limits to Growth', which was revised and altered to accommodate new information several times. This statement appeared in a public document for the first time in the Brundtland Report (UN, 1987). We consider touching the following measures under the umbrella of the 2030 SDG targets: (i) no poverty; (ii) zero hunger; (iii) good health and wellbeing; (iv) high-quality education; (v) gender equality; (vi) clean water and sanitation; (vii) clean, affordable energy; (viii) decent work and economic growth; (ix) industry, innovation, and infrastructure; (x) reduced inequalities; (xi) sustainable cities and communities; (xii) responsible consumption and production; (xiii) climate action; (xiv) life below water; (xv) life on land; (xvi) peace and justice; and (xvii) strong institutions and partnerships to achieve the SDGs (UN, 2015). Although these goals need to be covered to a certain depth, our clear priority here is SDG (ii): the eradication of hunger (Weitz et al., 2017). If this issue is solved, many other SDG goals will be reached simultaneously.

Global DRR refers to the Sendai Framework for Disaster Risk Reduction, 2015–2030 (UN International Strategy for Disaster Reduction, 2015), which outlines the following priorities for action to prevent new and reduce existing disaster risks: (i) understand disaster risk; (ii) strengthen disaster risk governance to manage disaster risk; (iii) invest in disaster reduction for resilience and; (iv) enhance disaster preparedness for effective response, and (v) to 'Build Back Better' in recovery, rehabilitation, and reconstruction. The framework aims to reduce disaster risk and losses substantially in lives, livelihoods, and health, as well as in the economic, physical, social, cultural, and environmental assets of persons, businesses, communities, and countries over the next 15 years.

The Paris Agreement (UN Framework Convention on Climate Change, 2015) marked a breakthrough in international climate negotiations, and started the process towards decarbonisation in the second half of the 21st century. The main tasks laid out in the agreement include: (i) the ratification and entry into force of the agreement (so far, out of 197 contributing parties, 195 have signed and 171 have ratified the agreement [Potsdam Institute for Climate Impact Research, 2018]) (this task is completed); (ii) the completion of a necessary agreement described in the 'Paris rulebook' on a package of implementation decisions (this was completed by the end of 2018 at the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change in Katowice); and (iii) the domestic implementation of nationally determined contributions (a new and ongoing process for all participating parties). Climate action within a country is a political process, and requires political leadership with inter-ministerial cooperation. To make nationally determined contributions a reality for development, it is necessary to provide financial means for capacity building and to involve the private business sector.

3.5 Improvement Measures

Improving and enhancing the adaptive capacity of countries in the ASEAN region is imperative to safeguard existing and future development progress in light of current and expected future climate variability, disaster frequency, and food production capacity. Barriers include the limited availability of scientific information, lack of communication, absence of a knowledge base on successful measures, and limited financial resources. Policymakers and planners need access to credible and context-specific climate information as a basis for decisions and one that is linked with financing. In practice, it is often appropriate to structure the adaptive process as a series of graduated steps, beginning with screening to identify exposure, sensitivities, impacts, and adaptive capacities, followed by more detailed analyses of critical areas (Anbumozhi, 2012).

Government agencies and public institutions need to (i) enhance communication between disaster and climate risk assessors and adaptation implementers; (ii) reduce the likelihood of conflict and duplication of efforts when managing disaster and climate-related risks;

(iii) lessen the chances of mistrust and misunderstanding between decision and policy makers and other stakeholders in adaptation activities; and (iv) overall, help to provide consistent, defensible, and useful advice to decision and policymakers with respect to adaptation roadmap priorities and practices.

The timing of administrative measures and dissemination of information is crucial, and sufficient time must be allotted if a broad public and ideally all stakeholders are to be involved. If a coordination task is taken up by several or no agencies or stakeholders, this creates inefficiency. To elaborate a comprehensive framework, like DRR and CCA for food security, it can be useful to collect several proposals from sector agencies and interest groups; however, broad participation by many stakeholders will prolong the implementation process unnecessarily. Alternatively, joint working groups from several sector agencies involving key stakeholders can lead to faster solutions.

Existing data and information, as well as information management systems, must be integrated into DRR, CCA, and food security measures. While this may require additional initial effort to source and harmonise dispersed and disparate sets of information, it is likely to strengthen existing information management systems instead of marginalising them. Different information sources—international, ASEAN, national, and local—will be used simultaneously. Differences exist between general or universally applicable and specific information sources. Ideally, such sources, such as digital maps and databases, that refer to climate, soil, water, and landscape resources will already be available. Cooperation with local or national universities should be sought to bring in new information and analysis. Cooperation with schools can lead to even broader implementation that can support the implementation of DRR and CCA measures for food security at the smallest village- and farm-level scales, while keeping sight of larger local and regional scales.

Wherever possible and practical, existing decision-support tools and regulatory instruments should be used. These can facilitate and serve as a guide for the implementation of adaptation measures. Examples include risk assessments, environmental impact assessments, social impact assessment, and building codes. This will strengthen existing tools and regulations, instead of weakening them through confusion and inadequate enforcement.

Other available tools, including methods used in territorial, business, or financial planning include the following: (i) the 'strength, weaknesses, opportunities, and threats' analysis (Mindtools, 2018); (ii) the 'client, actor, transition, worldview, owner of the problem, environment' approach to planning and management, in which actors responsible for making changes are identified (Checkland, 1981; Kukhnavets, 2017); (iii) scenario analysis (Hassani, 2016), in which several scenarios of a wanted or possible future are provided to assess the likely consequences thereof at a certain point in the future; and (iv) Local Agenda 21 and ecological restructuring approaches (Lyle, 1994), which offer advice as to how to regain previously lost land and water resources of a landscape.

Decisions as to when and how to adapt to disaster risks and climate change variability should be based on credible, comparable, and objective information. Ideally, the measurements and assessments required to provide this information will be made using internationally recognised, but locally adapted, methodologies and tools, thereby helping to ensure comparability amongst data collected by different assessors. For each kind of disaster, national or provincial vulnerability maps can be produced or adjusted for food security, in cooperation with available local and regional government agencies, resident universities, and involved stakeholders, and with the support or based on the guidelines of international organisations such as the FAO and UN International Strategy for Disaster Reduction. Recent disasters like the cylones Haiyan in the Philippines (Tuhkanen et al., 2018) and Nargis in Myanmar can provide a basis for comprehensive and standardised loss accounting for agriculture and the food value chain. While the cost of natural disasters, such as those incurred in averting fatalities and harm to infrastructure, is often known, that of damage to agricultural production networks and food value chains is often not registered, but can generate a share of 25% in losses (based on ad hoc assessments after disaster events) (FAO, 2015). Methods of calculating food production damage vary between countries. ASEAN countries have a unique chance to be at the forefront of measuring agricultural damage and losses by describing joint damage accounting methods, and preparing national inventories and a regional ASEAN inventory of disaster damage and food security. Adaptation activities should be based on cooperation to bring about desired changes, using both bottom-up and top-down approaches. Stakeholder involvement is also crucial (Haddaway and Crowe, 2018). This calls for enduring partnerships at all stages of the adaptation process, ensuring the active and equitable participation of private and public stakeholders, including business, legal, financial, and other stakeholders. However, such partnership requires partners of relatively equal strength or else a critical mass of concerned people within an area that is planning DRR and CCA to support food security. Thus, development aspects are to be included.

Thomalla et al. (2018) describe development and disaster risk as closely linked. People and assets are all exposed to risk. Their vulnerability to and capacity to cope with disasters are largely determined by development processes. Transformation is key to move from current development patterns that increase, create, or unfairly distribute risks, to forms of development that are equitable, resilient, and sustainable.

Many remote, local areas lack a critical mass of interested people and, increasingly, young people who are willing to stay in the area. Even when this critical mass is available in administrative centres, initiatives often cannot reach places with a particular need. Thus, already weak places will become even more disadvantaged relative to privileged locations. Subsistence agriculture alone cannot hold young people if they have better opportunities elsewhere. To reverse this trend, the agricultural value chain in remote areas needs to grow; otherwise, ever fewer people (mostly the old, ill, and/or less able) will stay. Schools may also face challenges as too few pupils may lead to their closing. The remaining pupils will have to begin commuting to distant schools, making their education more expensive for families. Remote rural areas will become continuously less attractive. A means of countering this trend is to establish functioning local markets wherever possible and to maintain or alter the economic basis of livelihoods.

On the other hand, the depopulation of remote rural areas as more villages are abandoned reduces the overall economic risk and burden inconsistently by reducing the number and value of potential disaster targets and lessening the amount of infrastructure to be maintained. Disasters can even become crucial and accelerating factors of centralisation, as small and remote places are abandoned and survivors are forced to move elsewhere.

With regard to global food security, centralisation, agricultural trade, technological innovation, and resource availability have become increasingly important. This is a game-changer for remote rural areas compared to the situation two generations ago in Europe or one generation ago in ASEAN countries, when agriculture was entirely based on the availability of land and local resources to produce food. Food and necessary resources to produce food are becoming increasingly dependent on imports and flows in supply chains. Emphasis must be placed on the objective of minimising the distributional negative impacts of disasters and climate change. Policy recommendations should be based on the ASEAN Socio-Cultural Community Blueprint, which provides advice to achieve a higher level of disaster resilience by anticipating, responding, coping, adapting, and building back better, smarter, and faster (ASEAN, 2016a). Continued commitment should follow in the spirit of the ASEAN Agreement on Disaster Management and Emergency Response (AADMER), which has been effectively facilitating regional cooperation between and amongst ASEAN Member States (ASEAN, 2016b). As a legally binding regional agreement, the AADMER has directly contributed to the enhancement of DRR and CCA for the benefit of the peoples and communities in ASEAN.

ASEAN countries can also take the lead in still underexplored tasks in DRR and CCA. There are no joint procedures for assessing values at risk in food supply chains and the potential impact of different categories of disaster damage and losses (cyclones, droughts, floods, earthquakes, and tsunamis, amongst others) in a local or regional context. ASEAN countries can take the lead in describing joint damage and loss accounting methods and preparing a regional ASEAN inventory related to disaster damage, climate change impacts, and food security. This can involve the mixing of new and established methods adjusted to the circumstances of the ASEAN region.

3.6 Conclusion

ASEAN countries can be at the forefront by describing joint measures related to DRR, CCA, and food security at the regional (ASEAN) level based on the established national country roadmaps. In summary, an overview of the measures (structural, non-structural, control, and improvement) is provided in Figure 3.4.

None of these measures is entirely new. The innovative approach suggested here is to consider these measures simultaneously and achieve synergies by uniting them into a single assessment group, instead of creating three separate groups. The financial requirements of these measures differ, and structural measures will likely take the largest share of available finances. Even so, employing green infrastructure measures wherever feasible is much cheaper than relying on technical infrastructure. Non-structural, control, and improvement measures require a programmatic approach with clear dissemination and implementation targets. The aim here is to mainstream DRR, CCA, and food security and capacity building at the smaller administrative levels (provincial, district, municipality, village, and farm unit); however, this can be challenging if sufficient resources are not available. The final aim is to develop measurable criteria to ensure the success of an adaptation roadmap and to control how such criteria can be accomplished.

Figure 3.4: Overview of Measures for Association of Southeast Asian Nations Country Adaptation Roadmap

STRUCTURAL MEASURES

- Technical Infrastructure ➡ Roads, Ports
- Green Infrastructure ➡ Green Nets and Green Rings
- Water and Food Storage Facilities
- Urban Gardening
- Agro-forestry Methods
- Reclaiming of Wetland Areas
- Afforestation and Forest Protection
- Avoid Mal Adaptation

NON-STRUCTURAL MEASURES

- Documentation of Disaster Events and Coincidence of Food Insecurity
- Risk Awareness Rising in Institutions, Businesses and the Public
- Land Use Planning and Hazard Zoning
- Disaster Preparedness Planning
- Exploring Motivations for Participation i in CCA and DRR
- Provision of Financing of CCA and DRR

CONTROL MEASURES

- Accounting of Disaster Damage and Loss in Agricultural Production and Food Processing
- Check Legislation, Programs for Inclusion of DRR and CCA
- Ensure Economic Transparency
- Guarantee Proper Use of DRR, CCA Means
- Provide Market Access and Appropriate Food Distribution Channels

IMPROVEMENT MEASURES

- Educational Programs for FS, DRR, CCA to Public Officers, Students, Civil Society
- Inclusion of ASEAN Documents ➡ Blueprint, AADMER
- Consideration of SENDAI DRR Framework
- Combination with National Determined Contributions to Paris Accord
- Compliance Sustainable Devt Goals 2030

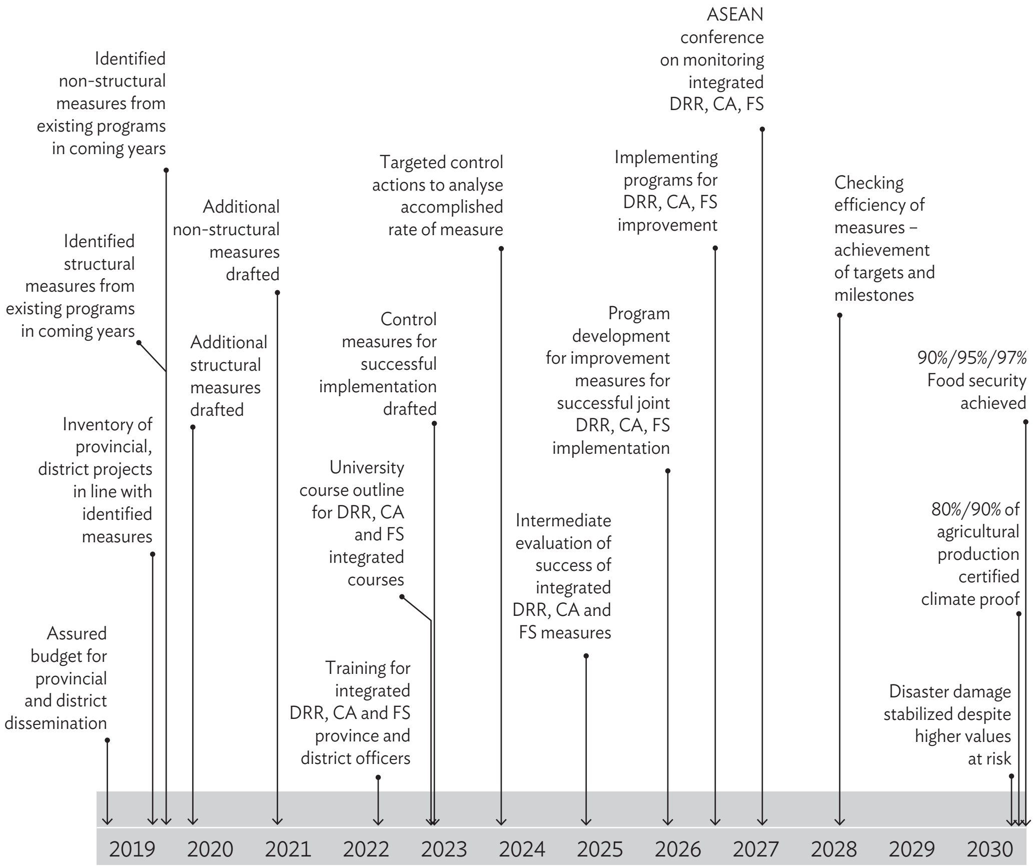
AADMER = ASEAN Agreement on Disaster Management and Emergency Response, ASEAN = Association of Southeast Asian Nations, CCA = climate change adaptation, DRR = disaster risk reduction.

Source: Author.

Finally, a sample timeline for country adaptation roadmaps is proposed (see Figure 3.5). We suggest a rather long timeline for this process and the year 2030 as a suitable target date for the successful implementation of DRR, CCA, and food security. The year 2030 is also used by international documents such as the Sendai Framework, and the new SDGs toward 2030. CCA is also likely to increase in intensity, at least from the viewpoint of avoiding ever greater damage.

The sample roadmap lays out the early, intermediate, and late milestones within the targeted 12-year period. The first step is to provide an initial adaptation budget based on international treaties and commitments. ASEAN countries actively participate in three major international frameworks and are committed to certain actions.

Figure 3.5: Sample Adaptation Roadmap for Association of Southeast Asian Nations Countries, 2019–2030



CCA = climate change adaptation, DRR = disaster risk reduction.

Source: Author.

Several projects and programmes can be classified as structural, non-structural, control, and improvement measures. While it is easier to find best practice or good guidance projects at the national scale, the aim here is to be more concerned with the smaller scale provincial level or, in the case of large provinces, even down to the district level. This exercise should make it possible to produce country hazard maps that incorporate new and updated information. This exercise may be followed by other measures from a longer term perspective, such developing courses to teach public officers or university students ways to keep disaster risks and damage low, or how to employ green infrastructure or other structural measures to abate climate change and safeguard agricultural production as the basis of food security. Control measures must first ascertain whether the adaptation is on the correct track with regard to the three objectives of DRR, CCA, and food security. This will inform the involved parties whether the intended aims can be reached or if additional efforts are required. In the coming years, improvement programmes and measures will likely be necessary. Provinces may benchmark their districts to analyse different trends in a particular region and to find explanations for them. Country-wide or ASEAN conferences will provide platforms to exchange experiences of adaptation efforts and may motivate participants to explore diverging developments within countries, provinces, or districts over time. This may increase the efficiency of adaptation programmes and measures. Finally, countries can set targets, either in line with or slightly diverging from the aims set in the overall international frameworks. While some countries will target zero hunger or 97% food security, others may find it acceptable if 10% of people are temporarily food insecure. Several countries may accept a higher level of damage from disasters, while others will target the stabilisation of such damage despite having more value at risk and a higher occurrence of more extreme events. Similarly, some countries may target a production area that is 80% climate-proof, while others may choose a different value according to their prioritisation of measures.

Finally, the adaptation roadmap is a planning document influenced by many known and unknown factors. Although surprises are inevitable, countries that are prepared are much more resilient than those who are not. Vulnerabilities should be identified at an earlier stage and countermeasures begun in a timely fashion. This will lessen the negative consequences of disasters, make it possible to cope with more climate change impacts, and guarantee food security despite increasing levels of uncertainty.

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CHAPTER 4

Tracking Climate Resiliency Actions in National Strategies

A POLICY AND INVESTMENT FRAMEWORK AND APPLICATION TO MYANMAR

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ABSTRACT

The global development community is increasingly recognising the need to achieve climate resiliency with regard to food systems; yet, operationalising this goal within the existing policy systems remains a challenge at the national level. In this chapter, we develop a policy and investment framework that can help track climate resilience actions as part of the development of policies and strategies at the national level. We apply this framework to Myanmar's recently developed Agricultural Development Strategy, and argue that such frameworks are an essential part of developing local capacities to translate climate-resilience strategies into national action and investment plans. Finally, we demonstrate how a food systems approach can help identify a set of multidimensional drivers at the underlying, intermediate, and immediate levels for decision making and support the coordination of actions at various levels.

4.1 Introduction

Ending malnutrition is critical for both economic and human development (Shekar et al., 2017). Since the agricultural sector directly impacts the food and nutritional security of the population, any increase in the burden on this sector can result in decreased food security. The United Nations Food and Agriculture Organization (FAO) (2014) has predicted that the agricultural sector will face increasing pressure from population growth and climate change over the next 3 decades and beyond. The sector will also face a 30% increase in the global population, resulting in intensified competition for increasingly scarce land, water, and energy resources, a struggle made even more complex by the existential threat of climate change. To provide for a population that is projected to grow from 7.3 billion in 2014 to 9.3 billion by 2050, and to support changing dietary patterns, it is estimated that food production will need to increase from the current 8.4 billion tonnes to almost 13.5 billion tonnes per year. Achieving this level of production from an already seriously depleted natural resource base will be difficult without including disaster risk reduction and climate change adaptation (CCA) in developmental planning.

The Intergovernmental Panel on Climate Change (2014) has stated that the negative impact of global warming on the earth is indisputable. Further, is it highly likely that the increase in greenhouse gas (GHG) emissions from anthropogenic activities has caused global warming since the mid-20th century. In addition to an increase in average temperatures and precipitation, global warming also increases the frequency of floods, droughts, and heat waves, as well as the intensity of typhoons and hurricanes. GHG emissions from agricultural fields account for approximately 10%–12% of global emissions (Intergovernmental Panel on Climate Change, 2014). When counting external factors such as deforestation, emissions from agriculture and other related activities are projected to increase by 32% (Balasubramanian, 2017). The impacts of climate change can be seen throughout the world in the form of rising sea levels, shrinking glaciers, the northward movement of plant habitats, changes in animal habitats, rising ocean temperatures, shorter winters, and the early arrival of spring.

Recent studies have found that more people than originally thought are vulnerable to and will be impacted by climate change in Asia and the Pacific (ADB, 2009). This includes the population that relies directly on agriculture (around 60% of the economically active population and their dependents). In the Greater Mekong Subregion alone, climate change is projected to drive up the price of rice by 37%, while rice yields in Asia and the Pacific are expected to decline by 14%–16% over the next 40 years due to water scarcity.

As a result, the number of malnourished children in Southeast Asia will increase by 16%. According to the World Bank (2017), the agricultural sector is responsible for a large share of the gross domestic product (GDP) of Association of Southeast Asian Nations countries (26.7% in Cambodia, 25.5% in Myanmar, and 18.1% in Viet Nam). Thus, the negative impacts of climate change may hinder the growth of all Asian countries. Further, of all the world's regions, Asia and the Pacific are the most prone to natural disasters. A lack of capacity to adapt to climate change, inadequate infrastructure, and the inability to prepare for natural disasters can magnify this impact.

In this chapter, we explain how food systems must change to accommodate the impacts of climate change. By reviewing the literature, we can diagnose the weaknesses of the current food system from a climate change perspective. This is a crucial step since it identifies gaps in the policies and strategies currently being implemented. Next, we develop an operational framework to analyse gaps, identify priority investment areas, and track progress (AIT), which can be used to adapt food systems to become climate-resilient. We apply this framework to Myanmar's Agriculture Development Strategy (ADS), which was developed by the Ministry of Agriculture, Livestock, and Irrigation (MOALI), and analyse gaps that must be addressed to make the ADS climate-resilient, while listing priority investment areas and providing a tracking system to monitor the progress of these investments.

4.2 Climate Change Adaptation for Improved Food Security

The negative impact of climate change on crop production is already evident in several regions around the world (Porter et al., 2014). Changing weather patterns are adversely affecting marginal and smallholder farmers in developing countries, while the negative impacts of climate change on the agricultural sector are amplifying the challenges created by population growth. To address this issue, the concept of climate-smart agriculture (CSA) emerged in 2009 with the aim of providing globally applicable principles to encourage sustainable agricultural productivity to meet the demands of a growing population, despite climate change (Lipper and Zilberman, 2018). CSA refers to a bundle of agricultural interventions that aim to increase yields, place more carbon in soils, and achieve greater resilience to heat and drought (FAO, 2010). Such practices, including alternate wetting and drying (AWD), row cropping, the adoption of stress-tolerant and high-yield seed varieties, deep placement of urea, and aquaculture or floating agriculture, are being adopted in both developing and developed countries to decrease the negative impacts of climate change and GHG emissions while sustaining crop productivity and profitability.

It is estimated that, given the current rate of population growth around the world, food production will need to increase by 60% by 2050 (FAO, 2014). Climate change is amplifying the challenges currently facing the agricultural sector, and farmers need to adapt quickly to changing natural environments to increase agricultural productivity while lessening damage to the environment through implementing sustainable solutions (Babu and Blom, 2014). Countries are facing several challenges in adopting sustainable agricultural policies and practices. Targeted capacity-building programmes can play an influential role in preparing a country's agricultural sector to deal with the growing threat of climate change. The concept of CSA encompasses the challenges mentioned above, providing a more holistic perspective on issues in agriculture. Patra and Babu (2017) provide a conceptual framework for helping a country transition from climate-vulnerable to climate-smart agriculture. They also provide a guide for database creation and the development of a district-level database on emissions from agriculture in India. This methodology can be used in other developing countries to mitigate the risks posed by climate change.

4.3 Diagnostic Review of the Agriculture Development Strategy

In this section, we diagnose the vulnerability of Myanmar's food system to climate change impacts. To do so, we completed an extensive desk review to build a policy, legal, and institutional matrix of multi-stakeholder actors, including ministries, agencies, and private sector players, who contribute to the food system. This is important because it enables us to identify how to develop climate-resilient policies and strategies. Using this information, we outlined the policy-making process in Myanmar. In the second step of the diagnostic review, we identified the level of climate-resilience as well as any gaps in current policy outcomes. For the purposes of this chapter, we used the ADS as an example and identified analytical needs, data requirements, and gaps to be addressed to make the ADS climate-resilient. The results of this diagnostic review are presented below.

4.3.1 | Country Context

Myanmar, with its fertile lands and low population density, is the largest country in mainland Southeast Asia with significant potential to increase agricultural production, yield, and profits. Due to its geographic location at the intersection of China and India, two of the world's most dynamic economies, it is well positioned to be a regional trading hub and key supplier of minerals, natural gas, and agricultural produce. Since its transition in 2011, Myanmar's economy has been growing at an average annual rate of 6.3% (World Bank, 2017). The key driver of Myanmar's economic growth has been the export of natural gas; however, this decreased by seven% in 2015–2016 due to heavy floods, which slowed new investment flows and created a more challenging external environment. Flooding in July 2015 affected some of the poorest and most vulnerable population centres in the country and created inflationary pressures.

Myanmar has a tropical climate with three seasons: a cool winter from November to February, a hot summer in March and April, and a rainy season dominated by the southwest monsoon from May to October. The Central Dry Zone has the lowest mean annual rainfall (500–1,000 millimetres per year) compared to the hilly regions in the east and north, and coastal regions in the south and in Rakhine state (2,500–5,500 millimetres/year) (Egashira and Aye, 2006).

Myanmar's current economic condition and structure are reflective of a low-income economy (World Bank, 2014). During 2009–2017, Myanmar's agricultural sector grew at an average annual rate of 2.5% (World Bank, 2017), approximately half the rate of its neighbouring countries, which are at a comparable development level. Despite a decrease in employment in agriculture, this sector accounts for 25% of the country's GDP, and employs 25% of the total labour force (World Bank, 2016). In 2012, agriculture employed more than half the workforce and accounted for 36.4% of GDP, compared to 37.3% for services and 26.3% for industry (World Bank, 2014).

Temperatures are projected to change by 1.7–8.4 degrees Celsius each year during 2045–2065. Since a large portion of Myanmar's population is dependent on agriculture, it is crucial to take steps to minimise the negative impacts of climate change. Impacts on the agricultural sector will further diminish the nutritional security of the country's population. According to the Demographic Health Survey of Myanmar 2015–2016 led by the Ministry of Health and Sports, 29.2% of all children suffer from stunting. Moreover, 7% of the total population suffers from wasting, while women aged 15–49 and children under the age of 5 showed a high prevalence of anaemia (Ministry of Health and Sports and International Coach Federation, 2017).

4.3.2 | Policy Process and Institutional Environment for Climate-Resilient Food Systems in Myanmar

To understand the policy process and institutional environment, it is important to ensure that CCA is included in development planning. At present, Myanmar's policy and institutional landscape has not been studied in depth and is quite nascent in terms of multi-sectoral and inter-sectoral discussions from the perspective of the food system. While several public policy institutions in Myanmar have had a direct effect on its food system, the MOALI has had the most far-reaching and wide-ranging impact on food systems through its 15 divisions. Other key players include the ministries of natural resources and environmental conservation, commerce, health, finance and planning, education, and social welfare and resettlement. An analysis of the policies and strategies of these sectors from a food-system perspective can lead to a better understanding of the policy process and their contribution to climate policy objectives.

Climate change is impacting different regions in Myanmar differently. For example, Ayeyarwaddy, Bago, Mon, and Takhine were afflicted by heavy rains and flooding in 2011, Sagaing region was severely impacted by flooding in 2012, and the Central Dry Zone was impacted by both flooding and landslides in 2015.

4.3.3 | Diagnoses of the Agriculture Development Strategy

The objective of the ADS is to accelerate growth through the strategic pillars of governance, productivity, and competitiveness. The ADS was developed to achieve an 'inclusive, competitive, food and nutrition secured and sustainable agricultural system contributing to the socio-economic well-being of farmers and rural people and further development of the national economy' (MOALI, 2018). It aims to develop the governance, physical and institutional infrastructure, and human resource capacities necessary to generate a more productive, sustainable, inclusive, and competitive agricultural and food sector capable of providing Myanmar's people with food and nutritional security. The strategy is expected to spur growth and shift millions out of poverty by boosting rural incomes and savings; generating jobs; and stimulating investments in farms, rural small and medium-sized enterprises, and people (MOALI, 2018).

This diagnostic review of the ADS discusses current plans to achieve specific outcomes, reviews analytical and data needs to implement the ADS effectively, and identifies gaps that must be addressed to achieve targeted ADS outcomes. The three main pillars of the ADS are governance, productivity, and competitiveness. Each pillar has its own objective and eight outcomes (MOALI, 2018). Table 4.1 shows each ADS pillar, objectives, and outcomes.

Table 4.1: Agriculture Development Strategy Pillars, Objectives, and Outcomes

Pillar 1: Governance	Pillar 2: Productivity	Pillar 3: Competitiveness
Objectives		
Enhanced governance and capacity of institutions responsible for agricultural development	Increased productivity and farmer incomes	Improved market linkages and competitiveness
Outcomes		
Planning. Effective integrated planning based on participatory processes at both the union and state or regional levels	**Agricultural research.** Improved research system for crop, livestock, and fisheries; and improved research-extension coordination systems with the participation of farmers and the private sector	**Business environment.** Improved business environment, information, and investment along the agri-food supply chain
Policy capacity. Improved capacity for policy formulation and analysis	**Agricultural extension.** Transformed public–private agricultural extension system delivering improved products (crops, livestock, fisheries) and technology for adoption and adaptation, better linked to agricultural research	**Intellectual property rights.** Protected intellectual property rights for the agricultural and food sectors
Monitoring and evaluation. Timely and effective monitoring and evaluation processes that inform a web-based management information system	**Education and training.** Develop (or revive) effective education and training to build 'human capital' in the agricultural and food sectors in response to the evolving needs of farmers and the private sector in rural areas	**Quality.** Develop reliable quality system that helps farmers and food processors get higher prices for higher quality goods
Statistics. Sound statistical systems for evidence-based decisions	**Irrigation and water management.** More responsive and reliable irrigation and drainage services, and more efficient and sustainable water management systems	**Rural development planning.** Enhanced framework for gender-equitable and participatory planning and implementation of rural development programmes institutionalised
Associations. Strong farmer and industry associations and federations, and triangular action of the Government of Myanmar, farmers and entrepreneurs, and millers for agribusiness development	**Crop inputs.** Increased use of improved farm production inputs and technologies by crop growers	**Rural infrastructure.** Rural infrastructure improves agricultural efficiency and profitability for smallholders

continued next page

Table 4.1: *Continued*

Pillar 1: Governance	Pillar 2: Productivity	Pillar 3: Competitiveness
Land. Strengthened farmers' land rights and enhanced capacity of institutions involved in agricultural land	**Mechanisation.** Increased application of appropriate mechanisation in the agricultural value chain	**Value chains.** Increased competitiveness and stakeholder participation in agricultural value chains engaged with prioritised commodities
Coordination. MOALI capacity for ADS coordination and implementation enhanced and guided by democratically appointed, gender-equitable civil society representation	**Livestock and fish.** Increased use of improved livestock and fish breeding, health, and husbandry services and technologies by livestock and fish producers	**Food safety.** Enhanced food quality and safety
Food and nutritional security. Improved food and nutritional security for the majority of the population	**Sustainable practices.** Sustainable farming, good agricultural practices, good animal husbandry practices, good aquaculture practices, and organic practices	**Financial services.** Improved access to a range of financial services for farmers and agribusiness enterprises

ADS = Agriculture Development Strategy; MOALI = Ministry of Agriculture, Livestock and Irrigation.

Source: Ministry of Agriculture, Livestock and Irrigation of Myanmar (2018), *Agriculture Development Strategy – Draft*. Nay Pyi Taw: Ministry of Agriculture, Livestock and Irrigation.

4.3.4 | Key Points from the Agriculture Development Strategy Diagnosis

This chapter identifies analytical and data needs and gaps that must be filled to achieve each of the ADS outcomes and create a climate-resilient food system. This section highlights the analytical and data needs for all three pillars, and highlights the gaps currently present in the outcomes. Annex 4.1 presents the analytical needs, data requirements, and gaps in the outcomes of all three pillars of the ADS; and the key points from the ADS diagnoses are outlined below.

Governance

The main objective of *governance* (Pillar 1 of the ADS) is to enhance the governance and capacity of the institutions responsible for agricultural development. This will improve the food and nutritional security of the population by enhancing institutional capacity to plan, develop, and implement policies and programmes to boost growth in the agricultural sector, resulting in increased production and farmer incomes.

At present, there is a lack of policy integration in existing climate risk management (CRM) plans and programmes, including the Myanmar Climate Change Strategy and Action Plan 2016–2030 and Myanmar Action Plan on Disaster Risk Reduction 2017. There is also a lack of understanding regarding the impact of climate change on agriculture amongst policymakers, practitioners, and farmers. To reduce the risk of climate change, all stakeholders need to understand how climate change impacts agriculture. Babu and Pinto (2017) have developed a comprehensive framework to assess the level of human, institutional, and policy capacity to achieve climate-resilient agriculture. Since weak human, institutional, and policy capacities are a major constraint on the building of climate resilience in developing countries, is it crucial to assess the country's current capacity in these areas.

Productivity

The second objective of the ADS is to increase productivity and farmer incomes (Pillar 2). To improve productivity, the efficiency of agricultural inputs such as land, water, seeds, and fertiliser must be improved, such as by developing and distributing drought-resistant seeds and regulating fertiliser use for soil conservation and carbon sequestration. Myanmar currently lacks the capacity to produce research on climate-resistant seeds and mitigation practices that can be adopted to reduce the impact of climate change.

Further, since rice production accounts for 32% of emissions from the agricultural sector (FAO, 2018), rice producers need to adopt climate-resilient techniques and practices. Excessive production of rice using irrigation is the top contributor of GHG emissions. Other major rice producers in the region, such as Bangladesh and Viet Nam, have adopted techniques like AWD to combat this issue. In Bangladesh, farmers using AWD achieved yields 9%–12% higher than those of farmers using conventional irrigation (de Pinto et al., 2017). Comparable results were seen in Viet Nam. Along with limiting GHG emissions, AWD adopters in Viet Nam saw a 20% decrease in production costs compared to farmers using conventional techniques (Quicho, 2013). This resulted in increased profits (Ha, 2014), mainly due to a decrease in irrigation and labour costs. Further, multiple studies have reported a decrease in GHG emissions of 6%–39% due to the adoption of AWD (Pandey et al., 2014; Narayan and Belova, 2013). However, as farmers' understanding of the importance of climate-resilience measures is limited, there is a need to increase farmer awareness of these techniques through agricultural extension and develop incentives for them to adopt these techniques and practices.

Competitiveness

The third objective of the ADS is to improve market linkages and competitiveness (Pillar 3). For example, promoting diversification of both on- and off-farm activities can increase income opportunities while decreasing GHG emissions. Improving rural infrastructure while using and promoting renewable sources of energy (such as hydropower, solar energy, biomass, and biogas) can also help mitigate the effects of climate change by reducing GHG emissions. Capacity building is also necessary to promote an inclusive, sustainable, and resilient renewable energy system. Lastly, there are no training programmes that focus on climate-resilient agricultural practices. Training agriculture extension agents on climate-resilient techniques will raise farmers' awareness of the impact of climate change on agriculture, resulting in increased competitiveness.

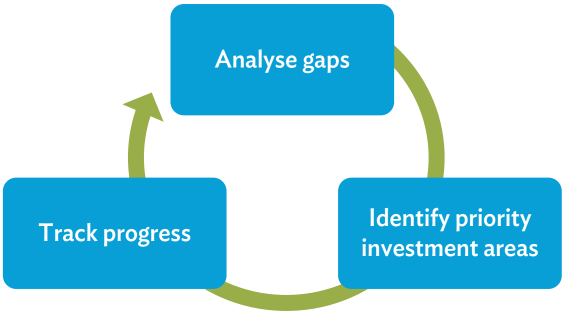
4.4 Operational Framework

This section presents the AIT operational framework that can be used to build a climate-resilient food system. This framework is broken down into the following three steps:

(i) analyse gaps in the policy currently being implemented;
(ii) identify priority investment areas (with the help of the strategy diagnoses [see Section 4.3]); and
(iii) track progress to ensure that the strategy being implemented is climate-resilient.

Repeating the AIT operational framework (see Figure 4.3) across different sectors and policies can help build a climate-resilient food system. Starting from the outer circle of Figure 4.2, which presents a climate-resilient food system, we can use the AIT framework to improve the climate sensitivity of the entire food system. In this chapter, we use this framework to assess the climate sensitivity of the ADS, identify priority investment areas for building a climate-resilient food system, and track the progress of the investments.

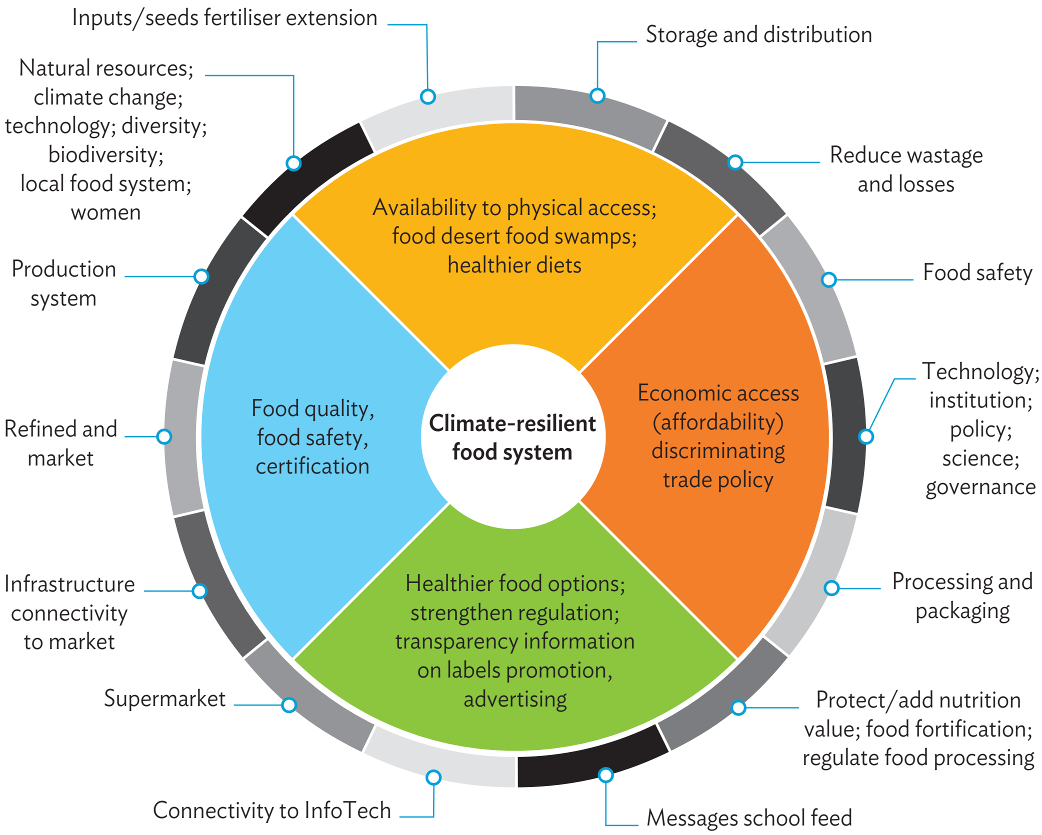
Figure 4.1: AIT Operational Framework



AIT = Analyse Gaps, Identify Priority Investment Areas, and Track Progress.

Source: Authors.

Figure 4.2: Food Systems Approach to Climate Resiliency



Source: Authors.

4.4.1 | Gap Analysis

Next, we consider the gaps that must be addressed to make ADS climate-resilient, based on the ADS diagnosis in Section 4.3 (for more information, see Annex 4.1). Despite an overall decrease in global poverty, Myanmar continues to suffer from high levels of poverty, hunger, and malnutrition. Based on the nutritional sensitivity review in the ADS, we highlight the steps that need to be adopted to promote a climate-resilient food system in Myanmar.

(i) To build a climate-resilient food system, specific policy and strategy goals resulting in climate-resilient agriculture need to be incorporated in all policy and strategy processes currently being implemented. This will involve further consultation and sensitisation amongst the stakeholders.

(ii) Furthermore, the outcomes of subsector policies should incorporate CCA into development planning. For example, to realise ADS outcomes such as improved crop production, inputs and technologies by crop growers could include the development and distribution of drought-resilient seeds and the regulation of fertiliser use for soil conservation.

(iii) Research on new technologies needs to be extended to include CCA and mitigation techniques. Also, research, extension, and education in agriculture need to be conceptualised in the context of more climate-resilient food systems. It is also necessary to improve the capacity to conduct research, as well as the flow of information amongst researchers, practioners, extension providers, and farmers.

(iv) Farmer land rights are currently vague and uncertain, hindering the implementation of long-term climate risk-mitigation measurements. There is also a lack of awareness regarding the impact of climate change on soil fertility.

(v) There is also a need to develop appropriate measures for water management and increase awareness of effective water systems to deal with diverse climate hazards such as droughts, cyclones, intense rain, floods, and saltwater intrusion.

(vi) To improve agricultural productivity and reduce risks due to climate change, it is necessary to adopt better crop production inputs through such activities as the promotion of soil demonstration and conversion techniques, more efficient fertiliser use, and the use of climate-resilient seeds.

4.4.1.1 Investment Priorities for Climate-Resilient Food Systems

This section identifies investment priorities for each outcome of the ADS to mainstream CCA for the implementation of the ADS. The investment priorities for each pillar under the ADS are summarised below, with detailed information available in Annex 4.2.

Governance

It is crucial to improve the governance and capacity of institutions responsible for agricultural development, and to strengthen capacity for advocacy, planning, and analysis across relevant ministries. The Government of Myanmar and the public sector play important roles in formulating policies, including the development of a comprehensive policy or strategy (such as the ADS). To build a climate-resilient food system, it is important to develop a multi-sectoral approach and recognise the need for combined actions across multiple sectors such as agriculture, education, and natural resource management. Moreover, it crucial to strengthen the capacity of local authorities, service providers, research institutions, and partners, especially investment in research on the risks associated with climate change. Linkages between CRM and agriculture, and climate-resilient practices should also be increased. Further, it is necessary to strengthen capacity for policy formulation and analysis relevant to CRM and agriculture, especially for MOALI (and Agriculture Policy Unit) staff. As there is currently no system to monitor and evaluate the impact of agricultural activities on climate change, investment is necessary to facilitate the collection and analysis of such data at the national and regional levels. Since not all regions are impacted in the same manner, this will help to develop region-specific strategies to mitigate the risks associated with climate change.

Productivity

To increase agricultural productivity and farmer incomes, it is important to invest in an agricultural research system especially focused on CRM, climate-resilient agricultural practices, and climate-resilient crop varieties. Further, transforming the agriculture extension systems (both public and private) can help mitigate the risks associated with climate change. Since awareness of the impacts of climate change on agriculture is limited amongst farmers, increasing this awareness through extension programmes is crucial. Moreover, boosting farmers' access to weather-related information (including early warning systems) can increase their resilience to climate change and disasters. There is a need for investment to increase the number of farmers with access to extension, and to include CRM in the current extension curricula and agriculture courses available at the university level. Finally, increased investment is needed in the development and distribution of climate-resilient crop varieties.

Competitiveness

To improve market linkages and competitiveness and to build a climate-resilient food system in Myanmar, it is crucial to transform the current agriculture extension system. For example, increased investment in rural infrastructure such as alternative power generation from renewable energy sources can decrease GHG emissions from the agricultural sector. Along with improving access to financial services for farmers and agribusiness enterprises, the number of agricultural insurance programmes for farmers should be expanded, resulting in fewer farmers being affected by climate change. Further, increasing investment in project intellectual property rights for climate-resilient seed varieties can boost research and development in this area, resulting in greater competitiveness amongst farmers.

4.4.1.2 Tracking System for a Nutrition-Sensitive Food System

After analysing gaps and identifying investment priority areas, it is essential to track the progress of these initiatives. Based on the priority investments mentioned above, the indicators that can be used to track the progress of these investments are summarised below (a complete list of indicators is in Annex 4.3).

Governance

In the drive to build a climate-resilient food system, improving government policy and strategy with a focus on CRM will result in effective and integrated planning at both the state and regional levels. Further, applying a multi-sector approach to policy advocacy, planning, and analysis with the aim of mainstreaming CCA into development planning across relevant ministries and sectors (i.e. agriculture, climate change, natural resource management, health, food safety, water and sanitation, education, and trade) will help build a climate-resilient food system. After investing to strengthen institutional capacity, it is important to track the number of integrated policies or strategies developed. The number of projects implemented by the MOALI on CRM and the agricultural sector should also be monitored periodically. There is currently no system to monitor and evaluate the impact of climate change on agricultural activities, and investment in this area should be followed by an increased number of periodic monitoring and evaluation reports on targeted CRM indicators by the Department of Planning, MOALI.

Productivity

Greater investment in agricultural research systems can directly boost agricultural productivity. To track the progress of such investments, it is necessary to monitor the increase in the number of researchers focusing on CRM. For example, research papers and documents regarding CRM and the agricultural sector can be used to evaluate progress made in agricultural research systems. To track the effectiveness of the education and training provided, the number of agricultural programmes that include the impact of climate change should be monitored. Finally, the number of farmers with access to information regarding climate-resilient practices and early warning climate data can be used to evaluate the effectiveness of the agriculture extension system.

Competitiveness

To improve market linkages, enhance competitiveness, and build a climate-resilient food system, it is essential to increase the number of on- and off-farm activities resulting in increased household income. A decrease in the number of farmers that depend on rain for agriculture can serve as an indicator of rural infrastructure development. Other such indicators include total irrigated area, number of water and distribution facilities (especially in high-risk areas), and decreased GHG emissions from the agricultural sector. Just as it is important to invest in increased access to agricultural insurance for farmers facing high risks due to climate change, monitoring the number of farmers with access to and using agricultural insurance is an important indicator of the success of such investment.

4.5 Conclusion

This chapter uses a food systems approach to understand different issues, challenges, and options with regard to mainstreaming climate change into development planning. First, we performed an extensive desk review to explain the country context and policy process, and identify key players. This information is valuable because it helps to identify policies and strategies related to climate change, as well as the actors responsible for implementing them. We then used a food systems approach to diagnose the ADS drafted by the MOALI to identify analytical needs, data requirements, and gaps that need to be addressed to meet the ADS outcomes. Next, we developed the AIT operation framework and applied it to the ADS by analysing the gaps that need to be addressed to make the ADS climate-resilient, identifying priority investment areas, and recommending a tracking system to monitor the progress of these investments. Replicating this framework across different sectors and policies will result in a climate-resilient food system. For example, this framework can be applied to such policies as the Myanmar Climate Change Strategy and Action Plan, Land Use Policy, and National Seed Law to ensure that these policies are climate-resilient. The framework developed here can be used for polices and strategies in different countries.

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Annex 4.1: Diagnosis for a Climate-Resilient Food System

Current Plans/ Evidence Needed	Analysis and Data for Effective Implementation of the Agriculture Development Strategy	Gaps
Pillar 1: Governance		
Outcome: Effective integrated planning based on participatory processes at both the union and state or regional levels		
• Integrate existing plans of different departments. • Establish targets and indicators that can be tracked and reported periodically.	• Data outcomes of existing programme and policies focusing on CRMs • Indicators, baselines and target of ADS impacts relevant to CRM	• Lack of policy integration in existing CRM plans and programmes (e.g. the MCCSAP 2016–2030 and MAPDRR 2017) • No indicators or targets suggested regarding climate change measurements (adaptation and mitigation)
Outcome: Improved capacity for policy formulation and analysis		
• Review existing CRM policies and programmes. • Commission policy studies. • Conduct regular independent policy reviews.	• Understanding of the linkage between agriculture and CRM • Policy studies focusing on the linkage between agriculture and CRM • Independent review of policies related to CRM	• Lack of policy integration in existing CRM plans and programmes (e.g. the MCCSAP 2016–2030 and MAPDRR 2017) • Lack of understanding of the linkage between agriculture and CRM
Outcome: Timely and effective monitoring and evaluation process		
• Strengthen the capacity of monitoring and evaluation units at the union. • Establish an appropriate methodology and system to carry out systematic ADS monitoring and evaluation.	• Implementation plan involved with the monitoring and evaluation of CRM outcomes in the agriculture sector • Indicators, baseline, and targets of ADS impacts relevant to CRM	• No standardised procedure to collect data in a reliable and timely way • No indicators or targets suggested regarding CRM
Outcome: Sound statistical systems for evidence-based decisions		
• Conduct an agriculture, livestock, and fisheries census. • Improve current system of collecting agricultural statistics using information and communications technology. • Conduct annual surveys on key issues identified by policy division.	• Collect data beyond production, especially related to the effects of climate change on the agriculture, livestock, and fisheries sectors. • Statistic data about the current situation and the readiness or awareness of rural households regarding climate change risk in the census and annual survey	• No standard procedure to collect and confirm data in a reliable and timely manner • No clear procedure to collect household-level data focusing on CRM

continued next page

Annex 4.1: *Continued*

Current Plans/ Evidence Needed	Analysis and Data for Effective Implementation of the Agriculture Development Strategy	Gaps
Outcome: Strong farmer and industry association and federation		
• Promote the formation of farmer associations and their federations to empower farmers in marketing and resource use as well as boost engagement on government policy and regulatory issues. • Conduct annual meetings of the MOALI with farmer organisations at the state or regional and union levels.	• Climate adaptation issues raised to empower farmer associations, especially in the case of communities in at-risk regions (e.g. deltas, coastal areas, and the Central Dry Zone) • Include discussions about CRM in the agricultural sector in the annual meeting of the MOALI and farmer organisation.	• Lack of communication focusing on CRM between governments, farmer associations, and the private sector
Outcome: Strengthened farmers' land rights and enhanced capacity of institutions involved in agricultural land		
• Remove restrictions that condition securing tenure through land titling over land held by smallholders. • Secure the holding and use of agricultural land of smallholders once these have been titled. • Prioritise the enforcement of the Vacant, Fallow, and Virgin Land Law. • Develop an agro-ecological zoning system for the country based on the principle of global agro-ecological zones. • Clarify land use rights by livestock farmers, fishers, and crop farmers, and establish clear rules for the use and management of grazing land.	• (Sound and clear) land tenure arrangement with climate change-mitigation instruments • Regulation and monitoring system for appropriate land use to prevent deforestation, encroachment, soil erosion, and reduction of the 'carbon sink' effect • Agro-ecological measurements with diverse inputs and conditions for resilience to climate change	• Vague and uncertain land rights system hinders the implementation of long-term climate risk mitigation measurements. • Lack of awareness of the impact of climate change on land use • Limited capacity of research and data analysis • Discordance between the CRM measurements and agriculture expansion
Outcome: MOALI capacity for ADS coordination and implementation enhanced and guided by MOALI professional expertise and democratically appointed, gender-equitable civil society representatives		
• Establish a coordination unit for the implementation of the ADS under the Department of Planning.	• Better understanding of the linkage between agriculture and CRM for staff working in the new coordination unit	• Limited understanding of the linkage between agriculture and CRM amongst MOALI staff

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Annex 4.1: *Continued*

Current Plans/ Evidence Needed	Analysis and Data for Effective Implementation of the Agriculture Development Strategy	Gaps
Outcome: Improved food and nutritional security for the most disadvantaged groups		
• Coordinate with ongoing food and nutritional security and multi-sector initiatives on nutrition and poverty alleviation.	• Identify multi-sector approaches to tackle food and nutritional insecurity issues caused by climate change, especially in the case of at-risk regions (e.g. deltas, coastal areas, and the Central Dry Zone).	• Improve coordination and promote multi-sector initiatives on food and nutritional security and poverty alleviation.
Outcome: The MOALI restructured to integrate existing units better and become more responsive to farmers, enterprises, and civil society		
• Evaluate alternative options for MOALI restructuring.	• Better understanding of the linkage between agriculture and CRM throughout the MOALI	• Limited understanding of the linkage between agriculture and CRM
Pillar 2: Productivity		
Outcome: Improved agricultural research system for crops, livestock, and fisheries; and improved research-extension coordination systems with the participation of farmers and the private sector		
• Establish a National Agricultural Research Council to coordinate and provide overall guidance to research and establish the Myanmar Academy of Agriculture, Livestock, and Fisheries services to carry out policy affairs for the research council. • Develop a research master plan to establish research priorities and research programme.	• Research activities contribute to promote climate-resilient species and climate-smart agricultural practices. • Include CRM and its linkage to the agricultural sector in research priorities.	• More investment in human resources development for research in CRM and the agricultural sector • Budget allocation for CRM and agricultural research • Strategic emphasis on research about the climate risk adaptation and mitigation measures in the agricultural sector
Outcome: Transformed public–private agricultural extension system delivering improved products (crops, livestock, fisheries) and technology for adoption and adaptation, better linked to agricultural research		
• Review extension systems and formulate a national extension policy and strategy encompassing the functional mandate of the MOALI. • Provide training and mobility and connectivity amenities to build and strengthen the capacity of agricultural, livestock, and fisheries extension services, institutions, and staff.	• Include the impact of CRM on the agricultural sector in the extension policy and strategy. • Include content about CRM measurements in the extension programme to promote awareness and the adaptation capacity of at-risk farmers and stakeholders	• Lack of CRM-relevant contents in the extension programme • More investment in human resource development for proper extension services relating to CRM and the agricultural sector

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Annex 4.1: ***Continued***

Current Plans/ Evidence Needed	Analysis and Data for Effective Implementation of the Agriculture Development Strategy	Gaps
• Strengthen the capacity of field extension staff. • Increase the number and capacity of subject matter specialists in those areas of greater interests to farmers. • Establish an information and knowledge system to provide advisory services to farmers.	• Capacity building programme for human resources (extension service staff, subject matter specialists, etc.) especially regarding CRM measurements	• Specific focus on the vulnerable, landless, women, and marginalised groups in climate-sensitive geographic areas
Outcome: Develop (or revive) effective education and training to build 'human capital' in the agricultural and food sector responding to the evolving needs of farmers and the private sector in rural areas		
• Upgrade the current Yezin Agriculture University campuses into a single consolidated university. • Establish or upgrade sectorial disciplines in Yezin and other universities. • Upgrade the 3-year diploma curricula of the state agricultural institutes in all states and regions.	• Include CRM content in university courses.	• Strengthen policy, institutional, and human capacity for CRM-sensitive agricultural interventions. • Emphasise the impact of climate risk on the agricultural sector. • Lack of CRM contents in higher education courses • Ensure that training curricula reaches all levels and covers critical and urgent issues regarding CRM.
Outcome: More responsive and reliable irrigation and drainage services, and more efficient and sustainable water management systems		
• Develop appropriate measures for water management in rainfed agriculture. • Establish a programme on groundwater development.	• Effective water management system dealing with diverse climate hazards (e.g. droughts, cyclones, intense rain, floods and storm surges, high temperatures, and saltwater intrusion)	• Lack of climate-resilient measures and technologies to manage climate hazards • Limited irrigation and water management systems with heavy dependency on rainfed agricultural production, which is not sustainable • Consideration of the sustainable use of groundwater to prevent saltwater intrusion

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Annex 4.1: *Continued*

Current Plans/ Evidence Needed	Analysis and Data for Effective Implementation of the Agriculture Development Strategy	Gaps
Outcome: Increased use of improved crop production inputs and technologies by crop growers		
• Build the capacity of seed research stations to produce breeder and foundation seeds. • Develop and implement a biodiversity policy and varietal conservation programme. • Implement measures to improve productivity and fertiliser use efficiency, including the promotion and demonstration of soil conservation techniques. • Develop and promote integrated pest management and bio-control of weeds.	• Develop and distribute climate-resilient (stress-resistant) crop seeds and adjust the cropping system. • Regulate fertiliser use for soil conservation and carbon sequestration. • Plant disease management system focused on climate change risk	• Lack of research and technological capacity • Accessibility and distribution of existing and forthcoming CRM measures • Limited understanding of the linkage between crop production and CRM • Discordance between the CRM measurements and agriculture expansion
Outcome: Increased application of appropriate mechanisation in the agricultural value chain		
Outcome: Increased use of improved animal and fish breeding, health, and husbandry services and technologies by livestock producers		
• Establish contingency planning and financing for emerging animal disease threats. • Establish an identification, inventory, and fishery resource for the conservation of adaptable fish species.	• Animal disease management system focused on climate change risk • Research the transformation of the ecosystem (both the livestock and fishery sectors) caused by climate change impacts (e.g. rising ocean temperatures, high temperatures, droughts, and floods). • Identify measurements to minimise methane emissions and deforestation caused by the livestock industry.	• Lack of research and technological capacity • Accessibility and distribution of existing and forthcoming CRM measures • Limited understanding of the linkage between the livestock and fishery sectors, and CRM • Discordance between the CRM measurements and agriculture expansion
Outcome: Establishing and adopting sustainable farming, GAP, good animal husbandry practices, good aquaculture practices, and organic agriculture practices		
• Coordinate, formulate, elaborate, document, and promote concepts, principles, guidelines, laws, regulations, and protocols for GAP, good animal husbandry practices, and organic agriculture. • Increase the production, value-addition, sale, and consumption of GAP and organic agriculture products.	• GAP in real practice (e.g. hybrid rice production technology, including a modified system of rice intensification, and alternate wetting and drying irrigation techniques)	• Incentivise and motivate farmers and stakeholders to apply GAP as adaptive farming practices.

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Annex 4.1: *Continued*

Current Plans/ Evidence Needed	Analysis and Data for Effective Implementation of the Agriculture Development Strategy	Gaps
Outcome: Improved resilience of farmers to climate change and disasters		
• Conduct research on stress-tolerant varieties and breeds of crops, livestock, and fish to develop climate-resilient agriculture that has higher yields. • Establish an early warning system and adopt early warning information for managing climate change risks. • Establish a climate information and weather indexation system designed to provide information to farmers. • Strengthen the seed and fodder reserve system to cope with natural disasters. • Improve the capacity of extension staff and farmers in climate-smart agricultural practices. • Implement a programme to in-build mitigation factors and resilience of livestock farmers to climate change. • Increase the use of climate-smart and conservation-oriented livestock utilisation practices and conservation farming. • Establish a fund for preparedness and response to droughts, flood, epidemics, and emergencies. • Carry out community-based disaster risk management capacity building.	• Develop and distribute climate-resilient (stress-resistant) crops, livestock, and fisheries. • Farmers' access to and awareness of climate information (including early warning systems and capacity-building programmes) • Policy countermeasures for climate change risks and negative impacts on agriculture	• Lack of research and technological capacity • Limited understanding about the importance of climate-resilient measures • Incentivise and motivate farmers and stakeholders to apply climate-resilient practices (i.e. climate-smart agriculture). • Lack of access and mobility of farmers with respect to CRM programmes and services

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Annex 4.1: *Continued*

Current Plans/ Evidence Needed	Analysis and Data for Effective Implementation of the Agriculture Development Strategy	Gaps
Pillar 3: Competitiveness		
Outcome: Improved business environment, information, and investment along the agri-food supply chain		
• Design and implement an investment promotion strategy for the agricultural and food sector. • Help strengthen the capacity of the Myanmar Investment Commission to expedite investment applications in the agriculture sector while effectively accounting for environmental and social impact analysis.	• CRM investment to strengthen the agricultural environment	• Attract more investment in a climate-resilient agro-environment • Coordinate CRM measures with national decision-making tools, including environmental and social impact analysis. • Promote climate-resilient diversification of rural livelihoods with more on- or off-farm income-generating opportunities.
Outcome: Protected intellectual property rights for the agricultural and food sectors		
• Develop, approve, and implement a Plant Variety Protection Law.	• Develop and distribute climate-resilient (stress-resistant) crop and energy crop varieties. • Develop and distribute CSA technology.	• Incentivise and promote the research and development of new climate-resilient crop and CSA technology. • Support farmers with the appropriate access to the intellectual property rights needed to deploy CSA technology.
Outcome: Development of a reliable quality system that helps farmers and food processors get higher prices for higher quality goods, incentivising quality upgrading **Outcome:** Institutionalisation of an enhanced framework for gender-equitable and participatory planning and implementation of rural development programmes		
• Implement a village-level community development initiative. • Build community capacity in the preparation and drafting of action plan projects.	• Adaptation and mitigation measures for CRM in the community development initiative or action plan	• Limited understanding of the importance of climate-resilient measures • Lack of access and mobility of farmers with respect to CRM programmes and services • Specific focus on the vulnerable, landless, women, and marginalised groups in climate-sensitive geographic areas

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Annex 4.1: ***Continued***

Current Plans/ Evidence Needed	Analysis and Data for Effective Implementation of the Agriculture Development Strategy	Gaps
Outcome: Improved rural infrastructure to boost the efficiency and profitability of smallholder agriculture		
• Promote renewable energies (e.g. mini-hydro, solar, biomass, and biogas). • Construct rural water supply infrastructure.	• A secured and efficient power-generation system considering the high potential of renewable energy sources and shorter return periods of climate hazards • Effective water management system dealing with diverse climate hazards	• Capacity building for inclusive, sustainable, and resilient renewable energy systems that take climate change into consideration • Lack of climate-resilient measures and technologies to manage climate hazards • Limited irrigation and water management systems that are heavily dependent on rainfed agricultural production, which is not sustainable
Outcome: Increased competitiveness and stakeholder participation in agricultural value chains engaged with prioritised commodities		
• Train trainers on climate-friendly agribusiness value chains.	• Capacity building programme for human resources, especially focused on CRM measurements	• Promote a training programme related to climate-resilient measurements and practices that can be adopted for the agricultural value chain.
Outcome: Enhanced food quality and safety **Outcome:** Improved access to a range of financial services for farmers and agribusiness enterprises		
• Explore options for financially and economically sustainable agricultural insurance and develop policies, laws, and regulations as appropriate.	• A financially sound and affordable agricultural insurance programme for farmers at risk of climate change	• Encourage in-depth consideration and research to formulate an insurance programme that is universally available and flexible to the diverse hazards of climate change.
Outcome: Trade-facilitated growth of agri-food and agricultural product exports		
	• Carbon emission-efficient trade facilitation	• Consider the carbon footprint of the trade of agricultural products.

CRM = climate risk management; CSA = climate-smart agriculture; GAP = good agriculture practice; MAPDRR = Myanmar Action Plan on Disaster Risk Reduction; MCCSAP = Myanmar National Climate Change Policy, Strategy and Action Plan; MOALI = Ministry of Agriculture, Livestock and Irrigation.

Source: Authors.

Annex 4.2: Investment Priorities for a Climate-Resilient Food System

Outcomes	Investment Priorities
Pillar 1: Improved governance	
Effective integrated planning based on participatory processes at both the union and state or regional levels.	• Existence of indicators, baselines, and targets of ADS impacts relevant to CRM
Improved capacity for policy formulation and analysis	• Increased investment in policy studies and review, focusing on the linkage between agriculture and CRM • Number of capacity-building programmes regarding policy formulation and analysis relevant to the linkage between agriculture and CRM • Number of MOALI (and Agriculture Policy Unit) staff members participating in the CRM capacity-building programme
Timely and effective monitoring and evaluation processes	• Existence of implementation plan for monitoring and evaluating CRM outcomes in the agricultural sector • Existence of indicators, baselines, and targets of ADS impacts relevant to CRM
Sound statistical systems for making evidence-based decisions	• Proportion of sustainable development indicators produced at the national level with full disaggregation when relevant to the target, in accordance with the Fundamental Principles of Official Statistics (SDGs indicator) • Monetary value of all resources made available to strengthen statistical capacity in Myanmar (SDGs indicator) • Collection of data especially related to the effects of climate change on the agriculture, livestock, and fisheries sectors • Disaggregation level of statistic information, which can track the climate vulnerability of at-risk regions
Strong farmer and industry associations and federations	• Creation of Unit of Farmer Organizations Affairs • Number of annual meetings of the MOALI with farmer organisations addressing CRM issues
Strengthened farmers' land rights and enhanced capacity of institutions involved in agricultural land	• Number of laws and regulations created or amended to arrange land tenure with climate change adaptation and mitigation instruments (i.e. improved land inventory and land-use regulation in at-risk areas) • Existence of a monitoring system to investigate the effect of climate change on soil condition (i.e. deforestation, encroachment, soil erosion, and the reduction of the 'carbon sink' effect) • Expenditures (monetary and in-kind) on capacity building and land rights-protection activities (especially in at-risk regions) • Input data collected for the analysis of climate change effects on the agricultural sector while developing agro-ecological zoning

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Annex 4.2: *Continued*

Outcomes	Investment Priorities
MOALI capacity for ADS coordination and implementation enhanced and guided by MOALI professional expertise and democratically appointed, gender-equitable civil society representatives	• Amount of budget committed to public–private and civil society partnerships (SDGs indicator, especially focused on CRM and the agricultural sector) • Communication about the strengthening of institutional, systemic, and individual capacity-building to implement adaptation, mitigation, technology transfer, and development actions (SDGs indicator) • Establishment of coordination unit for the implementation of the ADS under the Department of Planning • Capacity-building and technical assistance programme for staff members of the unit to promote better understanding of the linkage between agriculture and CRM
Improved food and nutritional security for the most disadvantaged groups	• Number of food and nutrition policy measures applied to vulnerable groups at risk of climate change • Proportion of people at risk of climate change, amongst the beneficiaries of the food and nutrition policy measures (e.g. food for work programme, food or input vouchers, and income support)
The MOALI restructured to integrate existing units better and become more responsive to farmers, enterprises, and civil society	• Institutional alternatives that can promote a climate-resilient agricultural environment and improve the capacity of staff members regarding CRM and the agricultural sector
Pillar 2: Productivity	
Improved agricultural research system for crops, livestock, and fisheries	• Research and development expenditure as a proportion of gross domestic product (SDGs indicator, focused on CRM and the agricultural sector) • Amount of international support on research and development for sustainable consumption and production and environmentally sound technologies (SDGs indicator, focused on CRM and the agricultural sector) • Researcher per one million inhabitants (SDGs indicator, focused on CRM and the agricultural sector) • Increased investment for CRM in the agricultural research system • Increased investment for research focusing on climate-resilient species and climate-smart agriculture practices • Number of CRM research programmes prioritised in research master plans

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Annex 4.2: *Continued*

Outcomes	Investment Priorities
Transformed public–private agricultural extension system delivering improved products (crops, livestock, fisheries) and technology for adoption and adaptation, better linked to agricultural research	• Number of farmers with access to extension • Number of extension materials containing CRM materials • Number of capacity-building programmes for human resources in the extension sector (e.g. extension service staff and subject matter specialists), especially regarding CRM measurements in the agricultural sector • Proportion of vulnerable, landless, women, and marginalised groups in climate-sensitive regions amongst the beneficiaries of the extension programme • Increase in the adoption of extension techniques by farmers to improve their climate resilience
Developed (or revived) effective education and training to build 'human capital' in the agricultural and food sector responding to the evolving needs of farmers and the private sector in rural areas	• Integration of mitigation, adaptation, impact reduction, and early warning into primary, secondary, and tertiary curricula (SDGs indicator) • Number of agriculture courses with CRM contents and vice-versa • Number of students who take agriculture courses with CRM contents and vice-versa
More efficient and sustainable irrigation and water-use systems	• Increased investment in studies and policy measures related to climate-resilient water management systems • Number and coverage of agriculture extension and advisory services regarding water resource management (especially in at-risk regions) • Increase in the number of extension workers providing knowledge of water management practices with CRM measures • Implementation of environmental impact analyses for irrigation projects • Establishment and activation of the irrigation management policy and water user associations at the regional level for countermeasures of diverse climate hazards (especially in at-risk regions)
Increased use of improved crop production inputs and technologies by crop growers	• Increased investment in studies and policy measures for climate-resilient crop production systems • Data collected for the plant disease management system focused on climate change effects • Increase in the number and coverage of agriculture extension and advisory services regarding climate-resilient crop production (especially in at-risk regions) • Increase in the number of extension workers providing knowledge of crop-production practices with CRM measures • Number of regulations on fertiliser use to conserve soil fertility • Annual soil testing introduced to provide farmers with accurate information regarding fertiliser use

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Annex 4.2: ***Continued***

Outcomes	Investment Priorities
Increased application of appropriate mechanisation in the agricultural value chain	
Increased use of improved animal and fish breeding, health, and husbandry services and technologies by livestock producer industries using sustainable practices	• Increased investment in studies and policy measures for ecosystems transformed by climate change, and climate-resilient animal and fish breeding, health, and husbandry services • Data collected about emerging animal disease threats focused on climate change effects • Number and coverage of agriculture extension and advisory services regarding climate-resilient livestock and fishery production (especially in at-risk regions) • Increase in the number of extension workers providing animal and fish breeding services with CRM measures • Number of policy measures to control environmental influences of the livestock industry (e.g. methane emissions and deforestation)
Sustainable farming, good agricultural practices, and good veterinary husbandry practices established and adopted	• Number of good agricultural practices and good veterinary husbandry practices with the implementation of CRM
Resilience of farmers to climate change and disasters improved	• Increased investment in the development and distribution of climate-resilient species (crops, livestock, and fisheries) • Increase in the number of farmers with access to weather-related information (including an early warning system and capacity-building programme) • Number and coverage of early warning dissemination outlets for climate hazards (by type of outlet) • Number of policy countermeasures for the negative impact of climate risks toward the agricultural sector • Increase in CSA practices and techniques
Pillar 3: Competitiveness	
Improved business environment, information, and investment along the agri-food supply chain	• Increased investment towards a climate-resilient agriculture environment • Implementation of environmental impact analyses as the primary national decision-making tool • Number of measures promoting the diversification of income-generating opportunities in rural areas (especially in at-risk regions)
Protected intellectual property rights for the agricultural and food sectors	• Number of intellectual property rights protected by national laws especially related to CRM (e.g. climate-resilient crop and energy crop varieties, and CSA technology)

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Annex 4.2: ***Continued***

Outcomes	Investment Priorities
Development of a reliable quality system that helps farmers and food processors get higher prices for higher quality goods, incentivising quality upgrading	
Institutionalisation of an enhanced framework for gender-equitable and participatory planning and implementation of rural development programmes	• Number of regional communities who own adaptation and mitigation measures for CRM in the community development initiative of action plans (especially in at-risk regions)
Improved rural infrastructure boosts the efficiency and profitability of smallholder agriculture	• Increased investment in alternative power generation with renewable energy sources considering shorter return periods for climate hazards • Increased investment in an effective and climate-resilient water management system, including rural water supply infrastructure
Increased competitiveness and stakeholder participation in agricultural value chains engaged with prioritised commodities	• Number of capacity-building (training of trainers) programmes on CRM measurements
Enhanced food quality and safety	
Improved access to a range of financial services for farmers and agribusiness enterprises	• Number and coverage of agricultural insurance programmes for farmers at risk of climate change
Trade-facilitated growth of agri-food and agricultural product exports	• Policy measures to promote carbon emission-efficient trade of agricultural products

CRM = climate risk management; CSA = climate-smart agriculture; MOALI = Ministry of Agriculture, Livestock and Irrigation; SDG = Sustainable Development Goal.

Source: Authors.

Annex 4.3: Tracking System for a Climate-Resilient Food System

Outcomes	Impact Indicators
Pillar 1: Improved governance	
Effective integrated planning based on participatory processes at both the union and state or regional levels	• Establish or operationalise an integrated policy, strategy, or plan that increases farmers' ability to adapt to the adverse impacts of climate change, fosters climate resilience, and lowers greenhouse gas emissions in a manner that does not threaten food production (SDGs indicator) • Proportion of local governments that adopt and implement local DRR strategies in line with national DRR strategies (SDGs indicator) • Adopt and implement national DRR strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030 (SDGs indicator) • Number of clauses or articles in the ADS that mention CRM plans and programmes • Regular and periodic tracking of the targeted CRM-relevant indicators
Improved capacity for policy formulation and analysis	• Establish or operationalise an integrated policy, strategy, or plan that increases their ability to adapt to the adverse impacts of climate change, fosters climate resilience, and lowers greenhouse gas emissions in a manner that does not threaten food production (SDGs indicator) • Number of clauses or articles in ADS that mention CRM plans and programmes • Number of policy studies and independent policy reviews regarding the linkage between agriculture and CRM • Number of MOALI (and Agriculture Policy Unit) staff who self-evaluate that they better understand the linkage between agriculture and CRM through the capacity-building programme
Timely and effective monitoring and evaluation processes	• Number and frequency of periodic monitoring and evaluation reports by the Department of Planning with targeted CRM-relevant indicators
Sound statistical systems for making evidence-based decisions	• Frequency of statistical data updates with CRM contents in the agricultural sector (census and annual surveys) • Number of statistic data collected with regard to CRM and agriculture
Strong farmer and industry associations and federations	• Number of farmer organisations with a common strategy or countermeasure toward the impact of CRM on the agriculture sector (especially in at-risk regions)
Strengthened land rights for farmers and enhanced capacity of institutions involved in agricultural land	• Proportion of the adult population with secure tenure rights to land, with legally recognised documentation, and who perceive their land rights as secure, by gender and by type of tenure (SDGs indicator, especially in at-risk regions) • Changed proportion of national land use • Rate of forest reduction (deforestation index) • Rate of illegal logging and encroachment for agricultural purposes • Rate of soil erosion • Number of analysis outcomes from agro-ecological zoning programmes that can be applied to climate resilience for agricultural production in at-risk regions

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Annex 4.3: ***Continued***

Outcomes	Impact Indicators
MOALI capacity for ADS coordination and implementation enhanced and guided by MOALI professional expertise and democratically appointed, gender-equitable civil society representatives	• Number of projects in the MOALI conducted based on the partnership with civil society or the private sector in CRM and the agricultural sector • Number of staff members who self-evaluate that they better understand the linkage between agriculture and CRM through the capacity-building and technical assistance programme
Improved food and nutritional security for the most disadvantaged groups	• Prevalence of undernourishment (SDGs indicator, especially in at-risk regions) • Prevalence of moderate or severe food insecurity in the population (SDGs indicator, especially in at-risk regions) • Prevalence of stunting amongst children younger than 5 (SDGs indicator, especially in at-risk regions) • Prevalence of malnutrition amongst children younger than 5 (SDGs indicator, especially in at-risk regions)
The MOALI restructured to integrate existing units better and become more responsive to farmers, enterprises, and civil society.	• Number of staff members who self-evaluate that they better understand the linkage between agriculture and CRM with institutional alternatives

ADS = Agriculture Development Strategy; CRM = climate risk management; DRR = disaster risk reduction; MOALI = Ministry of Agriculture, Livestock and Irrigation; SDG = Sustainable Development Goal.

Source: Authors.

CHAPTER 5

Financing Adaptation Roadmap

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ABSTRACT

This chapter discusses the financing of disaster risk management and climate change. Natural disasters and climate change will bring huge costs for the countries in Southeast Asia, and these costs are estimated to increase over time. Domestic finance, both public and private, will be a core source of funding to cover such costs, and several financial instruments, including innovative finance mechanisms, should be considered. Thus, the domestic financial market must be improved and a risk-sharing system developed to manage finance and risks. Therefore, this part proposes a step-by-step approach to make finance and innovative finance mechanisms available in the region. To facilitate this approach, two policy recommendations are proposed.

5.1 Introduction

Asia and the Pacific is considered one of the most vulnerable areas in the world in terms of climate change and natural disasters. Over the past decade, the region has been struck by several extreme natural disasters that produced many victims and damaged a wide range of assets, and the area is still dealing with these recent impacts. Disasters also continue to threaten the region's growth. A study by the Asian Development Bank (ADB) and International Food Policy Research Institute (2009) forecasted that climate change will lead to a 15% decrease in irrigated rice yields in developing countries and a 12% increase in the price of rice by 2050. In response to these challenges, member countries of the Association of Southeast Asian Nations (ASEAN) established their own roadmap to address climate change and the increasing incidence of severe disasters. Further, at the regional level, ASEAN has designed several policies to reduce the region's disaster losses, secure food production, and in turn, protect the development gains that have been attained.

In 2005, the ASEAN Agreement on Disaster Management and Emergency Response was signed. The objective of this agreement is 'to provide effective mechanisms to achieve substantial reduction of disaster losses in lives and in the social, economic and environmental assets of the Parties, and to jointly respond to disaster emergencies through concerted national efforts and intensified regional and international co-operation' (ASEAN Secretariat, 2005). In 2011, the ASEAN member countries adopted the ASEAN Roadmap for Disaster Risk Financing and Insurance (ASEAN Secretariat, 2011), and created a regional disaster risk financing and insurance programme (ASEAN, 2017) to implement the roadmap.

At the international level, several important agreements were adopted in 2015, including the Sendai Framework for Disaster Risk Reduction 2015–2030, the Addis Ababa Action Agenda, the 2030 Agenda for Sustainable Development, and the Paris Agreement. These agreements reflect long-term objectives to secure lives and livelihoods in sustainable manner. ASEAN member countries, along with other countries, support these agreements and are now preparing their own roadmaps to achieve the goals therein.

All of these agreements recognise the importance of mobilising resources to take the necessary actions. The outcome document of the Third United Nations (UN) World Conference on Disaster Risk Reduction highlights 'Investing in disaster risk reduction for resilience' as one of four priorities for action, and describes expected actions at the national and local levels as well as at the global and regional levels (UN, 2015a: paras. 30–31).

Further, the agreement at the Third International Conference on Financing for Development noted the following:

> *Shocks from financial and economic crises, conflict, natural disasters and disease outbreaks spread rapidly in our highly interconnected world. Environmental degradation, climate change and other environmental risks threaten to undermine past successes and future prospects. We need to ensure that our development efforts enhance resilience in the face of these threats… We encourage consideration of climate and disaster resilience in development financing to ensure the sustainability of development results. We recognize that well-designed actions can produce multiple local and global benefits, including those related to climate change. We commit to investing in efforts to strengthen the capacity of national and local actors to manage and finance disaster risk, as part of national sustainable development strategies, and to ensure that countries can draw on international assistance when needed.* (UN, 2015b: paras. 4, 62)

Thus, investment and finance are recognised as key tools to achieve these agreements. For ASEAN member countries implementing their own roadmaps, investment and finance are crucial considerations. It is therefore necessary to determine how much funding is needed for climate change adaptation (CCA) and disaster risk reduction (DRR) in ASEAN, and how to manage any funding gaps. This chapter discusses some thoughts on financing the implementation of roadmaps in ASEAN member countries. To this end, we discuss the following questions:

(i) What is the estimated cost of CCA and DRR?
(ii) What sort of financial sources and schemes will be used for CCA and disaster risk management (DRM)?
(iii) How will both short- and long-term funding gaps be managed?
(iv) What is the ideal strategy for local adaptation and DRR in the fiscal and financial sector in the ASEAN region?

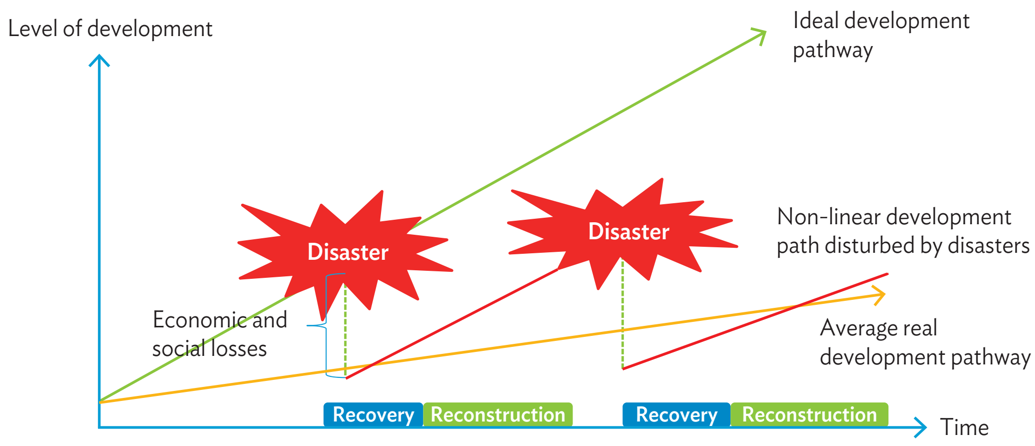
5.2 Cost of Climate Change and Disasters

5.2.1 | Damage Caused by Natural Disasters and Climate Change

Disasters are typically barriers to development. In principle, the main purpose of development is to improve people's quality of life. To achieve this goal, policymakers try to design the best development pathway in the context of each country. Such an ideal development pathway may be achievable if, and only if, no external shock occurs. Development efforts are easily disturbed by unexpected external shocks, such as natural disasters.

Figure 5.1 compares a development pathway with and without external shocks such as disasters. When a disaster occurs, many assets and much capital will be lost, and many economic and social activities will be disturbed. In addition, due to the loss of assets as well as business and social opportunities, a country's development may derail from the ideal pathway. If the impact of the external shock is limited and manageable within the country's capacity, it may be easy for the country to resume the derailed development pathway. However, if the impact of the external shock is too large and the country is unable to manage it, the country will incur huge costs and face a long recovery period, making it hard to return to the ideal development path. Developing countries in particular have limited capacity to manage the risk of large external shocks.

Figure 5.1: Development Path Disturbed by Disasters



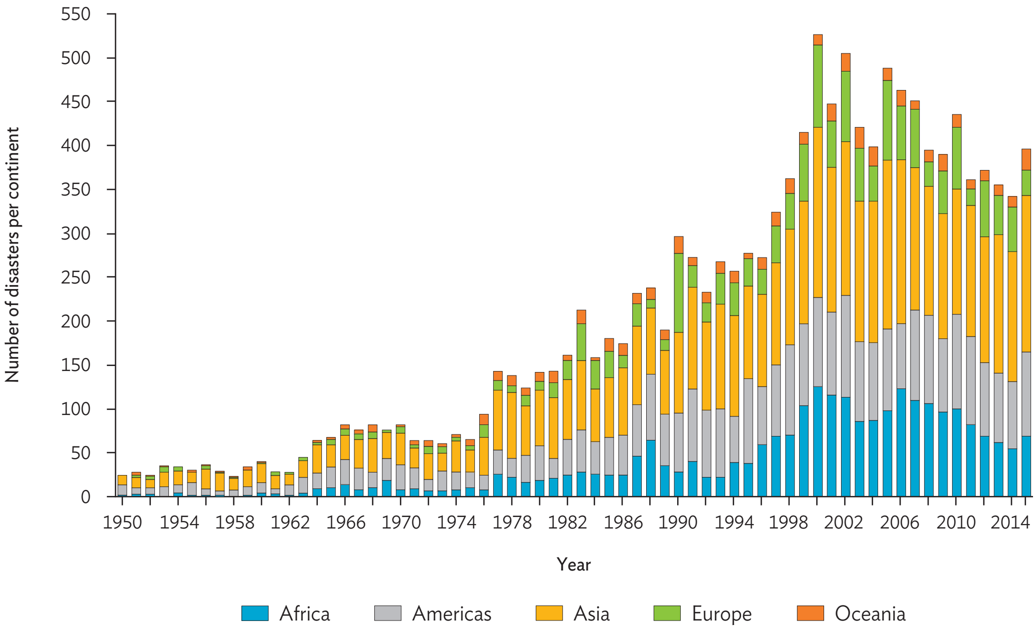
Source: Author.

Furthermore, the number of disasters is increasing. According to data from the Emergency Events Database, the number of disasters has increased exponentially since 1950, and has almost quadrupled since the early 1970s (Figure 5.2). Moreover, the scale of these disasters has also been increasing, inflicting ever greater losses and damage. Of the total number of disasters that have happened each year, around 40% occurred in Asia and the Pacific.

In 2011, Thailand was affected by a large flood. According to the World Bank and the Government of Thailand (2012), the total damage and losses amounted to B1.43 trillion (approximately $46.5 billion), more than 13% of that year's gross domestic product (GDP). The floods were estimated to have reduced real GDP growth in 2011 by 1.1% from pre-flood projections, reduced Thailand's current account from a projected $20.6 billion to $11.9 billion, and caused a 3.7% loss in tax revenue from estimated pre-flood revenues.

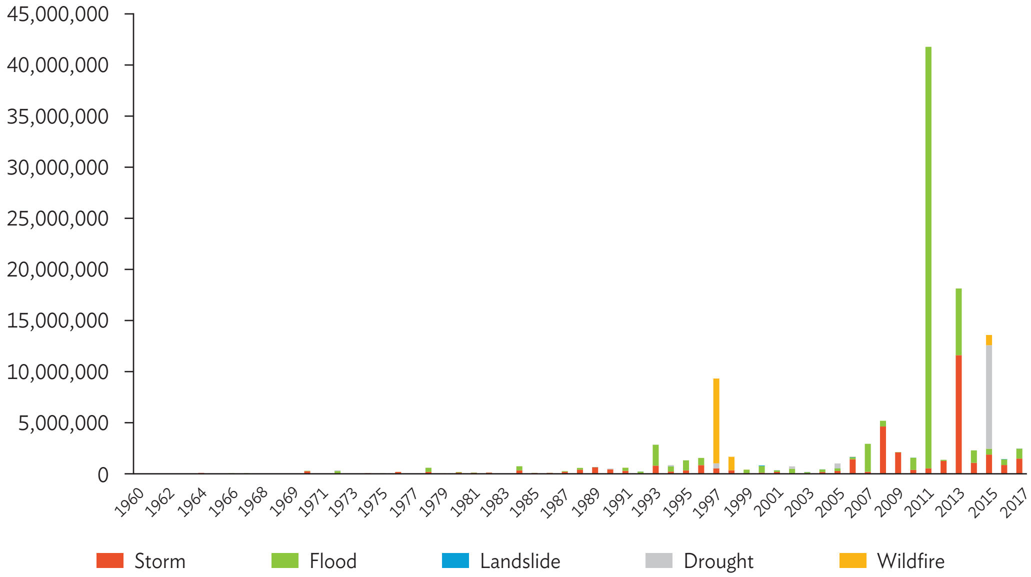
Figure 5.3 shows the economic damage caused by weather-related disasters in Asia. A comparison of the damages reported in Figure 5.2 reveals that economic damage caused by weather-related disasters has been gradually increasing since 2000.

Figure 5.2: Number of Disasters by Region (1950–2015)



Source: Centre for Research on the Epidemiology of Disasters (2019), Emergency Events Database. www.emdat.be (accessed 10 February 2019).

Figure 5.3: Total Damage from Weather-Related Disasters in Asia ($'000)

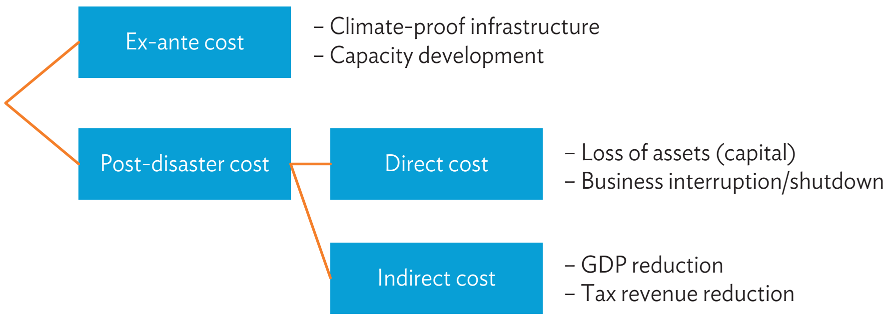


Source: Centre for Research on the Epidemiology of Disasters (2019), Emergency Events Database. www.emdat.be (accessed 10 February 2019).

There are two main reasons for this. First, the strength and frequency of natural disasters have been increasing. When a severe natural disaster hits, it damages many physical assets. Although most of these assets have been designed based on historical disaster data, they are still easily damaged as a result of unexpected changes in phenomena and in the severity of disasters. Second, the number of physical assets has increased due to economic growth, which has led to the increased accumulation of capital. When the number of physical assets increases, the probability of damage and amount of physical assets liable to damage also increase. If such newly developed physical assets are sufficiently resilient to the changing weather conditions, they may be unaffected by the disasters. However, as noted above, most physical assets are designed based on historical disaster data. Thus, economic growth and capital accumulation in terms of the increase in physical assets are two reasons why damage due to disasters is increasing.

Costs incurred for disaster management can be divided into two groups: ex-ante costs and post-disaster costs (see Figure 5.4). Ex-ante costs include several types of costs for disaster prevention measures, including additional costs for making physical assets resilient to disaster and climate change, and developing the capacity of countries to manage disaster and climate change. These are the costs of disaster preparedness. If the government and citizens spend enough on disaster prevention and preparation, the disaster risk exposure may be reduced. However, it is difficult to decide how much the government and citizens should spend to prevent and prepare for disasters.

Figure 5.4: Costs of Disaster

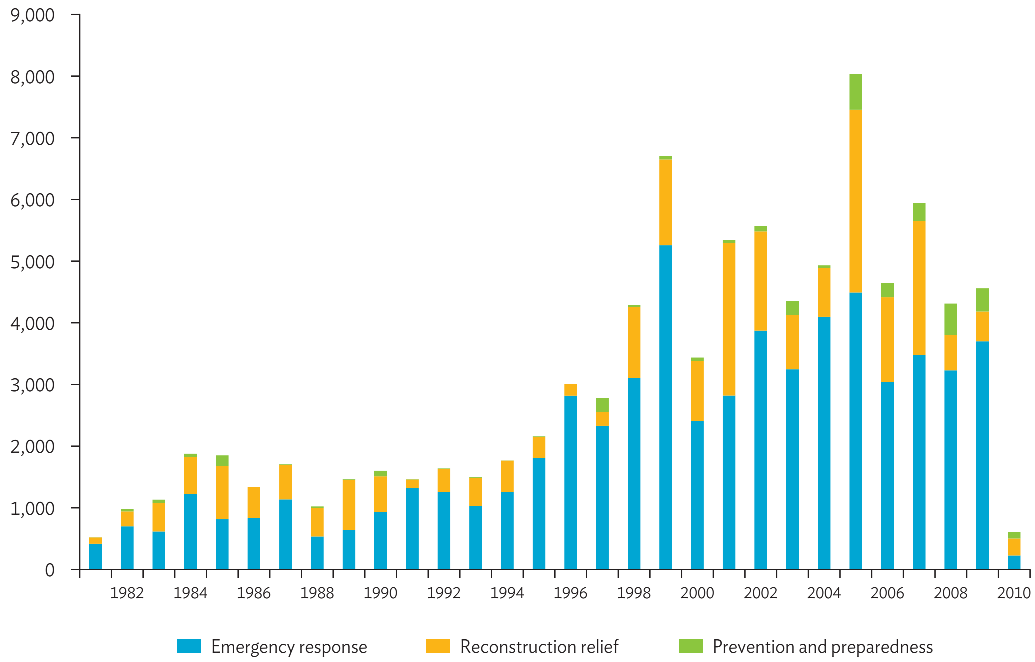


GDP = gross domestic product.
Source: Author.

Post-disaster costs can be divided into direct and indirect costs. Direct costs include the loss of assets and losses caused by business interruption and/or shutdown. When physical assets are damaged by disaster they must be rehabilitated or reconstructed. The owner of the physical assets may lose the value of the original assets, and need to pay to rehabilitate and/or reconstruct damaged assets. In the case of public assets that provide public services to citizens, the loss of assets will affect citizens' lives. Further, damage to assets by a disaster will affect various economic activities.

When severe disasters occur in developing countries, donors may provide financial assistance for disaster management. The World Bank (2013), which compiled disaster-related aid commitment data for a period of 30 years from 1981, has shown that most disaster-related aid is provided as an emergency response (69.2%) and as reconstruction relief (27.1%), while a limited amount (3.7%) is provided for prevention and preparedness activities (Figure 5.5).

Figure 5.5: Disaster-Related Aid Commitments ($'000)



Source: World Bank (2013), *World Development Report 2014: Risk and Opportunity – Managing Risk for Development*. Washington, DC: World Bank.

Although such disaster-related aid is essential for the victims, it can be considered an opportunity cost. If no disaster occurs, the aid money can be used for other development purposes, thus contributing to the country's economic and social development.

Further, disaster-related aid can cover only a limited part of the direct losses and damages caused by the disaster; the government and victims themselves must cover the rest. Victims must also cover indirect losses caused by delayed recovery and a decline in economic activities, which may also affect the clients of businesses run by the victims.

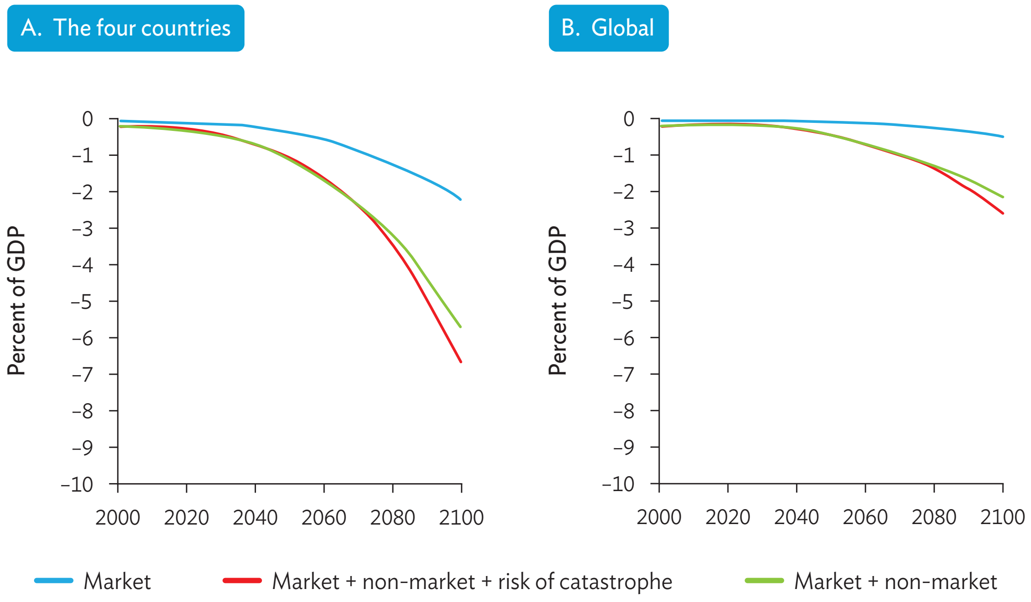
Disasters may also affect the business of financial institutions, such as domestic commercial banks. The most direct impact on the business of a financial institution is damage to its premises (headquarters and branches), and harm to its employees. Although financial institutions can also be victims of a disaster, they must do their best to continue to provide financial services to their clients, since clients affected by the disaster will need to access cash for emergency and recovery purposes.

5.3 Estimated Cost of Climate Change and Disasters

5.3.1 | Existing Research on the Cost of Adaptation and Disaster Risk Reduction in Asia

Several agencies and research institutions have carried out estimations as to the cost of CCA and DRR, and ADB has published several reports on this subject. ADB (2009) examined climate change issues in Southeast Asia, with a particular focus on Indonesia, the Philippines, Singapore, Thailand, and Viet Nam. Using the PAGE2002 model to analyse the situation, ADB (2009) reported that four countries (Indonesia, the Philippines, Thailand, and Viet Nam) could lose 6.7% of GDP by 2100, if non-market impacts and catastrophic risks are taken into account. This is far higher than the global figure of 2.6% (Figure 5.6). This report mainly focuses on the extent to which climate change will impact the macroeconomy, and does not necessarily include the direct cost of climate change-related disasters. However, the indirect cost of climate change is also very large.

Figure 5.6: Mean Impact under the A2 Scenario



ADB = Asian Development Bank, GDP = gross domestic product.

Source: Extracted from Asian Development Bank (2009), *The Economics of Climate Change in Southeast Asia: A Regional Review*. Manila: Asian Development Bank.

In a recent report on Asia's infrastructure needs, ADB estimated the financial requirements for developing infrastructure in Asia, noting that 'Compared with the baseline estimates, our climate change-adjusted estimates are 16% higher—rising from $22.6 trillion to $26.2 trillion, or from $1.5 trillion to $1.7 trillion annually' (ADB, 2017). This amount can be considered part of the ex-ante cost for climate change.

ADB (2017) estimated Southeast Asia's infrastructure investment needs at about $2,759 billion during 2016–2030 as a baseline. This means that $184 billion in investment will be required every year. When additional investment for climate change is added, the region's infrastructure investment needs during 2016–2030 increase to $3,147 billion, with an annual average of $210 billion. That is to say, $388 billion in additional investment will be required during 2016–2030 to adjust to climate change factors (Figure 5.7).

Figure 5.7: Infrastructure Investments by Region, 2016–2030

Region/Subregion	Baseline Estimates			Climate-adjusted Estimates		
	Investment Needs	Annual Average	Investment Needs as % of GDP	Investment Needs	Annual Average	Investment Needs as % of GDP
Central Asia	492	33	6.8	565	38	7.8
East Asia	13,781	919	4.5	16,062	1,071	5.2
PRC	13,120	875	5.0	15,267	1,018	5.8
South Asia[a]	5,477	365	7.6	6,347	423	8.8
India	4,363	291	7.4	5,152	343	8.8
Southeast Asia	2,759	184	5.0	3,147	210	5.7
Indonesia	1,108	74	5.5	1,229	82	6.0
The Pacific	42	2.8	8.2	46	3.1	9.1
Asia and the Pacific	**22,551**	**1,503**	**5.1**	**26,166**	**1,744**	**5.9**

GDP = gross domestic product, PRC = People's Republic of China.

[a] Pakistan and Afghanistan are included in South Asia.

Source: Extracted from ADB (2017), Meeting Asia's Infrastructure Needs. Manila: ADB. https://www.adb.org/sites/default/files/publication/227496/special-report-infrastructure.pdf (accessed 10 February 2019).

The figures in the 2017 ADB report include the cost of both mitigation and adaptation, and cover a limited number of sectors, including power, transport, telecommunications, water, and sanitation. Other sectors vulnerable to climate change such as agriculture are not included in this estimation.

The report observed the following:

> *Besides climate proofing in the sectors covered in this report, climate adaptation requires shifts in portfolio and significant investments in sectors not covered here, such as irrigation and food security, disaster risk management (flood control in particular), and coastal protection to maintain and build climate change resilience.* (ADB, 2017)

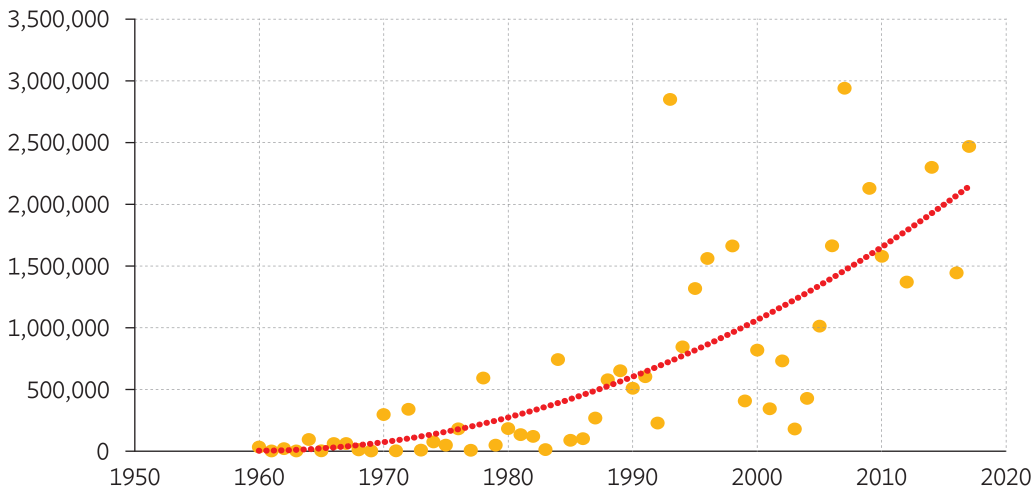
5.3.2 | Estimating Loss and Damage Due to Climate Change and Disaster in Asia

As noted above, ADB (2009; 2017) estimated the indirect cost and ex-ante cost reflecting the impact of climate change. However, this does not reflect damage caused by disasters.

To estimate the damages (direct costs), the trend of direct costs should be examined (see Figure 5.3). Figure 5.8 shows the trend of total damages since 1960, excluding years in which the damages were exceptionally huge (1997, 2008, 2011, 2013, and 2015). Even excluding extreme cases, a trend of increasing damage can be identified.

Based on the fit curve in Figure 5.8, we can estimate future damage due to natural disasters at $3.2 billion in 2030 and $5.3 billion in 2050. These figures may vary according to the scale of disasters, trends of accumulation of physical assets, and the vulnerability of those assets; however, it is clear that damage due to natural disasters will increase drastically in the future. Moreover, as the frequency and scale of extreme disasters have also been increasing in recent years, it seems likely that these trends will continue to shift due to climate change.

Figure 5.8: Trend of Total Damage Due to Climate-Related Disasters in Asia



Source: Centre for Research on the Epidemiology of Disasters (2019), Emergency Events Database. www.emdat.be (accessed 10 February 2019).

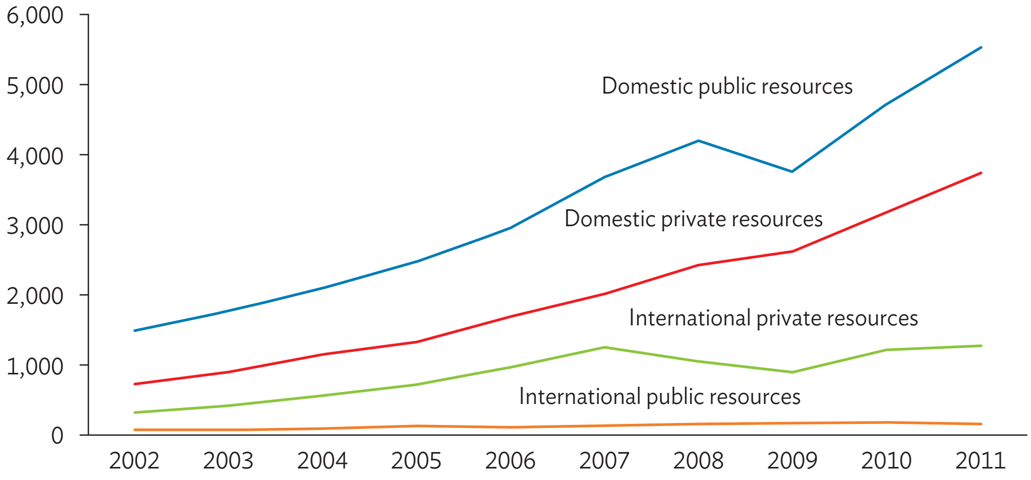
5.4 Finance Sources for Disaster Risk Management and Climate Change Adaptation

5.4.1 | Trends in Finance Flows in Developing Countries in Asia

Asia and the Pacific will require billions of dollars to transition to low-carbon growth paths and adapt to the unavoidable impacts of climate change. Nevertheless, developing countries in Asia are in a good position because finance for climate change action is already available from a variety of sources.

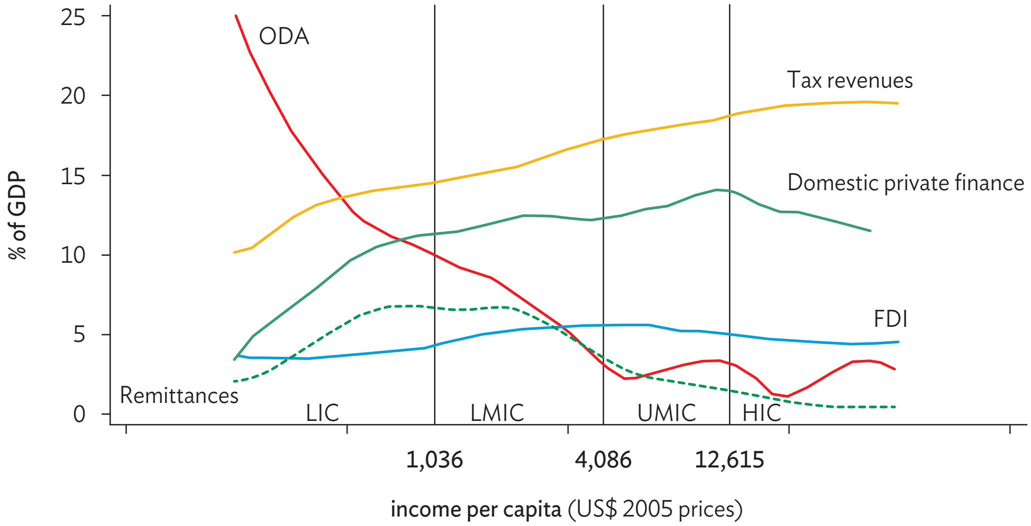
The European Report on Development (2015) shows that finance to developing countries is increasing dramatically (Figure 5.9). Domestic resources in particular (both public and private) are contributing significantly to the increased volume of finance. In contrast, contributions from international resources are stable and relatively limited, although such resources still play an important role in the development of these countries.

Figure 5.9: Trends in Finance to Developing Countries, 2002–2011 ($ billion, 2011 prices)



Source: Overseas Development Institute, European Centre for Development Policy Management, Deutsches Institut für Entwicklungspolitik, University of Athens, and Southern Voice Network (2015), *European Report on Development. Combining Finance and Policies to Implement a Transformative Post-2015 Development Agenda*. Brussels. http://ecdpm.org/wp-content/uploads/2015-European-Report-on-Development-English.pdf (accessed 10 February 2019).

Figure 5.10: Variations in the Composition of Finance by Level of Income (% of GDP)



FDI = foreign direct investment, GDP = gross domestic product, HIC = high income, LIC = low income, LMIC = lower middle income, ODA = official development assistance, UMIC = upper middle income.

Source: Overseas Development Institute, European Centre for Development Policy Management, Deutsches Institut für Entwicklungspolitik, University of Athens, and Southern Voice Network (2015), *European Report on Development. Combining Finance and Policies to Implement a Transformative Post-2015 Development Agenda*. Brussels. http://ecdpm.org/wp-content/uploads/2015-European-Report-on-Development-English.pdf (accessed 10 February 2019).

Several types of finance resources are currently available, and each country relies on different sources depending on its economic scale and level of income. Figure 5.10 shows differences in the composition of countries' finance by level of income.

Figure 5.9 shows that domestic resources dominate the sources of finance and that this volume is increasing dramatically; however, the data in Figure 5.10 show that the poorest countries rely on official development assistance (ODA) rather than domestic resources. This may be one of the reasons why less developed countries often ask donors to increase the allocation of ODA. Over-dependence on external funding, including ODA, could constitute a risk for these countries since they are unable to control external funding. Thus, each source of finance has its own characteristics, potential, and risks.

5.4.2 | Characteristics of Financial Sources

Sudo (2016) compared the characteristics, potential, and risks of each finance resource. In the following subsection, we will discuss each source of finance in greater detail.

Table 5.1: Characteristics, Potential, and Risks of Finance Sources

Source	Characteristics	Potential	Risk
Domestic public finance • National budget (national tax) • Municipality budget • Bonds • Domestic financial institutions	• Most stable and lowest risk source of finance • Good for finance for low-profit public projects • Contributes to leveraging domestic private finance	• Improved governance and financial system leading to increase in domestic finance flows and foreign direct investment	• Political difficulty of increasing tax revenue • Lack of capacity for appropriate public fiscal management • Risk of crowding out private finance
International public finance • ODA • OOF • Multilaterals	• Stable and low-risk finance but low predictability • Limited volume of finance • Must be used efficiently and effectively	• Leveraging of private finance	• Risk of crowding out private finance • Need for appropriate foreign reserve and foreign exchange management
Private finance	• Largest finance source • Contributes to sustainable development by investing in projects where social benefits are increased while private benefits are maximised • Generates employment opportunities and creates a sustainable development impact through business expansion	• Increased private finance flows into developing countries • Increased finance flows between developing countries	• Unstable due to the economic situation and sensitive to risks • Difficult to capture the total flow of private finance • Difficult to ensure transparency and accountability due to business confidentiality
Blended finance • PPP • European Union blending mechanism	• Sharing of risks and costs by the public; private finance will be mobilised and contribute to establish a better business environment and market.	• Increase in private sector participation	• Risk of market distortion • Risk of dependence on the public

ODA = official development assistance, OOF = other official flows, PPP = public–private partnership.

Source: Sudo, T. (2016), 'Domestic and International Finance in a Regional Perspectives' in V. Anbumozhi, K. Kalirajan, F. Kimura, and X. Yao (eds.) *Investing in Low-Carbon Energy Systems – Implications for Regional Economic Cooperation*. Singapore: Springer Science+Business.

5.4.2.1 Domestic Public Finance

Of the available sources of finance, domestic public finance is the most promising, most stable, and lowest risk. In general, domestic public finance will be collected through taxation, the issuing of bonds, and/or fundraising from the domestic market through other public entities, such as the national development bank. Domestic public finance is, in general, managed by the finance ministry and spent through the public expenditure system. Thus, domestic public finance is useful for public services where profit is limited but that provide a large public benefit. In addition, public expenditure may catalyse the mobilisation of private finance flows by sharing (or taking) risks associated with privately funded public projects, or by subsidising low-profit projects with a large public benefit. Therefore, good governance and financial system management along with the catalytic role of public finance may lead to an increase in domestic finance flows and foreign direct investment.

Nevertheless, domestic public finance does carry some risks. First, political difficulties may hinder increases in tax revenue. Although tax revenue may increase naturally if the country's economy grows, increasing tax revenue by changing the tax rate requires political acceptance. Obtaining public acceptance of a tax rate change is one of the most difficult challenges for politicians. Second, the inappropriate management of public finance may send the wrong message to the market (i.e. investors) and lead to a lost opportunity to increase private finance. Third, there is a risk of crowding out the private sector, since public finance is more desirable than private finance.

5.4.2.2 International Public Finance

International public finance, such as bilateral ODA, other official flows, and multilateral development finance, provide stable and low-risk finance. However, as discussed in the previous section, the volume of international development finance covers a very limited part of finance flows, even though the poorest countries still largely rely on ODA and multilateral development finance. In addition, as the main source of international public finance is from donor countries' fiscal budgets, both donor and recipient countries must be responsible for their accountability to their respective taxpayers. In addition to the pros and cons of domestic public finance, recipients need to manage foreign exchange risk and foreign reserves to maintain the stability of the value of their own currency and financial market.

In addition to traditional donors, emerging donors and funds have recently been playing an important role. For example, the Green Climate Fund, which was established to help non-Annex I countries tackle climate change, is expected to play a central role in facilitating climate change finance. The Government of China recently called for the establishment of the Asian Infrastructure Investment Bank to facilitate infrastructure investment in Asia and the Pacific. Such nontraditional international public finance providers are expected to play an important role in helping Asian countries access international finance.

5.4.2.3 Private Finance

Private finance accounts for a large part of finance flows in Asia and the Pacific. As shown in the previous section, the volume of foreign direct investment flows in Asia is more than 30 times that of ODA. Since private finance is directly linked to business, increasing private finance may lead to several public benefits, such as employment opportunities and market expansion. On the other hand, due to its profit-focused nature and sensitivity to risks, private finance is not necessarily considered a stable source. Further, due to its business confidentiality, it is difficult to ensure transparency and accountability.

In addition, the scale of private finance depends on the depth of the financial market. Access to banks and/or level of financial inclusion are important factors to consider for increased private finance. The level of development of the financial market in Asia differs by country. The Asian Development Bank Institute (2014) has suggested the importance of financial integration and cooperation in ASEAN in the pursuit of the economic integration of ASEAN.

5.4.2.4 Blended Finance

Mustapha, Prizzon, and Gavas (2014: 2) defined blended finance as 'the complementary use of grants (or grant-equivalent instruments) and non-grant financing from private and/or public sources to provide financing on terms that would make projects financially viable and/or financially sustainable.' Blended finance may enable the public sector to share risks and costs to facilitate the entry of private finance in infrastructure development.

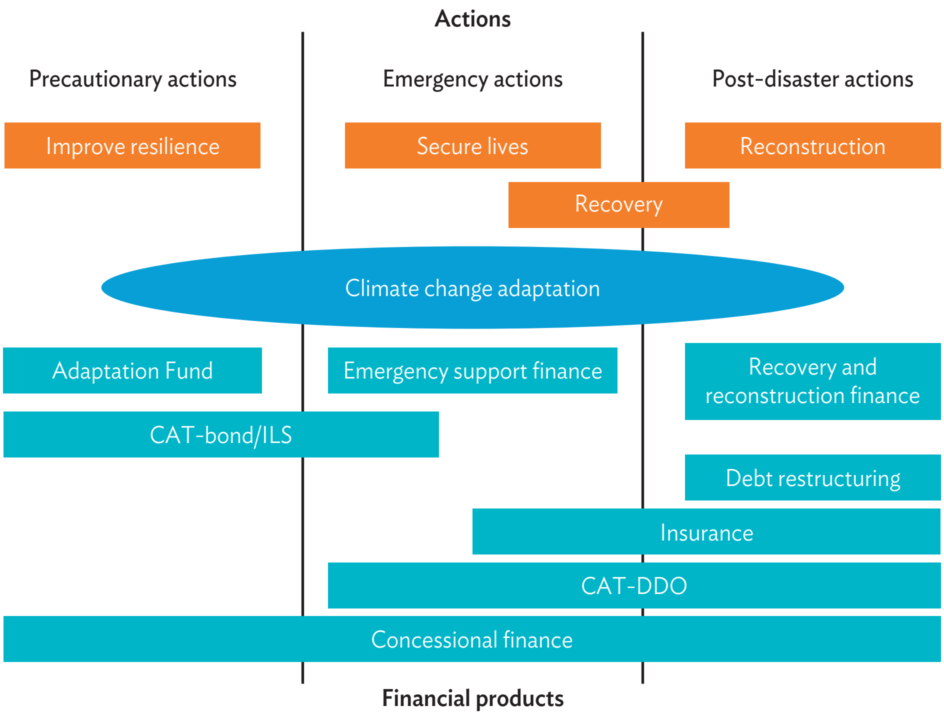
However, grants or grant-equivalent instruments from the public sector may provide favourable financial conditions for the private sector, which may distort the competitive environment. Thus, blended finance should be used when the competitive environment is secured.

5.5 Financial Instruments for Disaster Risk Management and Climate Change Adaptation

5.5.1 | What Sort of Financial Instruments Are Available?

Some financial institutions have already developed several financial products to cope with disaster and food security. In this section, we try to identify financial instruments for coping with disaster and food production volatility, and categorise them by stage of events. Figure 5.11 summarises some financial instruments for coping with major disasters. Actions are categorised according to three stages: precautionary, emergency, and post-disaster. The circumstances of these stages differ in terms of uncertainty and necessary terms and conditions of the instrument.

Figure 5.11: Financial Instruments for Disaster Risk Management and Climate Change Adaptation by Stage of Actions



CAT bond = catastrophe bond, CAT–DDO = catastrophe deferred drawdown option, ILS = insurance-linked security.
Source: Author.

5.5.1.1 Financial Instruments for Precautionary Actions

Precautionary actions are defined as actions to prepare for and strengthen resilience to extreme weather events. At this stage, it is unpredictable when and how large disasters will occur due to extreme weather events, creating uncertainty as to the scale of future disasters.

Consequently, project and programme managers must raise finance based on the design and financial requirements of their own project or programme. The manager may incorporate disaster risks into their consideration at the design stage by carrying out a sensitivity analysis. In this sense, the financial instruments used for the projects and programme fall under general project finance.

If the project or programme is sensitive to disaster risks, the managers may select the catastrophe bond (CAT-bond) to minimise (or transfer) the risks of default caused by damage due to a disaster. The nature of a CAT-bond is discussed in greater detail in Section 5.5.2.2.

Further, the public sector will provide services to help citizens cope with the disaster. For example, preparation of an evacuation centre, food stocks, and an early warning system are considered precautionary actions that the public sector should use its budget to undertake. In addition, other external funds, such as the Adaptation Fund and other concessional finance from donor countries and international development finance institutions, will be available for the purpose of supporting precautionary actions.

5.5.1.2 Financial Instruments for Emergency Response

Emergency response is defined as actions to secure the lives of victims, quickly repair lifeline utilities, provide evacuation centres and temporary housing for victims, and carry out related works for continuing victims' lives until they can resume their normal activities. Although most of these actions are temporary, they involve enormous costs and amounts of necessary resources. Therefore, quick disbursement and/or payment to cover these costs are essential to secure funds for emergency purposes. Thus, the public sector will generally secure some contingent funds for emergency purposes. However, as the actual scale of future disasters is unknown, this contingent budget will not necessarily be sufficient to cover the entire cost of the necessary emergency actions. In such cases, local governments where a disaster has hit will ask the central government for support in the form of funds and human resources, especially since the local government officials themselves may be victims of the disaster. Thus, mutual support is essential during disaster-related emergencies.

If the scale of the disaster is especially huge, even the central government may be unable to cover the costs of the emergency. In such cases, other countries' governments may provide emergency services, including financial and human resource support, as a courtesy.

Other financial instruments can also be helpful for emergency purposes. Insurance is a traditional and well-known instrument to alleviate the effects of an emergency. When a disaster occurs, the insurance premium will be paid based on the insurance terms and conditions. However, in most cases, the insurance premium will be paid based on the damage assessment. This assessment often takes some time, and recipients may be able to receive the insurance premium during the recovery stage. In some cases, the insurance company may pay the victims a lump sum as a part of the insurance premium in order to meet their needs. Another financial instrument that can be helpful in emergencies is the catastrophe deferred drawdown option (CAT–DDO). The CAT–DDO is a sort of credit line scheme that is used only for emergency purposes. In an emergency, victims as well as the government require cash urgently.
Since the CAT–DDO is a sort of line of credit, disbursement therefrom can be achieved quickly when the triggering requirement is satisfied. The details of the CAT–DDO will be discussed in Section 5.5.2.3.

Furthermore, as noted in the previous section, a CAT-bond eases the pressure of redemption and coupon payment for issuers of the bond, since the bond will be invalid if the assumed scale of disaster (trigger) happens. This can ease cash flow for the bond issuers during an emergency, and allows them to use cash prepared for redemption and/or coupon payment for emergency purposes.

5.5.1.3 Financial Instruments for Post-Disaster Actions

Post-disaster action is defined as actions to recover from damages, and reconstruct victims' normal lives. Recovery and reconstruction is a long process. In the case of severe damage caused by a disaster it can take years to complete recovery and reconstruction works, and the costs involved are huge. A large-scale disaster inflicts damage not only on physical infrastructure but also on soft infrastructure, such as the social system and institutions. Due to damaged assets, systems, and institutions, economic activity often declines during the emergency and post-disaster stages. This often leads to a decreased fiscal budget for the government due to the decline in tax revenue, and compels financial institutions to secure additional finance due to an increase in client withdrawals. Even if the social system and institutions are damaged by the disaster, the government needs to keep fiscal and financial management stable. Concessional finance from donors can help fill the financial liquidity gap for the government.

On the other hand, victims whose assets are damaged or lost due to the disaster face additional difficulties, as the value of their assets as collateral has decreased or been lost. Although these victims now need supplementary finance from financial institutions, they have limited financial capacity to borrow. In addition, outstanding loan balances and interest obligations may remain for victims who have previously borrowed from the banks. Thus, disaster victims face further financial difficulties.

In the recovery period after the Great Eastern Japan Earthquake, the Ministry of Finance of Japan took special measures for local governments in disaster areas. Fukuda (2014), who reviewed the function of local finance during the recovery process, highlighted the importance of the role of local financial institutions to support local companies that were damaged by the disaster to ensure business continuity and recovery of profit levels, and to assess and financially support new industries and businesses emerging during the recovery process.

Thus, the provision of additional financial liquidity and financial restructuring during the post-disaster stage are effective ways to mitigate the pressure of financial obligations on victims and help them cover the costs of restarting their businesses and/or normal lives as soon as possible so that economic losses due to the disaster can be minimised. Concessional finance, whether general budget support or project-based finance, from donors is helpful for countries in need of additional liquidity.

Insurance is the traditional financial instrument to cover the costs of damage due to a disaster. Once the insurance claims are settled, insured clients will receive funds to reconstruct their lives. The CAT–DDO plays a similar role in terms of liquidity support. Including the CAT-bond in the debt portfolio can help to restructure the portfolio, as the CAT-bond will be cancelled if the scale of the disaster exceeds the cancellation trigger condition.

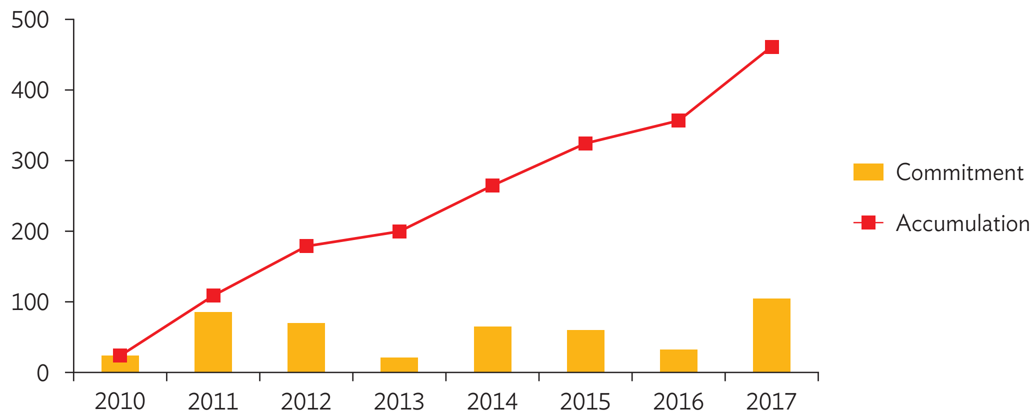
5.5.2 | How the Financial Instruments Work

In this section, we review some of the financial instruments for coping with disaster-related actions. As discussed in the previous section, there are several financial instruments that can help support disaster-related actions. Of these, we highlight the Adaptation Fund, CAT-bond, and CAT–DDO, amongst others.

5.5.2.1 Adaptation Fund

The Adaptation Fund is a financial mechanism established under the Kyoto Protocol of the UN Framework Convention on Climate Change. The objective of the Adaptation Fund is to finance concrete adaptation projects and programmes in developing countries, particularly countries vulnerable to the adverse impacts of climate change. As of September 2017, the Adaptation Fund had committed about $461 million to 95 projects. Annual commitments and accumulation of the commitment amounts are shown in Figure 5.12. The average project size is $4.9 million, while that of projects (other than readiness grants) is $6.6 million. Of the total committed amount, about $171 million (37.2% of commitments) has been disbursed so far.

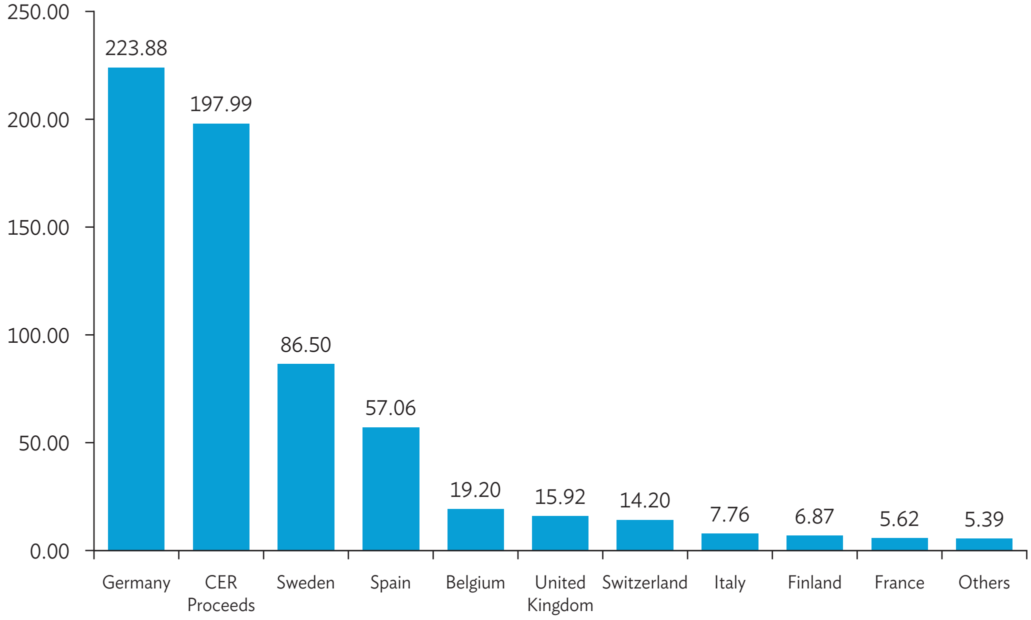
Figure 5.12: Annual and Accumulated Commitments by the Adaptation Fund ($ million)



Source: Extracted from the Adaptation Fund (2017). https://www.adaptation-fund.org/ (accessed 30 October 2017).

The Adaptation Fund was originally designed to be financed from a 2% share of the proceeds of certified emission reductions issued for clean development mechanism projects. The Adaptation Fund is now receiving contributions from public and private donors. The World Bank (2017), as a fund trustee, reported the financial status of the Adaptation Fund. Figure 5.13 shows the receipt of funds by resources. As of 30 September 2017, the Adaptation Fund had received $442.40 million from donor contributions, more than twice the amount from certified emission reduction proceeds ($197.99 million), the originally expected source of funds. The top donor is Germany, followed by Sweden, Spain, Belgium, and the United Kingdom.

Figure 5.13: Receipt of Funds by Resources ($ million)



CER = certified emission reduction.

Source: World Bank (2017), *Adaptation Fund Trust Fund Financial Report Prepared by the Trustee*. 30 September 2017. https://www.adaptation-fund.org/wp-content/uploads/2017/09/AFB.EFC_.21.8-Trustee-Report-June-2017-with-report.pdf (accessed 30 October 2017).

Although the Adaptation Fund is one of the key financial mechanisms under the UN Framework Convention on Climate Change, it constitutes a very limited part of contributions to adaptation, compared to contributions from other financial sources and considering the size of the financial need.

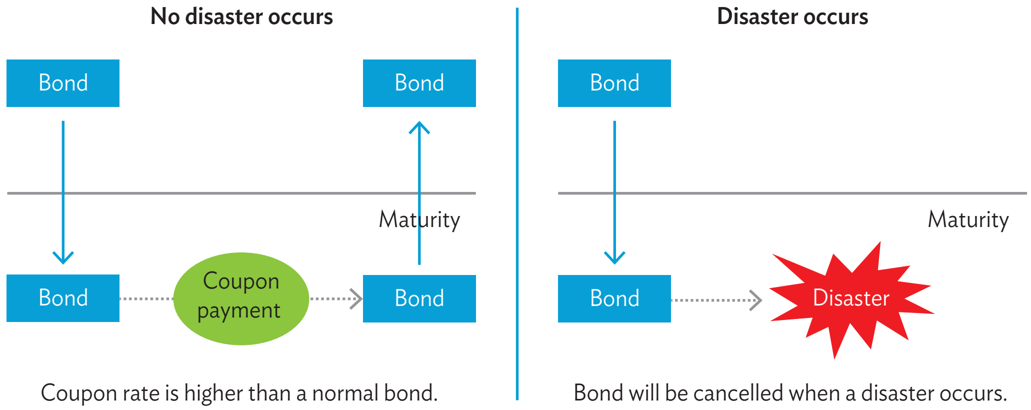
Trujillo and Nakhooda (2013: 28) pointed out that ‘the operationalization of the Adaptation Fund has played an important role in scaling up available finance for adaptation in developing countries, albeit from a very low baseline,’ and they evaluated the role of the Adaptation Fund as having ‘developed a functional system for delivering adaptation finance that meets high levels of transparency, and has important provisions for accountability and learning.’

Although the Adaptation Fund plays an important role, as noted above, it primarily covers the cost of precautionary actions against climate change, meaning that, due to its limited scale, it mainly supports capacity development for adaptation planning.

5.5.2.2 Catastrophe Bond

A CAT-bond is a disaster-risk linked security that transfers the risks of disaster-related damages from a bond issuer to investors. If no disaster occurs, the bond issuer would pay a coupon to the investors. If trigger conditions (such as the occurrence of a large-scale disaster) are met, the principal will be forgiven. Figure 5.14 shows how the CAT-bond mechanism works. CAT-bonds are typically used by insurers as an alternative to traditional catastrophe reinsurance. Therefore, the CAT-bond is considered to be an insurance-linked security (ILS).

Figure 5.14: The Catastrophe Bond Scheme

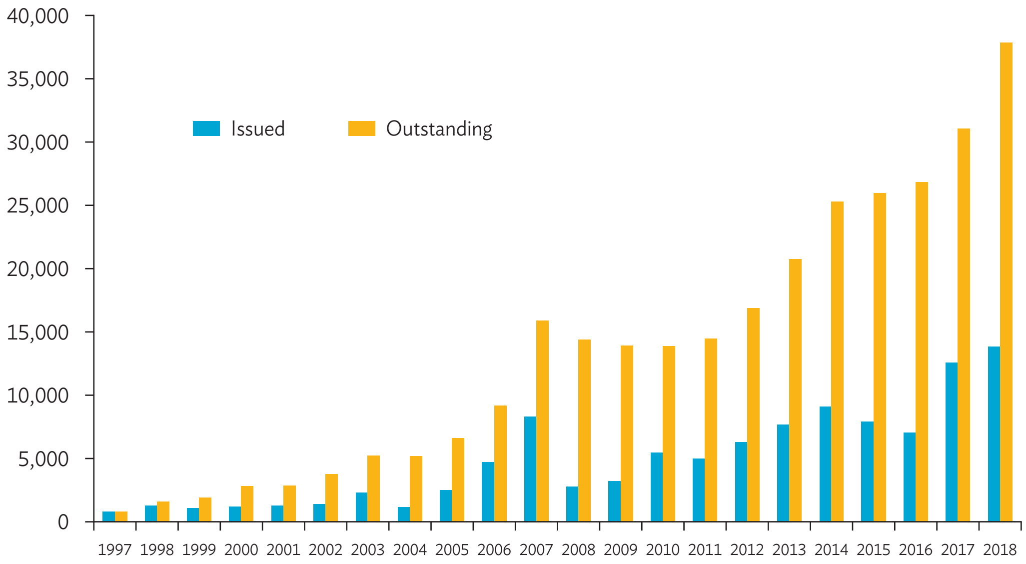


Source: Author.

Since the CAT-bond is considered a risky security, its coupon rate is higher than that of normal bonds issued by the same issuer with the same maturity. That is, the coupon rate reflects the default risks of the bond triggered by a catastrophic disaster.

For the bond issuers, although they have to pay a higher coupon rate, they will be released from the burden to repay the principal and of the bond if the cancellation condition is triggered. This helps bond issuers secure finance for recovery and reconstruction. On the other hand, investors will receive higher returns if no disaster occurs. Sudo (2008) analysed the effectiveness of the CAT-bond as a tool to share disaster risks with the market, and found that the potential of a CAT-bond applies to fundraising on the part of both insurance companies and commercial companies as a part of their debt portfolio.

Figure 5.15: Catastrophe Bond and Insurance-Linked Securities Risk Capital, Issued and Outstanding, by Year ($ million)



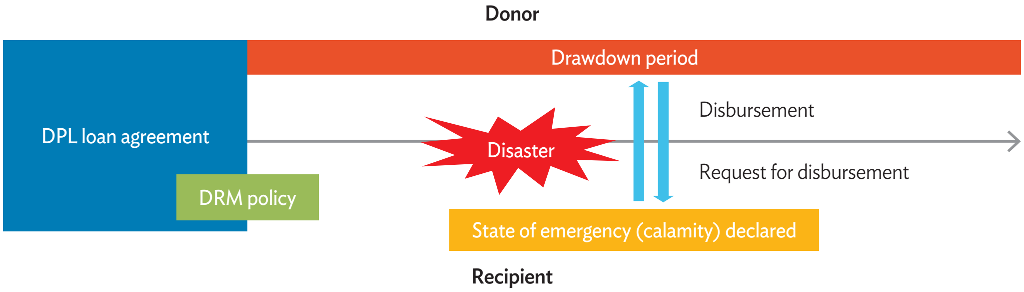
Source: Artemis Deal Directory. http://www.artemis.bm/dashboard/catastrophe-bonds-ils-issued-and-outstanding-by-year/ (accessed 10 February 2019).

Figure 5.15 shows the trends of issued and outstanding CAT-bond and ILS risk capital as reported by Artemis (2019). According to these data, the issuance of the CAT-bond and ILS has increased gradually since 1997, with the largest issuance of the decade occurring in 2007, before declining drastically in 2008. After that, issuances of the CAT-bond and ILS gradually recovered, and the historically largest issuance of the bond occurred in 2017 and 2018. Reflecting this trend, the outstanding CAT-bond and ILS risk capital has been increasing, reaching around $35 billion at the end of 2018.

5.5.2.3 Development Policy Loan with a Catastrophe Deferred Drawdown Option

The CAT–DDO is an application of the development policy loan (DPL) with a drawdown option, and was developed by the World Bank (World Bank, 2011a). The DPL is a lending scheme to support the fiscal budget of the government of a developing country. In the DPL, donors and the recipient country agree to a list of actions for specific policy purposes when the loan agreement is concluded. Both the donors and recipient country monitor the progress of the actions in the list, and the disbursement will be made when the targeted actions are implemented.

Figure 5.16: Transaction of the Catastrophe Deferred Drawdown Option



DPL = development policy loan, DRM = disaster risk management, RQ = request.
Source: Author.

Figure 5.16 shows how the CAT–DDO works. The scheme of the CAT–DDO is almost the same as that of the DPL. The difference between the DPL and CAT–DDO is whether or not the trigger for disbursement occurs. In the CAT–DDO, the policy matrix is formulated as a list of policy actions related to DRM. Once the policy actions are completed, the drawdown option is enacted, that is, the disbursement will be made once the trigger event occurs.

The World Bank provided a CAT–DDO to the Philippines in 2011. The objective of the project was to enhance the capacity of the Government of the Philippines to manage the impacts of natural disasters. This objective was achieved by supporting the following aspects of the government's DRR and DRM framework: (i) strengthen institutional capacity for DRM efforts, (ii) mainstream DRR measures into development, and (iii) better manage the government's fiscal exposure to natural disaster impacts. The World Bank explained:

> *The CAT–DDO allows governments to respond quickly to emergency needs without diverting resources from important long-term development projects. The product is typically used to finance liquidity gaps in the government budget for countries exposed to natural disasters. It is triggered by a Presidential Declaration of a State of Calamity.* (World Bank, 2011b)

The triggering disaster, tropical cyclone Sendon (Washi), occurred in December 2011, and the Government of the Philippines declared a state of calamity, after which the World Bank quickly disbursed $500 million from the DPL. Thus, the CAT–DDO works as a contingency line of credit, which provides emergency liquidity to help recipients cope with extreme disasters.

5.5.2.4 Traditional Insurance Scheme

Insurance is a traditional means of protection from financial loss. In 2016, Asia suffered higher economic losses due to natural and manmade catastrophes than any other region in the world. Swiss Re (2017) reported that economic losses from disaster events in Asia in 2016 reached an estimated $83 billion, of which approximately $9 billion was covered by insurance. This includes the damage caused by the magnitude 7.0 earthquake in Kyushu, Japan, in April. Economic losses caused by this earthquake were estimated at $25 billion–$30 billion, of which $4.9 billion was insured. In the rest of the Asian region, other disasters in 2016 caused $53 billion–$58 billion in economic losses, of which $4.1 billion was covered by insurance. That is, less than 10% of economic losses that occurred due to disasters in the rest of the Asian region were insured. There are a number of problems with the traditional insurance scheme, including adverse selection, moral hazard, information asymmetry, and high transaction costs such as monitoring and administrative costs in developing countries. Further, Nakata (2015) noted that insurance for natural disaster is uncommon in practice, since the fact that a catastrophe typically incurs a macro risk invalidates the application of the strong law of large numbers, on which a typical insurance mechanism is based. Nakata, Sawada, and Tanaka (2010) showed that the diverse probability belief is inevitable, resulting in a weak demand for catastrophe insurance. Further, Chantarat et al. (2015) pointed out that, without an effective insurance market, public disaster assistance and highly subsidised public insurance programmes have constituted the key supports for affected populations.

With regard to agriculture, crop insurance is an insurance scheme against the loss of crops due to natural disasters. In the United States, a subsidised multi-peril federal insurance programme administered by the Risk Management Agency is available to most farmers. This scheme covers 551 types of crops. The United States Department of Agriculture (2017) reported that, as of 21 December 2017, more than $3.4 billion in indemnities for the year had been paid. Pierro and Desai (2009: 2) noted that 'traditional crop insurance has been seen as a poor model for export, particularly in developing countries, most of which are under serious fiscal constraints and have smallholder economies suffering from high exposure to covariate risk, the risk of simultaneous losses from a single event'.

In view of the person insured, a traditional insurance scheme is a matured and reliable risk management scheme covering economic losses caused by disasters. However, the settlement of insurance claims may be delayed since damage assessment by insurance companies takes a long time; this in turn delays recovery actions on the part of the victims, leading to additional economic losses. Therefore, some insurance companies include partial payments to the insured as a part of insurance claims so that the insured can use these funds for emergency recovery.

5.5.2.5 Index-Based Insurance

An index-based insurance scheme is an alternative to the traditional insurance scheme. Index-based insurance is financial protection based on the performance of a specific index in relation to a specific trigger. Unlike traditional insurance, contracts for index-based insurance are written on an objective index (e.g. precipitation and temperature) that works as a proxy for crop losses. Under index-based insurance, there is no need to use insured farmers' actual losses to determine an insurance claim. This can drastically reduce transaction costs and time to assess damages.

Pierro and Desai (2009) offered some practical examples of index-based insurance in certain countries. Some international organisations, such as the World Bank (2011c), International Fund for Agricultural Development, and World Food Programme (2011), have compiled detailed information on the creation of weather index-based insurance schemes based on their experiences in several countries. Chantarat et al. (2015) discussed the index-based insurance scheme as an attractive means of addressing traditional insurance imperfections, with a case study on index-based insurance for rice farmers in Thailand.

The Bank for Agriculture and Agricultural Co-operatives, in collaboration with the World Bank and Japan Bank for International Cooperation, introduced a pilot weather index-based insurance scheme for maize and rice. According to Yimlamai (2010), the World Bank pilot for maize began in 2006 and covered 110 farmers on 1,970 acres in Nakorn Ratchasima Province. This project was expanded to 2,535 farmers in seven provinces (Nakhon Ratchasima, Saraburi, Lopburi, Nakhon Sawan, Phetchabun, Pitsanulok, and Nan). The index was developed based on the growth pattern and water requirement of maize.

Since these schemes were implemented as a pilot, coverage of the insured was limited. Index-based insurance also faces the basis risk of differences between the payout as measured by the index and the actual loss incurred by the farmer; this may cause losses for farmers and, in turn, loss of trust in this scheme.

5.5.3 | Pros and Cons of Disaster-Related Financial Instruments

There are several financial instruments to cope with large-scale natural disasters and CCA. However, due to differences in the nature of these financial instruments, their applicability differs depending on several different factors, including purpose, stage, scale of finance, and beneficiary. As policymakers do not necessarily appreciate the nature of these financial instruments, they may sometimes misunderstand and/or misuse the instruments. To facilitate understanding of the differences amongst financial instruments for DRM and CCA, Tables 5.2 and 5.3 show the pros and cons of different financial instruments based on the conditions mentioned above.

Table 5.2: Pros and Cons of Financial Instruments (for Precautionary Actions)

	Pros	Cons
Adaptation Fund	• Clear objective of the fund • Useful for capacity development in adaptation	• Limited in scale
Climate-proof financing	• Supporting disaster-resilient infrastructure	• Difficulty of finding appropriate levels of resilience and cost
CAT-bond	• Debt service will be cancelled or reduced when a disaster occurs.	• Higher financial costs

CAT = catastrophe.

Source: Author.

Table 5.3: Pros and Cons of Financial Instruments (for Post-Disaster Actions)

	Pros	Cons
Emergency grant assistance	• Cost-free and additional finance	• Uncertainty as to the amount to be received (depends on donors' efforts)
CAT–DDO	• Quick disbursement • Supports emergency liquidity	• Limited cases • Uncertainty for finance provider in disbursement (monetary cost for preparing to disburse)
Insurance	• Traditional and established scheme • Partial payment will be provided as a part of insurance claims.	• Insurance is not necessarily suitable for large-scale disasters. • Adverse selection, moral hazard, information asymmetry, and high transaction costs • Lengthy damage assessment period and delayed settlement of claims
Index-based insurance	• Reduces the inefficiency of traditional insurance such as adverse selection, moral hazard, information asymmetry, and high transaction costs • Quickly settled once triggers are met	• Data availability—difficulty of setting appropriate triggers • Basis risk—difference between the payout as measured by the index and the actual loss incurred by the farmer

CAT–DDO = catastrophe deferred drawdown option.

Source: Author.

These tables show that no single instrument can meet all DRM and CCA purposes at every stage. Thus, it is crucial for policymakers to understand what choices, combinations, and uses of financial instruments are appropriate.

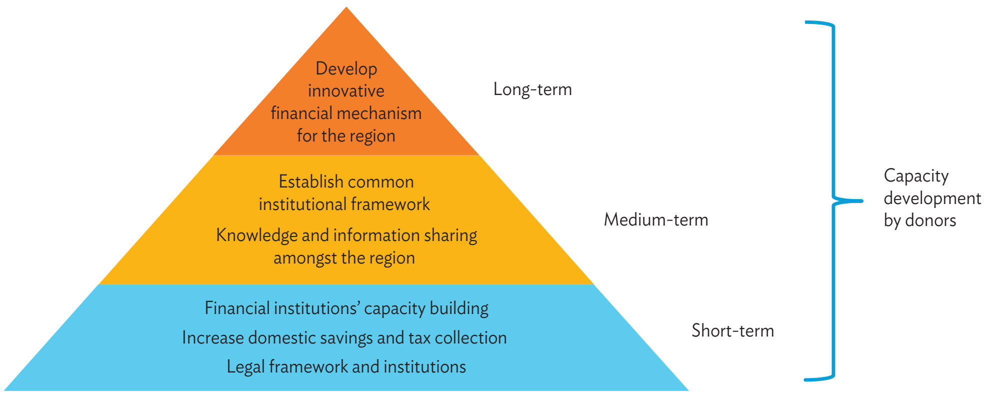
5.6 Roadmap Towards Developing an Adaptation and Disaster Risk Reduction Finance Market in Southeast Asia

5.6.1 | Long-Term Process to Develop Capacity to Mobilise Finance

Several funding sources and financial instruments have been identified in previous chapters. Although CCA, and DRM involve extensive costs, these can be covered by the available funding sources and financial instruments if the countries in Southeast Asia use them effectively. Although many of these options are applicable in the region, several need to be improved to make all options for finance mobilisation available. As it is difficult to use advanced technology without fulfilling the requirements, a step-by-step approach is the most appropriate way to develop capacity.

Figure 5.17 shows the steps for developing capacity to mobilise funding and use financial instruments appropriately. These steps are divided into three timeframes: short-, medium-, and long-term.

Figure 5.17: Roadmap Towards Developing an Adaptation and Disaster Risk Reduction Finance Market in Southeast Asia



Source: Author.

5.6.1.1 Short-Term Actions

In the short term, the institutional foundation should be developed. This includes the creation of a legal and institutional framework, increased savings and tax collection, and enhanced capacity of financial institutions to manage risks and appraise investment. A legal and institutional framework is the core of this foundation. Without a legal and institutional system, the financial market will not be confident, preventing institutions from working effectively and citizens from using financial services such as deposits and savings. Therefore, the development of a reliable and stable legal and institutional framework is key to advance to the next step. Based on such a framework, domestic financial institutions should develop their own capacity to provide efficient, effective, and reliable financial services to their clients.

5.6.1.2 Medium-Term Actions

In the medium term, the above actions should be expanded at the regional level. Once each country establishes its own legal and institutional system, the country will be able to manage its own financial market. This means that each country will need to manage a variety of risks, including disaster and climate change. However, current and future trends of natural disaster and climate change indicate that a country will be unable to manage some circumstances on its own. In such cases, loss and damage should be covered by other countries, particularly neighbouring countries. In this sense, knowledge and information on natural disasters and climate change should be shared at the regional level so that each country will be able to use this knowledge and information to manage disaster and climate change risks. Further, a common legal and institutional system amongst countries in the region will expand risk absorption capacity, since large risks associated with natural disasters and climate change can be shared amongst the countries in the region. Differing legal and institutional systems amongst countries limit capacity to absorb risk. Therefore, communalising the legal and institutional systems of countries in the region will be indispensable to advance to the next step.

5.6.1.3 Long-Term Actions

Once a common legal and institutional system and risk-sharing system are established amongst the countries in the region, financial risks can absorbed by the common financial market, and countries in the region will be able to use innovative finance mechanisms. As noted in previous chapters, several innovative financial mechanisms will be applicable under this condition. In the long term, each country can select several innovative financial mechanisms, and/or develop its own innovative financial mechanisms appropriate for its own circumstances and conditions.

5.6.1.4 Need for Capacity Development

A step-by-step approach is the appropriate way for countries in the region to approach these problems. However, it is crucial for these counties to undertake capacity development since they have limited capacity and experience to take these steps. Therefore, developed countries like Japan and other donors should support capacity development for these countries based on their own knowledge and experiences. Donors will also benefit from improved financial markets in the region, as well as countries' greater capacity to manage risks associated with disasters and climate change. Thus, donors should support these countries in advancing their actions step by step.

5.6.2 | Managing Funding Gaps

As discussed in the previous section, it is important to establish a reliable, efficient, and effective financial market in the region on a step-by-step basis. Unfortunately, however, nobody knows when a large-scale natural disaster will hit a country, creating a huge amount of direct and indirect post-disaster costs. Therefore, actions to address CCA and natural disasters cannot be postponed until then, and countries must consider how to manage funding gaps in both the short and long term.

5.6.2.1 Short Term

In the short term, the key finance sources are domestic investment and finance, both public and private. To increase the amount of domestic investment and finance, the government should improve the liquidity of the domestic financial market. Since the main source of finance by the banking sector is savings, the government and banking sector should motivate citizens and companies to increase savings as a source of private sector finance, and the government should review the tax collection system to improve tax revenue as a source of public finance. However, market conditions in developing countries are sometimes vulnerable to external and internal shocks, and any failure of market operation can cause economic growth to decline. Therefore, careful policy implementation and market operation are desirable. At the same time, the capacity of domestic financial institutions to manage risks and conduct appropriate financial appraisals should be developed and recipients' creditworthiness improved through financial institutions' advising function. Donor backing of such actions will be an effective means of support.

Use of international and regional donor finance is another option to improve domestic market liquidity. However, it should be noted that too much dependency on donor finance may weaken a country's ability to manage its own market. Thus, improving the domestic market system is the best way to manage a short-term funding gap.

5.6.2.2 Long Term

In the long term, if a country takes a step-by-step approach as outlined in the previous section, funding options for managing funding gaps will be increased, and the government and private sector (including citizens) may be able to use several funding options, including innovative financial mechanisms. The availability of such mechanisms depends on the financial risk management capacity of financial institutions. Once a common risk (or finance) pool is established amongst the countries in the region, financial institutions may be able to manage their financial risks by using a common risk pool. Such a pool could serve as infrastructure for sharing risk information amongst the financial institutions and governments in the region.

5.6.2.3 Overarching Strategy for Local Adaptation in the Fiscal and Financial Sector

Local-level barriers include the accessibility and availability of finance. As local areas are vulnerable to external shocks such as natural disasters and climate change, fiscal and financial support for improving the resilience of local areas to such shocks is essential.

In terms of fiscal support from the government, it is essential to invest in local infrastructure such as climate-proofing measures for the electricity, transport, and agricultural sectors. In particular, improving the value (supply) chain system (including roads, bridges, and storage) is important to secure economic activities as well as the lives of citizens. In many cases, foods will be supplied from rural areas to cities, and some goods will be supplied from cities to rural areas. Thus, securing value (supply) chains is indispensable to secure the lives of citizens in both urban and rural areas.

Further, financial access for local areas should be improved. Although microfinance and microinsurance schemes can effectively support daily life in rural areas, these financial instruments are often insufficient when a large-scale natural disaster occurs. In this regard, public support mechanisms for rural areas are indispensable. The government should also involve local stakeholders to share information and manage risks on natural disasters and climate change.

5.7 Conclusion and Recommendations

5.7.1 | Conclusion

This chapter discussed the financial issues in DRM and CCA. Several estimations of disaster costs reveal that these are increasing. Thus, countries in Southeast Asia should consider how to manage risks associated with disasters and climate change, and how to mobilise finance to manage such risks.

There are several financial sources available in the region. The largest of these are domestic public and private finance. Several other financial instruments are useful for managing risks associated with disasters and climate change. These innovative financial mechanisms are required to manage financial risks; however, their availability is currently limited.

Based on these discussions, this chapter provides a roadmap to mobilising financial instruments effectively using a step-by-step approach. Such an approach can enable countries in the region to improve their domestic financial markets and share risks and information within the region. In turn, several innovative finance mechanisms will be available in the region, thus expanding the options for mobilising finance for DRM and CCA.

5.7.2 | Policy Recommendations

Based on the above argument, the following policy recommendations are identified.

(i) Improve the market foundation (short term).

Domestic finance sources, both public and private, are at the core of financing CCA and DRR actions. Therefore, improving the domestic financial system (including the legal and institutional systems) is highly recommended to strengthen the foundation of the financial market.

Once the financial market foundation is strengthened, the government should encourage financial institutions and their clients to increase liquidity in the market, and the government should improve the tax collection system to increase tax revenues.

(ii) Develop innovative finance mechanisms appropriate for each country's condition (long term).

In the long term, countries in the region should establish risk (finance) pooling mechanisms to share the financial risks. When such a risk-pooling mechanism works well, each country will be able to use and/or develop innovative finance mechanisms suited to its own circumstances.

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CHAPTER 6

Towards a Resilient Food System and Building Adaptation Roadmaps

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In terms of mainstreaming disaster risk reduction (DRR) and climate change adaptation (CCA) into developmental planning to ensure food security, the most vulnerable sectors and value chains include the agricultural and water sectors, and the food, fisheries, and livestock value chains. Several papers presented at a regional workshop on this topic applied an analytical framework involving a combination of sector-wide reviews (using secondary sources on impacts, policies, and institutions) and several case studies of implementation experiences. These case studies, which covered several countries in the Association of Southeast Asian Nations (ASEAN) region and abroad, helped workshop attendees and contributors gain a deeper understanding of the barriers to achieving better adaptive capacity. This chapter discusses the general conclusions drawn in that workshop.

6.1 Disaster and Climate Change Impacts on Food Security

Climate change and related natural disasters are a looming global reality. The ASEAN region, which is already home to 300 million people living on less than $1.25 a day, is projected to be the region most affected by the impacts of disasters and climate change. Given their substantial dependence on agriculture, heavy reliance on ecosystem services, dense population concentrations, high levels of economic activity in coastal areas, and relatively poor health services, the poor in these countries are at a significant risk of the impacts of future disasters and climate change. Thus, this region contains a vast latent need that will have to be met.

Multiple authors have found that people in the ASEAN region, especially the farmer community, are more vulnerable to disasters and climate change than originally thought. It is estimated that more than 50% of farmers and their dependents, which accounted for around 350 million of ASEAN population, have been affected by disasters and climate change. Research by the Economic Research Institute for ASEAN and East Asia and other studies indicate that agriculture is the most vulnerable sector. In the ASEAN region alone, disaster risks and climate change combined are projected to drive up the price of rice by as much as 37%, as water scarcity, droughts, and floods reduce rice yields by 14%–20% over the next 30 years. The number of malnourished children in Southeast Asia is projected to increase by 16%, to 11 million. A warmer and drier climate and more frequent and intense extreme weather events are projected to reduce the gross domestic product of all ASEAN countries. In addition to this gloomy scenario, an insufficient capacity to adapt to disaster risks and climate change impacts, inadequate infrastructure, meager household incomes and savings, and limited support from public services is creating a veritable time bomb.

6.2 Adaptation and Resilience Strategies

Building resilient value chains and adapting to climate change is a challenging developmental problem. Efforts to adapt to disasters and the changing climate are connected to many aspects of development, and the implementation of adaptation activities is closely linked to a wide range of other activities, including natural resource management, agricultural technology, disaster preparedness, infrastructure improvement, health systems, and poverty alleviation, amongst others. Furthermore, the effects of disasters and climate change vary over time and places in the region, creating unique, dynamic adaptation needs in each country. When dealing with the physical impacts of climate change and natural disasters, each country's institutional and socioeconomic circumstances affect its capacity for resilience capacity and adaptation. In this tangled context, it becomes challenging to determine how adaptation measures should be designed, who should design them, and where investments should be prioritised.

Fortunately, many policies that are good for economic development in general also offer effective strategies for adapting to disasters and climate change. Such no-regret strategies include (i) investment in adaptive research on food security; (ii) improved water management to deal with extreme rainfall events; (iii) governance of common natural resources; (iv) transportation and communication infrastructure, as well as regional and international trade facilitation; (v) private-sector participation in insurance and credit markets; and (vi) the facilitation of migration to allow poor victims to take full advantage of changes in the climate and economic landscape, which are intertwined with an increase in the frequency and scale of disaster events.

There is an urgent need to integrate these resilience and CCA strategies into sectoral and regional development programmes. Adaptation policies, including long-term weather forecasting, dissemination of technology, and the creation of drought- and flood-resistant crop varieties, will require planning and investment at the national and international levels. Almost 70% of the water in ASEAN is used for irrigation, livestock rearing, and inland aquaculture activities. Therefore, improving water management by understanding water flow and water quality, improving rainwater harvesting, storing water, and diversifying irrigation techniques is critical. Other steps that can be initiated to blunt the impacts of climate change are greener practices, better erosion control and soil conservation measures, sustainable agro-forestry and forestry techniques, and better town planning. Since the affected communities are often constrained by access to credit, facilitating better access to credit is a related area that needs attention. In addition, catastrophe or weather-risk insurance and index insurance (i.e. insurance linked to a particular index, such as rainfall, humidity, or crop yields rather than actual loss) can be used as new climate risk-management tools. Making these improvements and building climate-resilient rural roads in the region will cost about \$3.0 billion–\$3.8 billion annually from 2010 to 2050 (ADB, 2009).

To date, several countries have piloted initiatives to promote mainstreaming, and several efforts are underway to build select national action programmes for adaptation through more comprehensive planning documents. There has also been speculation as to whether environmental impact assessment statements, Sustainable Development Goal targets, and/or the Sendai Framework for Disaster Risk Reduction could provide an effective vehicle for mainstreaming adaptation into sectoral planning and achieving food security. However, most of these efforts are still in the early stages. Likewise, the national climate change plans recently released by several countries under the Paris Climate Agreement have not yet been operationalised, and it is unclear how they will interact with other national planning efforts and the ASEAN Community Vision 2025. The multilateral funds pledged for CCA across developing countries currently amount to about \$400 million—far below the \$4 billion–\$86 billion needed annually, as estimated by several experts and aid agencies. Thus, from a financing perspective there are potential benefits of enhancing coherence between DRR and CCA.

6.3 Opportunities to Enhance Adaptive Capacity

Policy-making bodies within ASEAN concerned with DRR, the impact of climate change, and food security cannot wait for the academic and international communities to resolve all existing uncertainties, as there is little to be gained by waiting another couple of years before taking concrete steps to deal with these issues. This is particularly true in Cambodia, the Lao People's Democratic Republic, Myanmar, and Viet Nam where extreme events are already imposing severe burdens on farming communities and economic growth, which very much depends on the performance of the agricultural sector. The crucial role of information and products in developing resilience and adaptation solutions must be emphasised. Available climate and disaster information must be examined to ascertain where the need for systematic observation is most pressing. Collaboration between national and international providers of climate information, the research community, users in all sectors, and decision makers is crucial, as is generating awareness amongst different user communities of the usefulness of such information. There is an urgent need for climate change assessment tools that are more geographically precise and useful for sectoral policymaking, and reviewing programme and scenario assessment. Economic diversification to reduce dependence on climate-sensitive resources could also be an important adaptation strategy. It is necessary to encourage improved food security through crop diversification, the development of local food banks for people and livestock, improved local disaster preparedness, and better food preservation capabilities. Further, since climate change and natural disasters have gender-differentiated impacts, gender diversification (an area that has been neglected thus far) can bring wider perspectives to decision making, and women can contribute significantly to this process.

Thematic and country papers discussed at the 2017 Kuala Lumpur conference introduced several methods for measuring the impacts of disasters and climate change, as well as adaptation concepts and cases of mainstreaming. These measures have been applied in many countries over several years. One lesson for policymakers is that resilience and adaptation policies for food security must be tailored to local business continuity plans, because the local impacts of disasters and climate change vary significantly from place to place. Policymakers must be careful when transferring interventions from one country to another to ensure that the interventions are appropriate to the new location. Technologies, management practices, crop varieties, and financing models that have proven successful in one country need to be evaluated carefully before being introduced in another country to ensure that they will remain successful as the climate changes.

The development of infrastructure and human capacity at the institutional level may support or prevent good practices from being extrapolated from one country to another.

In some circumstances, ASEAN may benefit from policies designed and implemented in developed countries, and certain best management practices and new technologies may be transferrable from developed to developing countries. For example, water-saving technologies, stress-resistant crop varieties, early warning systems, and innovative financing systems created in developing countries could be modified by international and regional research institutes to the conditions prevalent in developing countries. These could then be introduced carefully with full support systems, such as institutions and financing, in place.

In large countries such as Indonesia, Malaysia, Thailand, and Viet Nam, factors such as climate, landscape, institutions, and local capacities may vary a great deal across the country. Such countries need to be careful in designing different policies for different regions within the country. Even small countries must be careful not to adopt uniform policies from different regions. One way to address physical and structural differences in a country is to develop different policies depending on a set of climatic conditions, disaster risks, and existing infrastructure and institutions in the country's various regions. Further, countries' economic and institutional abilities to implement adaptation measures may also vary.
It is possible that communities facing similar situations will be affected differently, depending on other physical and economic or institutional conditions that they may face. Both physical and economic conditions may affect the type of adaptation relevant to each location and the ability of the community residing in each location to adapt. Therefore, policymakers should tailor information, planning tools, and financial mechanisms to the assistance that each location will receive.

6.4 Building Adaptation Roadmaps

While the need to react to climate change and adapt to disaster risks is increasingly being recognised at all levels and by all players (albeit to varying degrees), there is a serious gap in public awareness with respect to constructive actions to address very complex adaptation issues. Increasing speculation is making it difficult to agree upon and implement the much-needed mainstreaming, further exacerbating climate risks. Thus, there is an urgent need to begin developing a common vision for a regional adaptation roadmap that involves all principal stakeholders and reconciles diverse perspectives.

Managing expectations from decision makers regarding the adaptation process is important. Successful adaptation does not just happen. A key recommendation is to plan and execute carefully a long-term national programme for supporting public participation in disaster risks and CCA aimed at educating and building the capacity of all stakeholders involved. The first step could be to develop detailed guidelines and provide training on public participation for both environmental authorities and sectoral agencies, adjusted for each sector. Significant attention should be given to building capacity at the local level to help communities understand the disaster and climate risks and linkages to sector activities, and thus garner participation in public forums. Overall, the programme should be designed and targeted in keeping with the diversity of the stakeholders.

Effective mainstreaming requires informed consensus on disaster and climate change risks, objectives, and policies based on a good understanding of the shared roles and responsibilities of all players, including sectoral agencies, ministries of the environment, ministries of planning, provincial authorities, and the affected community. This fundamental notion of shared responsibility is currently challenged in ASEAN countries by the general perceptions amongst the public, project proponents, and development authorities alike that climate change is the sole responsibility of environmental agencies, disaster response is a humanitarian assistance issue, and food security is better handled by the agriculture ministries, who are failing to implement necessary measures effectively. As the growth rates of ASEAN economies continue to accelerate, responses to disaster and climate change will come under increased scrutiny and pressure. The cases discussed in the Economic Research Institute for ASEAN and Southeast Asia papers demonstrate that, unless an increasing demand for mainstreaming is matched by adequate capacity building, it would be naive to expect substantial progress and unfair to place sole blame on the sectoral agencies.

Sectoral agencies face significant capacity constraints in meeting their existing mandates, introducing new adaption programmes and tools, and improving the effectiveness of existing ones. It is recommended that ministries of the environment and education, as well as sectoral agencies, use recent examples of several good practices to develop a medium-term capacity-strengthening action plan to meet current and projected needs, including financing requirements. Such a plan should first explore the possible capacity gains from (i) rationalising decision-making processes; (ii) upgrading climate and disaster information; (iii) decentralising responsibilities, staff, resources, and equipment to regional offices; (iv) outsourcing certain non-core functions; and (v) training to upgrade skills. It would conclude with a staffing plan, including the need for any additional positions to meet core needs, after exhausting all options to improve processes and efficiency. The plan could then be used for negotiations with planning and financing agencies, subject to making a strong and verifiable case.

There is also a fundamental need for sectoral agencies to facilitate better climate-proofing of individual projects; build business continuity plans along value chains, boost the resilience of the sector as a whole; and improve cross-sectoral coordination, particularly at the planning stage. Case studies and sector reviews show that monitoring and enforcement of specific sources can do much to improve the situation on the ground. At present, disaster and climate factors are not considered at the time of local decisions, in spatial planning, in project design, and in technology and infrastructure selection.

All institutions can play a key role in strengthening the necessary knowledge base and technical capacity to adapt to climate change and build resilience plans. Unless steps are taken to initiate and strengthen cooperation amongst academic and research institutions, regional and international organisations, and nongovernmental organisations to provide opportunities for strengthening the knowledge base, dealing with climate change and disaster risks may be unmanageable. Although some relevant information is already available from various institutions, it is important to focus future efforts on (i) disseminating it more evenly across the country; (ii) providing high-quality and comparable sector-specific training across states and organisations; and (iii) developing targeted, well-designed, and well-delivered programmes for community learning.

The lack of effective mechanisms for inter-agency coordination is too often a barrier to mainstreaming and attaining food security. It is thus critical for sectoral, environmental, and financing authorities to evaluate, share, and promote national best practice examples of policies and institutional mechanisms, as well as relevant international experience that can enable early and meaningful participation of environmental agencies in the planning and design of infrastructure development projects. New priorities and programmes will require even greater cross-sectoral cooperation and integration within particular spatial zones. Local governments appear to be best positioned and to have the right incentives to ensure the coordination needed. Thus, it is important to provide them with sufficient authority and capacity to forge such coordination. Devolving more powers to and building the capacity of local governments is necessary to develop and implement CCA programmes aimed at measurably improving climate risk reduction in the areas within their jurisdiction, with the participation of all concerned sectors and affected communities.

The scale of the regional adaptation roadmap is immense. The institutional changes and large-scale improvements needed on the ground will require national commitments and consensus on a programme of actions spanning both the short and long term. Many of these measures will involve further examination and design, as well as consultations with the public, other government agencies, and the affected communities.

In the short to medium tem, irrespective of whether a programmatic approach is pursued in specific instances, a set of key policy choices are proposed that can build the adaptive capacity of the countries against disasters and climate change. These can be summarised as follows:

(i) Moving up in the policy ladder; integrating sectoral policies on agriculture, environment, and civil protection; and linking them with economic policy and national planning.
(ii) Moving down into specific investment plans now, to avoid economic and environmental costs later. Countries also need to move forward to improve the resilience of value chains and lift productivity. To stand still will be to fall behind as others move on to lower cost, more competitive, and more secure sources of inputs and connect to consumer markets.
(iii) Moving together—since global problems start at home, global solutions require local actions. Domestic leadership now will shape regional and international thinking.

It is important to reach a broad agreement quickly with all major stakeholders on these priority actions, starting with the identified list (see Table 6.1), and to develop a medium- to long-term implementation programme for the agreed actions, supported by necessary resources, monitorable targets, and clear accountability mechanisms.

These policy options by no means represent the full spectrum of criteria that could be considered in shaping the adaptation roadmaps, and most policymakers will develop a range of other specific criteria relevant to their country's particular disaster risks, climate impacts, and development concerns. However, these policy choices can support the development of an enabling institutional and policy environment that will build capacity over time; foster mainstream adaptive actions by a range of stakeholders (e.g. academia, the private sector, local governments, and civil society); and encourage successful imitative replication.

An enormous agenda is not new for ASEAN, which has risen to meet such challenges on numerous occasions. Encouragingly, various players have recently taken many steps and initiatives in setting the right direction in the ASEAN Socio-Cultural Community Blueprint.

Table 6.1: Key Proposed Actions for Improving the Adaptative Capacity and the Role of Different Stakeholders

Key Issue	Strategic Policy Choices/Actions	Responsible Institution	Timeline
Promote Public Awareness	Develop national and sub-regional program on disaster risk reduction (DRR) and climate change impacts its causes, and best adaptation practices.	Sector agencies	Short to medium term (1–3 years)
	Develop sectoral guidelines and training on public participation in adaption programs.	Ministry of Environment	Short term (1 year)
	Devise gender specific strategies to deliver the DRR and climate risk information.	Sectoral agencies	Short term (1–3 years)
	Share local knowledge with environmental and sectoral agencies to disseminate examples of when public participation improves adaptation responses.	Media, civil society	Short term (1–2 years)
Improve Scientific Capacity	Develop and regularly update public online database on disaster and climate risk indicators.	Ministry of Environment	Short to medium term (1–5 years)
	Upgrade and expand targeted research and educational programs and/or sectoral research and training scientists, institutions etc.	Sectoral ministries	Short term, then continues
	Publicize the regional knowledge centers and create its satellite offices to disseminate relevant information to affected communities.	Academia, civil society	Short term (1–3 years)
	Maximize the effectiveness of current acts and programs by developing clear procedural guidelines regarding climate change adaptation add-ons.	Sectoral ministries, local governments	Continuous
Set Feasible Standards/ Benchmarks for Structural Measures	Review best international practice procedures for infrastructure standard setting and develop national guidelines; strengthen/expand the application of zoning concepts in setting national standards.	Ministry of Environment, academia	Medium term (1–5 years)
	Strengthen the instruments of social and economic impact assessment of new infrastructures by developing as clear methodology drawing on best international practices and adjusted to national/local context.	Sectoral ministries	Short to medium term (1–7 years)
	Provide necessary climate and economic information, collaborate on the analysis and facilitate consultation with industry.	Planning commission, sectoral agencies	Short term (1–3 years)
	Provide information on social/community impacts of the proposed standards.	Civil society, academia	Short term (1–3 years)

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Table 6.1: *Continued*

Key Issue	Strategic Policy Choices/Actions	Responsible Institution	Timeline
Develop New Programs to strengthen Non-Structural Measures	Develop a focused and well packaged program for most vulnerable locations that integrate targeted structural measures with non-structural measures, including a funding mechanism for scaling up.	Planning Commission, sectoral agencies	Medium term (1–7 years)
	Develop a set of regulatory incentives to support voluntary initiatives, using existing good practices.	Ministry of Environment	Continuous
	Provide training and capacity building to policymakers and private sector operators for better no-regret adaptation management focusing on international best practices that are locally appropriate.	Sectoral ministries, academia	Medium term (1–7 years)
	Periodically update sectoral guidelines for monitoring and adding new sectors of growing impact.	Local governments, NGOs	Continuous
Improve Cross-Sectoral Coordination	Strengthen existing formal mechanisms such as Environmental Impact Assessment (EIA) Statements, Sustainable Development Goals (SDGs) an to involve environmental authorities in designing structural and non-structural measures.	Ministry of Environment	Short term (1–3 years)
	Coordinate the development of strategic adaptation framework for using global environmental financing instruments.	Ministry of Environment	Medium term (2–4 years)
	Remove the tariff and non-tariff barriers related to key stable foods items	Ministry of Trade	Short term (1–3 years)
	Empower local governments to oversee regional climate change adaptation programs and foster cross-sectoral coordination.	Sectoral agencies and civil society	Short term (1–3 years)
	Develop sectoral guidelines to overcome specific identified gaps and facilitate uptake of best practices.	Sectoral agencies	Short term (1–3 years)
Augment Financial Resources	Explore innovative financing instruments including insurance programs, catastrophe bonds, and other risk transfer products to support future developments via global climate change agenda.	International donors	Short term (1–3 years)
	Develop a consistent budgetary framework for integrating disaster and climate risks and set it as input into a consistent and realistic delivery mechanisms related to most vulnerable sectors, communities or households in a transparent way.	Ministry of Finance	Short term (1–3 years)
	Link trade and business promotion incentives to adaptation financing; make heavy representation within regional/international adaptation funding institutions and help shape allocation decisions.	Planning Commission	Short term (1–3 years)
	Develop and implement medium term capacity strengthening action plans, as well as training and staffing plan to meet growing mandates.	Line agencies	Middle term (1–5 years)

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Table 6.1: *Continued*

Key Issue	Strategic Policy Choices/Actions	Responsible Institution	Timeline
Strengthen the Capacity for Regional Cooperation	Introduce an enhanced methodology for DRR and climate prediction at regional level; strengthen early warning systems for international river basins and economic impact assessment of collective cross border actions.	Academics from advanced economies	Short term (1–3 years)
	Share and promote regional best practice examples of mainstreaming adaptation practices in sectoral planning.	ASEC	Short to medium term (1–7 years)
	Provide technical and human resources needed for effective management of cross-border climate change impacts and make clear the roles and responsibilities of all parties involved for collective actions.	Ministry of Environment and Foreign Affairs	Short to medium term (1–5 years)
	Develop a network of regional centers within appropriate existing institutions to provide high quality training and knowledge to have high standard of professionalism across the countries.	ASEC	Continuous

ASEC = Association of Southeast Asian Nations Secretariat.

Source: Authors.

With its focus on concepts and cases of DRR and CCA, this chapter lays the foundation for a more structured and systematic analysis of how adaptation roadmaps can be built at the country level with short- and medium-term targets. Subsequent work should enrich the portfolio of policy choices, adaptation measures, methods, and cases presented here by focusing on an economic cost analysis for each action, and developing monitorable targets. This will be particularly relevant to local governments and those who devise adaptation strategies, as well as policymakers and the international community. These relevant stakeholders are strongly recommended to join forces in what must be a collective endeavour to address these issues that affect the social fabric, economic base, and ecosystem that ultimately shape the future of 650 million people living in ASEAN Member States.

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PART

II

Cambodia, Lao PDR, Myanmar and Viet Nam (CLMV) Adaptation Roadmaps

CHAPTER 7

Roadmap of Climate Change Adaptation for Cambodia

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7.1 Background

Cambodia is situated in the tropical zone and has a coastline 435 kilometres long. Its topography resembles a bowl surrounded by hills with the Tonle Sap Great Lake in the middle. Due to the considerable size of its forested land area, Cambodia has a significant carbon sink capacity that could provide the country with benefits in the carbon market. However, the country is also prone to floods, droughts, tropical storms, and vector-borne diseases. Its coastal areas are exposed to rising sea levels and severe impacts from typhoons, while rising temperatures are leading to more frequent and intense extreme weather events within a fragile socioeconomic context. The country's climate vulnerability frequently results in loss and damage to human life, livelihoods, and the national economy.

Cambodia was ranked 13th in the Global Climate Risk Index (1995–2015), and 8th in the 2016 World Risk Index. In 2014, Standard & Poor's rating service ranked Cambodia's economy as the most vulnerable in the world to the effects of climate change. The Notre Dame Global Adaptation Index categorises Cambodia as *high-vulnerability* and *low-readiness*. In October 2013, heavy rainfall resulted in flash floods that impacted over half a million people and affected 50% of Cambodia's provinces. Loss and damage resulting from the floods was estimated at $356 million, including damage to and destruction of physical assets and loss of agricultural production and other economic activities. A year earlier, in 2012, severe drought had affected 11 of Cambodia's 24 provinces and tens of thousands of hectares of rice-growing land. Such periodic and ever-more intense climate shocks can rapidly compromise livelihoods and put food security at risk. According to the Climate Risk and Adaptation Country Profile elaborated by the World Bank Group in 2011, the average annual temperature in Cambodia has increased by 0.8°C since 1960. The frequency of warm days and nights has increased dramatically, while cold days and nights have significantly decreased.

Climate projections indicate that temperatures across the country will rise by 0.7°C–2.7°C by 2060 and 1.4°C–4.3°C by 2090. Rainfall trends and patterns are uncertain and difficult to predict. Although they are likely to vary between different geographical areas, an overall increase in rainfall is expected during the monsoon season. In addition to more frequent severe floods, as seen over the last decade, rainfall patterns will become progressively less predictable by 2050.

In 2014, vulnerability assessments indicated that 17.2% of Cambodia's communes (279 communes) were 'highly' vulnerable, and over 31.5% (512 communes) were 'quite' vulnerable to multiple climate hazards. The agriculture, water resources, infrastructure, forestry, health, and coastal development sectors are the most vulnerable to the impacts of climate change. Agriculture, which represented 26.5% of gross domestic product in 2015 according to the National Institute of Statistics, is highly dependent on rainfall and on the annual flooding and recession of the Tonle Sap Great Lake. In terms of water resources, the rural communities most affected by climate impacts are highly dependent on water resources for agricultural production. Sustainable irrigation systems and sound freshwater management are critical to build the country's resilience. Infrastructure has also been critically affected by the increasing occurrence and severity of floods, which result in high maintenance costs and the recurrent need to upgrade rural roads and irrigation infrastructure. By 2050, it is projected that over 4 million hectares of lowland forest, which currently experience a dry season lasting 4–6 months, will become exposed to water-deficit periods of 6–8 months or more. Climate change can also impact human health, both directly and indirectly. Some examples of these impacts include changes in the geographical range and incidence of vector- and water-borne diseases, infectious diseases, and malnutrition and hunger as a result of severe disturbances to food production systems and ecosystems. Finally, coastal resources already face a number of environmental pressures, including over-fishing and over-exploitation of forests and mangrove ecosystems, that lead to increased erosion. Climate change exacerbates existing challenges through sea-level rise, saline intrusion, and coastal erosion, which contribute to the shrinking of arable land, reduction of drinking water sources, and loss of coastal infrastructure.

7.2 Policy Responses to Climate Change

In response to these challenges, the Government of Cambodia ratified the National Framework Convention on Climate Change in 1996 and, in 2013, undertook a high-level national policy dialogue on climate change that led to the development of the Cambodia Climate Change Strategic Plan (CCCSP), 2014–2023.

This plan had eight key objectives, namely:

(i) to promote climate resilience by improving food, water, and energy security;
(ii) to reduce sectoral, regional, gender vulnerability, and health risks from climate change impacts;
(iii) to ensure climate resilience of critical ecosystems (e.g. Tonle Sap Lake, the Mekong River, coastal ecosystems, and highlands), biodiversity, protected areas, and cultural heritage sites;
(iv) to promote low-carbon planning and technologies to support sustainable development;
(v) to improve capacities, knowledge, and awareness for climate change responses;
(vi) to promote adaptive social protection and participatory approaches in reducing loss and damage due to climate change;
(vii) to strengthen institutions and coordination frameworks for national climate change responses; and
(viii) to strengthen collaboration and active participation in regional and global climate change processes.

The CCCSP is consistent with Cambodia's National Strategic Development Plans. For example, the 2014–2018 plan has a section dedicated to environmental protection, conservation, and climate change. Building institutional capacity and utilising science-based solutions to address climate risks are common themes running through these overarching national policy documents. Within this framework, line ministries have prepared Sectoral Climate Change Strategic Plans supported by actionable Climate Change Action Plans (CCAPs); these were prepared in 2013–2014 and lasted through 2018. So far, 15 ministries have developed CCAPs encompassing a total of 171 climate actions (7% of them are mitigation-oriented and 93% have an adaptation focus).

In addition to national government policies that respond to climate challenges, development partners are supporting a number of flagship climate change initiatives that are helping to shape climate action and build resilience in Cambodia. The most relevant of these national policies and supporting initiatives are as follows:

(i) The National Adaptation Plan process aims to strengthen ongoing climate adaptation policy responses through cross-sectoral programming, financing, and implementation; and provides an umbrella-framework to build resilience at the national level. The National Adaptation Plan process is supported by Deutsche Gesellschaft für Internationale Zusammenarbeit and the United States Agency for International Development;

(ii) The Cambodia Climate Change Alliance (CCCA) takes a comprehensive and innovative approach to address climate change in Cambodia. The CCCA programme was designed to strengthen and be fully aligned with the national institutional framework for climate change. It plays a unique role in strengthening the national institutional framework to coordinate the climate change response. The overall objective of the CCCA is to strengthen the capacity of the National Committee for Sustainable Development (NCSD) to fulfill its mandate to address climate change, and to enable line ministries and civil society organisations to implement priority climate actions. Phase 1 of the CCCA (2010–2014) was funded by the European Union, the United Nations Development Program, the Swedish International Development Cooperation Agency, and the Danish International Development Agency. Phase 2 (2014–2019) is funded by the European Union, United Nations Development Program, and Swedish International Development Cooperation Agency. The initiative is implemented by the Ministry of Environment and coordinated by its Department of Climate Change.

(iii) The Strategic Program for Climate Resilience (tentative timeframe 2012–2019) emphasises two streams to promote climate resilience: (a) developing knowledge of climate impacts in Cambodia and mainstreaming climate risk management into the agriculture, water resources, and transport and urban infrastructure sectors; and (b) applying new skills, techniques, technology, and engineering practices to climate-proof hard investments. Financial support is provided from the Climate Investment Funds via the Asian Development Bank (ADB).

7.3 Nationally Determined Contribution

Cambodia intends to sustain the delivery of its nationally determined contribution (NDC) mainly through the implementation of the CCCSP. The majority of the NDC's priority projects draw from the line ministries' CCAPs and target adaptation measures. Of these projects, 13 address adaptation, five address mitigation, and one involves recommendations from the Second National Communication. Table 7.1 summarises the priority actions in the NDC related to climate adaptation, and the link to planning and implementation processes. In 2018, these will form the basis of a stock-taking and progress-monitoring exercise within the United Nations Framework Convention on Climate Change.

Table 7.1: NDC's Priority Actions

Intended Nationally Determined Contribution Adaptation Priority Actions	Existing Climate Change Strategies and Plans
Promote and improve the adaptive capacity of communities, and restore the natural ecosystem to respond to climate change.	Implementation of Climate Change Action Plan for Environment and Protected Area (2014–2018)
Implement measures of management and protection of areas to adapt to climate change.	Implementation of Climate Change Action Plan for Environment and Protected Area (2014–2018)
Strengthen climate information and early warning systems.	Implementation of Climate Change Action Plan for Water Resources and Meteorology (2014–2018)
Develop and rehabilitate flood protection dykes for agricultural and urban development.	Implementation of Climate Change Action Plan for Water Resources and Meteorology (2014–2018)
Increase the use of mobile pumping stations and permanent stations in response to mini-droughts, and promote groundwater research in response to drought and climate risk.	Implementation of Climate Change Action Plan for Water Resources and Meteorology (2014–2018)
Develop climate-proof tertiary-community irrigation to enhance agricultural production yields from paddy fields.	Implementation of Climate Change Action Plan for Rural Development (2014–2018)
Promote the climate resilience of agriculture by building sea dykes in coastal areas and scaling-up climate-smart farming systems.	Implementation of Climate Change Action Plan for Water Resources and Meteorology (2014–2018); and Climate Change Action Plan for Agriculture, Forestry and Fisheries (2014–2018)
Develop crop varieties suitable to agro-ecological zones and resilient to climate change (include coastal zones).	Implementation of Climate Change Action Plan for Agriculture, Forestry and Fisheries (2014–2018)
Promote aquaculture production systems and practices that are adaptive to climate change.	Implementation of Climate Change Action Plan for Agriculture, Forestry and Fisheries (2014-2018)
Repair and rehabilitate existing road infrastructure and ensure its effective operation and maintenance, taking into account climate change impacts.	Implementation of Climate Change Action Plan for Public Works and Transport (2014–2018)
Upscale the Malaria Control Program towards achieving pre-elimination status for malaria.	Implementation of Climate Change Action Plan for Public Health (2014–2018)
Upscale the national programme on acute respiratory infection, diarrhoea, and cholera in disaster-prone areas, including conducting surveillance and research on water- and food-borne diseases associated with climate variables.	Implementation of Climate Change Action Plan for Public Health (2014–2018)
Strengthen technical and institutional capacity to conduct climate change impact assessments, climate change projections, and mainstreaming of climate change into sector and sub-sector development plans.	Implementation of recommendations from the draft Second National Communication

Source: Department of Climate Change (2018), *Cambodia National Adaptation Plan Financing Framework and Implementation Plan 2017*. http://camclimate.org.kh/en/ccd/dcc-news/423-new-released-cambodia-national-adaptation-plan-financing-framework-and-implementation-plan.html (accessed 4 April 2019).

7.4 Adaptation Priority Actions

To date, 148 of the 171 projects identified in the CCAPs have not been implemented and remain largely unfunded. Only 23 projects are fully or partly funded. The 40 priority actions for climate change adaptation identified by the 15 sectoral CCAPs are outlined in Table 7.2.

Table 7.2: Climate Change Adaptation Priority Actions

No.	Sector	Priority Action
1	Fisheries	Promote aquaculture production systems and practices that are more adaptive to climate change.
2	Forestry	Develop and implement regulations and mechanism for REDD+.
3	Agriculture	Promote climate resilience for agriculture by building and maintaining sea dykes in coastal areas.
4	Water and sanitation	Carry out risk assessment and management to improve the water supply and sanitation in the Tonle Sap Great Lake provinces.
5	DRR	Strengthen climate information and early warning systems.
6	Agriculture	Promote and upscale climate-smart farming systems that are resilient to climate change.
7	Infrastructure	Repair and rehabilitate existing road infrastructure and ensure an effective operation and maintenance system, taking into account climate change impacts.
8	Cross-cutting	Develop and rehabilitate flood protection dykes (Kampong Trabek, Bateay) for agricultural and urban development.
9	Water	Upscale 20 mobile pumping stations and 10 permanent stations in response to mini-droughts.
10	Fisheries	Promote the climate resilience of wild fishery resources.
11	Fisheries	Enhance climate resilience in the fisheries sector.
12	Livestock	Enhance animal waste management and climate change emission mitigation.
13	Cross-cutting	Develop institutional capacity for natural disaster coordination and intervention.
14	Cross-cutting	Build capacity on and raise awareness of climate change and DRR for the Farmer Water User Community.
15	Water and irrigation	Improve climate risk management and rehabilitate small-, medium-, and large-scale irrigation infrastructure.
16	Infrastructure	Promote climate-proofing and retrofitting of existing and planned schools and university infrastructure.
17	Forestry	Promote sustainable forest management.
18	Health	Upscale the national programme on acute respiratory infection, diarrhoeal disease, and cholera in disaster-prone areas, and conduct surveillance and research on water- and food-borne diseases associated with climate variables.
19	Agriculture	Develop climate change-resilient crop varieties suitable to agro-ecological zones (include coastal zones).

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Table 7.2: *Continued*

No.	Sector	Priority Action
20	Agricultural infrastructure	Climate-proof tertiary-community irrigation development to enhance agricultural production of paddy fields in four communes in the Mekong Delta, District Kampong Ro, Svay Rieng Province.
21	Forestry	Promote reforestation and afforestation to increase carbon stocks.
22	DRR	Pilot community-based disaster reduction, preparedness, and response plans.
23	Agriculture	Promote post-harvest technology for cereal and tuber crops, and conduct research and transfer of appropriate post-harvest technology.
24	Knowledge management	Develop a knowledge and information system on climate change.
25	Cross-cutting	Promote gender responsiveness in water management, cross-cutting impact, and adaptation.
26	Cross-cutting	Build capacity on climate-proofing rural infrastructure design, construction, and maintenance for 250 civil engineers at the national and subnational levels.
27	Knowledge management	Enhance knowledge management related to climate change adaptation and promote need-based innovation.
28	Cross-cutting	Improve capacity for flood and drought forecasting and modelling for technical offices at the national and subnational levels.
29	Capacity building	Raise awareness of climate change for village development committees.
30	Tourism	Promote livelihood resilience through the development of community-based tourism and ecotourism.
31	Education	Develop educational policies, analyses, research, and planning for climate change adaptation and mitigation.
32	Capacity building	Build awareness and capacity at the national and subnational levels to mainstream climate change into rural development planning processes.
33	Cross-cutting	Strengthen the capacity of agricultural and agro-industry development entrepreneurs and agricultural cooperatives in low-carbon production.
34	Land use	Integrate climate change response measures with commune land use planning.
35	Housing	Promote resettlement and development to adapt to natural disasters at the urban and rural levels.
36	Livestock	Promote resilience in animal production and adaptation to climate change (technical package).
37	Rubber	Promote, pilot, and scale-up rubber clones from the International Rubber Research Development Board member countries in responding to climate change.
38	Forestry	Conduct capacity development, research, and awareness-raising on REDD+.
39	Cross-cutting	Support line ministries to mainstream climate change into development planning and budgeting.
40	Cross-cutting	Conduct national and sectoral vulnerability assessments.

DRR = disaster risk reduction, REDD+ = reducing emissions from deforestation and forest degradation.

Source: Department of Climate Change (2018), *Cambodia National Adaptation Plan Financing Framework and Implementation Plan 2017*. http://camclimate.org.kh/en/ccd/dcc-news/423-new-released-cambodia-national-adaptation-plan-financing-framework-and-implementation-plan.html (accessed 4 April 2019).

7.5 Financing Demand and Gap

The estimated climate change adaptation financing demand refers to the 15 sectoral CCAPs prepared during 2013 and 2014 by the climate-sensitive institutions (line ministries). These 15 CCAPs comprise 171 projects under 40 priority areas, requiring a total of $865.5 million to implement. This creates huge financing gaps, as outlined in Table 7.3.

Table 7.3: Climate Change Adaptation Financing Demand and Gap

No.	Ministry	No. of CCAP Projects	No. of Priority Actions	Funded projects	Partially Funded	Non-funded	Estimated Cost	Financing Gap	Gap (%)
1	MOE	17	2	8	4	5	27,670,000	6,940,000	25.0
2	MOWRAM	16	8	0	1	15	272,500,000	272,150,000	100.0
3	MRD	10	5	4	1	5	56,530,000	17,880,000	32.0
4	MAFF	29	17	0	1	28	187,550,000	187,100,000	100.0
5	MPWT	11	1	1	0	10	210,975,000	210,375,000	100.0
6	MOH	11	1	0	1	10	46,800,000	46,400,000	99.0
7	MIH	17	0	0	1	16	11,000,000	10,750,000	98.0
8	MLMUPC	8	2	0	1	7	9,120,000	8,870,000	97.0
9	MME	9	0	0	1	8	5,020,000	4,820,000	96.0
10	MOEYS	7	2	0	1	6	10,600,000	10,250,000	97.0
11	MOINFO	5	0	0	1	4	4,330,000	4,205,000	97.0
12	MOT	8	1	0	1	7	3,400,000	3,275,000	96.0
13	MOWA	6	0	1	1	4	3,620,000	3,360,000	93.0
14	NCDM	11	1	0	1	10	11,750,000	11,650,000	99.0
15	MPTC	6	0	0	0	6	4,605,000	4,605,000	100.0
	Total	**171**	**40**	**14**	**16**	**141**	**865,470,000**	**802,630,000**	**92.7**

CCAP = climate change action plan; MAFF = Ministry of Agriculture, Forestry and Fisheries; MIH = Ministry of Industry and Handicraft; MLMUPC = Ministry of Land Management, Urban Planning and Construction; MME = Ministry of Mines and Energy; MOE = Ministry of Environment; MOEYS = Ministry of Education, Youth and Sport; MOH = Ministry of Health; MOINFO = Ministry of Information; MOT = Ministry of Tourism; MOWA = Ministry of Women's Affairs; MOWRAM = Ministry of Water Resources and Metrology; MPTC = Ministry of Posts and Telecommunications; MPWT = Ministry of Public Works and Transport; MRD = Ministry of Rural Development; No. = number; NCDM = National Committee for Disaster Management.

Source: Department of Climate Change (2018), *Cambodia National Adaptation Plan Financing Framework and Implementation Plan 2017*. http://camclimate.org.kh/en/ccd/dcc-news/423-new-released-cambodia-national-adaptation-plan-financing-framework-and-implementation-plan.html (accessed 4 April 2019).

7.6 Institutional Arrangement

The NCSD was established by the Royal Decree No. 0515/403 (dated 9 May 2015), and its main mandates are (i) mainstreaming sustainable development into national policies, strategies, plans, programmes, and legislations; (ii) coordinating the implementation and evaluation of national policies, strategies, plans, programmes, and legislations; and (iii) leading actions related to the green economy, climate change, biodiversity, and biosafety. The NCSD is honourably presided over by the Prime Minister and chaired by the minister of environment. Its members comprise 27 secretaries of state from relevant ministries, 25 governors from all provinces, and 7 secretaries general from relevant general secretariats.

The NCSC General Secretariat situated in the Ministry of Environment consists of five departments: (i) the Department of Administration, Planning and Finance; (ii) the Department of Climate Change; (iii) the Department of Green Economy; (iv) the Department of Science and Technology; and (v) the Department of Biodiversity.

The main roles of the Department of Climate Change are that of focal point to the United Nations Framework Convention on Climate Change, and of coordinator to mainstream climate change-related actions, both mitigation and adaptation, into all national policies and strategies, as well as the sectoral plans and programmes of line ministries and institutions.

Furthermore, Ministerial Decree No. 2 (dated 5 May 2017) created the Climate Change Technical Working Group to support the NCSD by focusing on coordinating climate change-related actions in the country, including both mitigation and adaptation. It has 25 members from relevant ministries and institutions.

References

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CHAPTER 8

Climate Change Adaptation Roadmap of the Lao People's Democratic Republic

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8.1 Introduction

The Lao People's Democratic Republic (Lao PDR) set out its long-term goal for national development in its Eighth Five-Year National Socio-Economic Plan (2016–2020), with a Vision 2030. According to this vision, the goal for the Lao PDR is to transition from a least developed country to a middle-income country by 2030 supported by inclusive, stable, and sustainable economic growth while alleviating poverty. The Lao PDR recognises the strong link between sustainable economic development and the need to mainstream environmental considerations, including action on climate change, into its development plans. This recognition is reflected clearly in the Eighth National Socio-Economic Development Plan 2016–2020, the Socio-Economic Development Strategy until 2025, and the Vision to 2030.

The National Strategy on Climate Change of the Lao PDR (NSCC) was approved in early 2010, and was followed by the Climate Change Action Plan 2013–2020 in April 2013. The country subsequently submitted its intended nationally determined contribution (INDC) to the United Nations Framework Convention on Climate Change on 30 September 2015.

8.1.1 | Vision, Goals, and Key Initiatives

The objective of these initiatives is to secure a future in which the Lao PDR is capable of mitigating and adapting to changing conditions in a way that promotes sustainable economic development, reduces poverty, protects public health and safety, enhances the quality of the Lao PDR's natural environment, and advances the quality of life of all of the country's inhabitants.

The overarching goal is to facilitate sustainable development and increase the resilience of key sectors to climate change and its impacts such as natural disasters, while enhancing national and international cooperation, alliances, and partnerships, and improving public awareness and understanding of climate change, vulnerability, and economic impacts. To achieve these goals, the Lao PDR will seek to:

(i) establish and upgrade its policies, strategy, work plans, and legal documents related to climate change and its impact, as well as managing, monitoring, and reporting on the climate change situation on a regular basis;
(ii) increase and upgrade the organisational structure of agencies responsible for climate change, and ensure both the quantity and quality of human resources;
(iii) establish information and knowledge management, and exchange climate change information at the domestic, regional, and international levels;
(iv) build capacity on climate change through domestic, regional, and international cooperation;
(v) increase investment related to climate change through the use of the government budget, other domestic funding sources, and international funding sources;
(vi) establish an integrated school curriculum and raise public awareness on climate change nationwide; and
(vii) strengthen bilateral and multilateral cooperation with other countries and international organisations to access funding, transfer technology, gain more knowledge and experience, and strengthen regional and international linkages on climate change.

8.2 Target Projects and Activities

These objectives will be pursued under four key initiatives:

(i) strengthening institutional and human resource capacities on climate change,
(ii) enhancing adaptive capability for coping with climate change,
(iii) mitigating the impacts of climate change by reducing greenhouse gas (GHG) emissions, and
(iv) strengthening education and raising public awareness of climate change.

In addition to the overarching strategy set out in the NSCC, climate change action plans for the period 2013–2020 define mitigation and adaptation actions in the sectors of agriculture, forestry, land use change, water resources, energy, transportation, industry, and public health.

The Lao PDR is highly climate-vulnerable, and the country's GHG emissions were only 51,000 gigagram (Gg) in the year 2000, which is negligible compared to total global emissions. Despite this, the Lao PDR has ambitious plans to reduce its GHG emissions while at the same time increasing its resilience to the negative impacts of climate change. For example, the National Forestry Strategy to the Year 2020 sets out an ambitious target to increase forest cover to 70% of land area by 2020, and maintain it at that level going forward. This will reduce the risk of floods and prevent land degradation, while substantially and lastingly mitigating GHG emissions. In terms of the Lao PDR's large-scale electricity generation, the electricity grid draws on renewable resources for almost 100% of its output. The Lao PDR also aims to utilise unexploited hydropower resources to export clean electricity to its neighbours such as Cambodia, Singapore, Thailand, and Viet Nam, thus enabling other countries in Southeast Asia to develop and industrialise in a sustainable manner. The Government of the Lao PDR has also laid the foundations for the implementation of a renewable energy strategy that aims to increase the share of small-scale renewable energy to 30% of total energy consumption by 2030.

Climate change is already causing economic loss and affecting the livelihoods, food security, water supply, and health of much of the country's population. As the frequency and intensity of climate-related hazards such as droughts and floods are expected to increase in future, the Lao PDR must urgently take steps to build its resilience by boosting adaptation efforts across all sectors. A more detailed summary of the country's vulnerabilities to climate change and the adaptation actions proposed to address them are discussed further in section 3 of the Lao PDR's INDC.

The Lao PDR is committed to implementing its NSCC and sectoral climate change action plans for the benefit of the nation, region, and the world. However, to deliver the identified mitigation and adaptation actions, it will require technical and financial support. Such support will make it possible to implement the NCCS efficiently, optimise the identified potential GHG reductions, and adapt effectively to the negative and immediate effects of climate change.

As set out in the Vision for 2030, the Lao PDR intends to balance its need for development without compromising its environment. With respect to climate change adaptation, this translates into the following goals, which are articulated in the NSCC:

(i) increase the resilience of key economic sectors and natural resources to climate change and its impacts;
(ii) enhance cooperation, and build strong alliances and partnerships with national stakeholders and international partners to achieve national development goals; and
(iii) improve public awareness and understanding of various stakeholders about climate change, vulnerabilities, and impacts to increase stakeholder willingness to take actions.

The Lao PDR's economy is already experiencing the impacts of climate change, and the majority of the population remains highly vulnerable to climate hazards, especially floods and droughts. This is because the Lao PDR's economy and more than 70% of the population depend on natural resources, both for their livelihoods and to ensure food security. The agriculture sector is responsible for 29.9% of gross domestic product, and approximately 70% of the population depend on this sector for their livelihoods. Increasing climate resilience and food security with respect to agriculture is therefore a high priority. Another high priority is the provision and management of water resources, as this contributes to social wellbeing, economic productivity, and water supplies for agriculture, industrial processes, and energy production.

Flooding and droughts are major climate risks in the country, threatening livelihoods almost every year. Since 1995, 14 of 17 provinces as well as the capital, Vientiane, have experienced floods. The country's annual rainfall is expected to become increasingly variable and, accompanied by rising temperatures, could significantly impact water resources, ecosystems, and agricultural production. In addition, floods adversely impact housing, health and education, industrial activities, and infrastructure (e.g. transportation, water, and sanitation). For example, flooding in 2005 caused widespread disruption with an estimated economic cost of $29 million.

The Lao PDR is also experiencing increasingly frequent episodes of drought, with severe droughts occurring in 1996, 1998, and 2003. It is estimated that 6 out of 17 provinces are already at high risk of droughts. Droughts adversely affect water resources, hydroelectricity generation, and agricultural production, resulting in widespread economic losses.

The National Adaptation Programme of Action (2009) maps out a country-driven programme to address immediate and projected climate change adaptation requirements in the agriculture, forestry, water resources, and public health sectors. The adaptation programme was further developed in the NSCC to cover the main economic sectors—agriculture and food security, forestry and land use change, water, energy and transport, urban development, industry, and public health—targeted for implementation by 2020.

One of the guiding principles of the NSCC is to develop and implement integrated, low-cost adaptation and mitigation solutions, improve energy efficiency, promote cleaner production, and provide adaptation and mitigation synergies as well as economic, environmental, and socioeconomic benefits. Hydroelectricity has great potential in the Lao PDR to provide clean energy and reduce GHG emissions, while meeting other objectives such as flood, irrigation, and water supply management. The forestry sector contributes to both the national economy and the livelihoods of many Laotians. Sustainable forest management therefore improves the resilience of communities and ecosystems while reducing GHG emissions by absorbing carbon dioxide.

To work towards achieving the NSCC's vision and goals and to implement climate change action plans effectively for all sectors, it is immediately necessary to develop a monitoring and evaluation system for the Lao PDR. Table 8.1 reflects the nation's adaptation priorities given the current understanding of expected climate impacts. These actions will be continuously assessed and improved when monitoring and evaluating data, and when new information about climate change and its impacts become available.

Table 8.1: Focus of Climate Change Adaptation Projects in Key Sectors

Sectors	Focus of Projects and Programmes
1. Agriculture	• Promote climate resilience in farming systems and agricultural infrastructure.
2. Forestry and land use change	• Promote climate resilience in forestry production and forest ecosystems. • Promote technical capacity in the forestry sector for managing forests for climate change adaptation.
3. Water response	• Strengthen water resource information systems for climate change adaptation. • Manage watersheds and wetlands for climate change resilience. • Increase water resource infrastructure resilience to climate change. • Promote climate change capacity in the water resource sector.
4. Transportation and urban development	• Increase the resilience of urban development and infrastructure to climate change.
5. Public health	• Increase the resilience of the public health infrastructure and water supply system to climate change and natural disaster. • Improve public health services for climate change adaptation and coping with climate change-induced impacts.

Source: Authors.

The following target projects and activities will be implemented to achieve the climate change goals, objectives, and key initiatives mentioned above, with a focus on promoting climate change adaptation and mitigation, and managing impacts, such as natural disasters. Below we identify key ministries that will implement a detailed plan, including funds, effectively in the future.

Table 8.2: Key Sectors for Climate Change Adaptation to 2030 (the Lao PDR's Intended Nationally Determined Contribution, 2015)

A: Agriculture Sector		
No.	**Action plan focus outputs Responsibility = Ministry of Agriculture and Forestry**	
A.1	Objective 1 and related activities	Promote climate resilience in farming systems and agriculture infrastructure: • Improve appropriate resilient agricultural farming system practices and technologies to address climate change impacts. • Develop and improve crops and animal diversification and resilience especially in areas at risk of flooding and drought.
A.2	Objective 2 and related activities	Promote appropriate technologies for climate change adaptation: • Promote and enhance the development of appropriate technologies to cope with climate change. This may include the conservation of agricultural soil, animal health and disease outbreak monitoring and control, long-term feed storage improvement, climate-resilient crops, efficient water-use cropping systems, short rotation cropping, and maximising the use of indigenous climate-resilient knowledge. • Upgrade agricultural research and extension services to define and promote existing agricultural practices to reduce the negative effects of climate change. • Promote two seasons of rice cultivation in flood-prone areas through the use of adaptive and short-rotation rice varieties. • Promote appropriate techniques for crop and animal production, as well as meteorological and agricultural technologies in areas at risk of natural disasters.
A.3	Main barriers to implementation	• Limited knowledge, capacity, and technology on appropriate conservation farming systems, integrated and sustainable agriculture, agro-forestry, soil degradation and quality restoration, pest outbreak management, tolerant crops, and different animal varieties • Limited information, knowledge, and capacity on the vulnerability assessment of conservation farming systems, as well as integrated and sustainable agriculture to support mitigation and adaptation • Ineffective law enforcement, especially land concession, conversion, chemicals. and environmentally friendly agriculture • Lack of comprehensive land development policy, including effectiveness • Limited budget for the promotion of and investment in climate-resilient agriculture

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Table 8.2: *Continued*

A: Agriculture Sector		
No.	**Action plan focus outputs Responsibility = Ministry of Agriculture and Forestry**	
A.4	Support required	• Capacity building including research on appropriate conservation farming systems, integrated and sustainable agriculture, agro-forestry, soil degradation and quality restoration, pest outbreak management, and tolerant crops and different animal varieties. • Financial support to pilot and promote appropriate conservation farming systems, integrated and sustainable agriculture, agro-forestry, soil degradation and quality restoration, pest outbreak management and tolerant crops and different animal varieties.
A.5	Estimated cost	$709 million (2007–2030) (Government of the Lao PDR, 2015)
B: Forestry and Land Use Change Sectors		
No.	**Action plan focus outputs Responsibility = Ministry of Natural Resources and Environment Ministry of Agriculture and Forestry**	
B.1	Objective 1 and related activities	Promote climate resilience in forestry production and forest ecosystems: • Develop and enforce appropriate laws and regulations, and implement guidelines for sustainable forest management. • Strengthen capacity in integrated land use planning and watershed forest management, and reduce slash and burn practices to increase the resilience of forests to cope with climate change. • Promote integrated actions on watersheds, reservoir management, water storage for agro-forestry, wildlife management, fisheries and tree varieties, and the prevention of drought. • Conduct forest surveys and allocation for sustainable management and rural development. • Strengthen the capacity of technical staff and village forest volunteers to enable optimal planting, management, and utilisation of community forests in response to climate change. • Promote forest seed and seedling production for reforestation and forest restoration. • Research and select forest species resilient to pests, diseases, drought, and soil erosion.
B.2	Objective 2 and related activities	Promote technical capacity in the forestry sector to manage forests to adapt to climate change: • Increase awareness and technical capacity of village forest volunteers on climate-resilient natural forest management, agro-forestry, and plantation technologies. • Assess capacity limitations and needs in the management of the forestry sector in relation to climate change adaptation.

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Table 8.2: *Continued*

B: Forestry and Land Use Change Sectors		
No.	**Action plan focus outputs** **Responsibility = Ministry of Natural Resources and Environment** **Ministry of Agriculture and Forestry**	
B.3	Main barriers to implementation	• Limited knowledge and capacity on climate change impacts on the forest sector, on adaptation technologies such as ecosystem-based approaches, on climate-resilient flora and fauna species, and on sustainable forest management for addressing climate change impacts and wood demand management. • Capacity on sustainable production forest and ecosystem management is limited. • Sustainable production forest law enforcement and management is ineffective. • Lack of financial support and investment
B.4	Support required	• Strengthening capacity building on the planning and establishment of information management systems; the development of an action plan for different types of forests and technologies; climate change adaptation technologies (e.g. ecosystem-based approaches, and resilient species and forest systems); sustainable production forests and ecosystem-based forest management techniques; and access to international finance and systematic sector investment planning. • Strengthening capacity building for access to international finance and systematic sector investment planning. • Financial support and investment in commercial forest carbon projects including a financial mechanism, the market, technology, calculation, and monitoring.
B.5	Estimated cost	$40.5 million (until 2020) (United Nations Development Programme, Water Resources and Environment Agency, and Global Environment Facility, 2009)
C: Water Resources		
No.	**Action plan focus outputs** **Responsibility = Ministry of Natural Resources and Environment**	
C.1	Objective 1 and related activities	Strengthening water resource information systems for climate change adaptation: • Strengthen information gathering, modelling, and vulnerability assessment for climate change in priority river basins in the Lao PDR. • Develop and implement reliable early-warning flood systems, reporting, and information disseminating services.
C.2	Objective 2 and related activities	Managing watersheds and wetlands for climate change resilience: • Strengthen the protection of watersheds to safeguard and moderate downstream flow during periods of high and low flow. • Study and promote the conservation of wetlands as part of a climate-resilient, ecosystem-based approach.
C.3	Objective 3 and related activities	Increasing water resource infrastructure resilience to climate change: • Develop and strengthen standards and procedures to ensure the safety of dams and other water resource related infrastructure; and prepare investment plans for upgrading and safeguarding infrastructure for water resource management. • Design and build multi-purpose dam and reservoirs to ensure sufficient water supply in drought-prone areas and seasons. • Construct and/or rehabilitate dykes and enhance river bank protection and irrigation systems to increase climate resilience.

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Table 8.2: *Continued*

C: Water Resources		
No.	**Action plan focus outputs Responsibility = Ministry of Natural Resources and Environment**	
C.4	Objective 4 and related activities	Promotion of climate change capacity in the water resource sector: • Increase awareness and technical capacity of staff regarding climate change impacts on water resources, appropriate technologies, and wetland management. • Increase water resource management capacity for climate change adaptation. • Study the impacts of water treatments on groundwater and the ecosystem.
C.5	Main barriers to implementation	• Knowledge and capacity with regard to climate change impacts on water resources, early warning systems, wetland management, climate-resilient technologies, and financial assessments are limited and inadequate. • Early warning systems and flood risk management are limited and inadequate. • Integrated watershed management is not effectively promoted due to a lack of comprehensive water storage and a water quality plan. • Lack of a financial mechanism to access finance, mobilise resources, and support investment.
C.6	Support required	Capacity and financial support for: • Flood/drought management and early warning systems • Development of a policy for dam safety and a multipurpose water supply • Climate-resilient water resources infrastructure • Law enforcement
C.7	Investment for adaptation	$44 million (until 2030) (Government of the Lao PDR, 2015)
D: Transport and Urban Development		
No.	**Action plan focus outputs Responsibility = Ministry of Public Work and Transport**	
D.1	Objective 1 and related activities	Increasing the resilience of urban development and infrastructure to climate change: • Conduct climate risk audits for key infrastructure services. • Ensure that flood protection and drainage design for urban infrastructure (roads, drains, flood protection works, water and wastewater facilities, landfills, hospitals, and other public buildings) are adequate for climate change conditions. • Ensure that urban water supply systems have adequate design and operational standards for climate change impacts, including access to low flows in water sources, water treatment capability, and flood protection. • Build storm surge and flood protection works for urban infrastructure.
D.2	Main barriers to implementation	• Research, information, and capacity on sustainable and climate-resilient urban planning and development technologies • Limited knowledge and capacity on sustainable and climate-resilient urban planning and development, and technologies • Lack of financial mechanism, access to finance, and resource mobilisation

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Table 8.2: ***Continued***

D: Transport and Urban Development		
No.	**Action plan focus outputs Responsibility = Ministry of Public Work and Transport**	
D.3	Support required	Strengthen human resources capacity and financial capacity on: • Develop financial and investment plans for the implementation of climate-resilient urban planning and development and deployment of technology. • Mainstream appropriate, climate-resilient technologies in the environmental impact assessment. • Strengthen cooperation and partnership, financial mechanism, access to finance, and resource mobilisation.
D.4	Investment for adaptation	$190 million (until 2020)
E: Public Health Sector		
No.	**Action plan focus outputs Responsibility = Ministry of Public Health**	
E.1	Objective 1 and related activities	Increasing the resilience of public health infrastructure and the water supply system to climate change: • Develop climate-resilient, health-related infrastructure and facilities such as health care centers, laboratories, rural water supply, and sanitation systems. • Increase capacity on climate change impact assessments, estimate financial needs, and implement resilience plans in the health sector.
E.2	Objective 2 and related activities	Improving public health services for climate change adaptation and coping with climate change-induced impacts: • Improve education, research on climate change-induced disease and health impacts, its treatments (by both modern and traditional methods), monitoring, and reporting. • Improve access to human resources and increase service coverage in vulnerable communities. • Improve medical and food supplies, nutritional surveillance, and drinking water by better managing the water supply network. • Increase public and vulnerable community awareness on climate change-induced health risks, provide advisories and warnings, enhance first aid, and promote self-help and access to health care services in communities. • Develop policies to increase the ability of vulnerable groups and the poor to access health services.
E.3	Main barriers to implementation	• Inadequate capacity to conduct climate change vulnerability and impact assessments • Inadequate capacity and human resources • Limited budget, quality, and quantity of human resources

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Table 8.2: *Continued*

E: Public Health Sector		
No.	**Action plan focus outputs Responsibility = Ministry of Public Health**	
E.4	Support required	• Capacity building on disease outbreak monitoring, response plans, and human resource development planning. • Technical and financial support to raise awareness of climate change impacts and health risks. • Capacity and financial support to develop monitoring centers, laboratories, mobile teams and stations, and treatment centres.
E.5	Investment for adaptation	$5 million (until 2020)

Lao PDR = Lao People's Democratic Republic.

Sources: Government of the Lao People's Democratic Republic (2015), *Lao PDR's Intended Nationally Determined Contribution (INDC)*. United Nations Framework Convention on Climate Change. https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Laos/1/Lao%20PDR%20INDC.pdf (accessed 1 October 2018); United Nations Development Programme, Water Resources and Environment Agency, and Global Environment Facility (2009), *National Adaptation Programme of Action*. New York: United Nations Development Programme. https://unfccc.int/resource/docs/napa/laos01.pdf (accessed 10 October 2018).

8.3 Mitigation Contribution in the Lao People's Democratic Republic

The Lao PDR has identified a number of actions that it intends to undertake to reduce its future GHG emissions, subject to the provision of international support. These are outlined in Table 8.3, together with preliminary estimates of the projected emissions reductions that will occur as a result. These estimates have been drawn from a variety of sources and should be reviewed and updated to address consistency and accuracy in analytical methods once more reliable data and information are available. The Lao PDR's GHG emissions are very low in the global context, and its historic contribution to climate change has been minimal. Despite this and its status as a least developed country, the government intends to implement policies that support the long-term goal of limiting global GHG emissions in line with the objectives of the United Nations Framework Convention on Climate Change and the findings of the Intergovernmental Panel on Climate Change's Fifth Assessment Report. This represents the first time that the Lao PDR has made an international undertaking to take action on mitigation, and therefore fulfills the requirements of the Lima Call for Climate Action to go beyond existing efforts.

Table 8.3: Climate Change Mitigation through the Reduction of Greenhouse Gas Emissions in 2015–2030

No.	Name of Activity	Objectives of the Activity	Estimated CO_2 Equivalent Reductions
1	Implementation of the 'Forestry Strategy to the Year 2020' of the Lao PDR	To increase forest cover to 70% of land area (i.e. 16.58 million hectares) by 2020. Once the target is achieved, emission reductions will carry on beyond 2020.	60,000 kt–69,000 kt of CO_2 equivalent (once the target has been met, from 2020 onwards)
2	Implementation of the Renewable Energy Development Strategy	To increase the share of renewable energy to 30% of energy consumption by 2025 (note that large-scale technologies with installed capacity equal to or greater than 15 MW are not included in this policy's target). For transport fuels, the objective is to increase the share of biofuels to meet 10% of the demand for transport fuels by 2025.	1,468,000 kt of CO_2 equivalent (by 2025).
3	Implementation of the Rural Electrification Programme	To make electricity available to 90% of households in rural areas by 2020. This will offset the combustion of fossil fuels to produce power where there is no access to the electricity grid.	63 kt of CO_2 per year (once the target has been met in 2020)
4	Implementation of transport-focused NAMAs	In one NAMA feasibility study, road network development is identified as the primary objective, which will reduce the number of kilometers travelled by all vehicles. The second objective is to increase the use of public transport compared to business as usual. In addition to reducing greenhouse gas emissions, this activity will lead to a reduction in nitrous oxide and sulfur oxide emissions, which will have significant co-benefits such as improved air quality that will in turn positively impact human health.	Road network development = 33 kt of CO_2 per year, and 158 kt of CO_2 per year for public transport development
5	Expansion of the use of large-scale hydroelectricity	The objective of this activity is to build large-scale (>15 MW) hydropower plants to provide clean electricity to neighbouring countries. The total installed capacity of the hydropower plants will be approximately 5,500 MW by 2020. In addition, 20,000 MW of additional hydroelectric capacity is planned for construction after 2020.	16,284 kt of CO_2 per year (2020–2030)
6	Implementation of climate change action plans	To build capacity to monitor and evaluate policy implementation success, with the aim of producing new policy, guidance, and data. The objective is to develop and implement effective, efficient, and economically viable climate change mitigation and adaptation measures.	To be estimated as part of the implementation plan
7	Estimated cost	$180 million This is assuming that the cost for forest management is approximately $10.84/hectare (this does not include costs related to plantations and therefore provides a lower bound of the total cost related to this measure).	Ends in 2030.

CO_2 = carbon dioxide, kt = kilotonnes, Lao PDR = Lao People's Democratic Republic, MW = megawatt, NAMA = nationally appropriate mitigation action.

Source: Government of the Lao PDR (2015), *Lao PDR's Intended Nationally Determined Contribution (INDC)*. United Nations Framework Convention on Climate Change. https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Laos/1/Lao%20PDR%20INDC.pdf (accessed 1 October 2018).

To maximise the ambition of its mitigation contribution while taking into account the need for economic development, the Lao PDR has prioritised mitigation actions that both address the main causes of future increases in emissions and also have significant development co-benefits. This is considered a fair approach to the nation's first INDC. Forestry-based actions will not only increase the amount of GHG sinks in the Lao PDR, but will also provide adaptation co-benefits contributing to the prevention of flooding, soil erosion, and landslides; and the protection of biodiversity and ecosystem services. Improving public transport will not only result in lower GHG emissions as a result of travel, but will also improve air quality and support more sustainable economic growth. The rural electrification programme will reduce GHG emissions, promote rural development, and reduce poverty. Finally, the export of hydropower to other countries in the region will allow these economies to grow in a more sustainable manner, by replacing consumption of fossil fuels.

Table 8.4: Implementation of 'Forestry Strategy to the Year 2020' of the Lao People's Democratic Republic

No.	Action Plan Focus	Outputs
1	Description	Trees and forests are greenhouse gas sinks, that is, they absorb CO_2. They also preserve land quality, mitigating the risk of flooding and landslides. Increasing and maintaining total forest cover therefore has significant mitigation impacts and development co-benefits.
2	Objectives	The objective of this activity includes increasing total forest cover to 70% of land area (16.58 million hectares). Once this target is achieved, emission reductions will carry on beyond 2030 as forest cover is maintained.
3	Base year	2000
4	Methodology for assessing base year and anticipated future emissions	See the calculations presented in the Lao PDR's Second National Communication to the United Nations Framework Convention on Climate Change, Chapter 4, sections 4.4.2 and 4.4.5, and the Technology Needs Assessment (2013). The base year of 2000 is selected, as this is when the latest emissions inventory was calculated as part of the process of compiling the Second National Communication.
5	Anticipated emission reductions	If these measures are implemented effectively, the country will successfully increase its natural forest coverage to 70% (about 16.58 million hectares), with an additional 500,000 hectares of plantation, logging, and conversion forest under control until 2020. In this scenario, the forests in the Lao PDR would be able to sequestrate about 60,000 kt–69,000 kt of CO_2 equivalent by 2020.
6	Plan to achieve the goal	• Implement the plans set out in the Forestry Strategy to the Year 2020 of the Lao PDR. As the strategy runs until 2020, the Lao PDR will begin revising the next set of action plans to maintain forest cover at 70% after the target date of 2020. Work on developing the new strategy will begin in 2018.

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Table 8.4: *Continued*

No.	Action Plan Focus	Outputs
		• Implement the REDD+ programme, which has provided a framework for the development of the forestry sector in the Lao PDR since around 2007. As early as 2009, a number of REDD+ pilot activities and projects supported by development partners were initiated, and in 2010, the Lao PDR became one of the first pilot countries under the Forest Investment Program, a multilateral programme under the Climate Investment Funds. • Implement the voluntary partnership agreement, which is a bilateral trade agreement between the EU and a timber-exporting country outside the EU. The Government of the Lao PDR announced its interest in negotiating a voluntary partnership agreement in February 2012. • Continue to carry out the Forest Law Enforcement, Governance and Trade Action Plan, which began in October 2013, with support from Germany´s Deutsche Gesellschaft für Internationale Zusammenarbeit.
7	Main barriers to implementation	• Ineffectiveness of existing forest management systems, including law enforcement, especially on forest harvesting, conversion as a result of development projects, collection, and management of forest funds. • Forest inspection system is not systemised or effectively enforced. • Resources and capacity for forest inventory, planning, and restoration is limited. • Poverty and limited livelihood options lead to forest encroachment. • Unclear or lack of policies and guidelines to promote forest restoration and reforestation
8	Support required	Capacity building, technology transfer, and financial support on: • law enforcement; • forest monitoring and inspection system; • forest restoration and rehabilitation; • sustainable community forest management and agro-forestry for mitigation and poverty reduction; • policy for investment in forest restoration; • forest inventory and planning system; and • research on forest ecosystem, economic, and best practices in relation to climate change mitigation.
9	Estimated cost	$180 million This is assuming that the cost for forest management is approximately $10.84 per hectares. This does not include costs related to plantations and therefore provides a lower bound of the total cost related to this measure.

CO_2 = carbon dioxide, EU = European Union, kt = kilotonnes, Lao PDR = Lao People's Democratic Republic, REDD+ = Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries.

Source: Government of the Lao PDR (2015), *Lao PDR's Intended Nationally Determined Contribution (INDC)*. United Nations Framework Convention on Climate Change. https://www4.unfccc.int/sites/submissions/INDC/Published%20 Documents/Laos/1/Lao%20PDR%20INDC.pdf (accessed 1 October 2018).

Table 8.5: Implementation of Renewable Energy Development Strategy

No.	Action Plan Focus	Outputs
1	Description	The Renewable Energy Strategy (2011) outlines actions and plans to increase the use of small-scale hydropower, solar energy, biomass, biogas, municipal solid waste to energy, and wind technologies, as well as transport fuels (bioethanol and biodiesel), to provide clean energy to consumers.
2	Objectives	• To increase the share of renewable energy to 30% of energy consumption by 2025. • To increase the share of biofuels to meet 10% of the demand for transport fuels by 2025.
3	Base year	2011
4	Methodology for assessing base year and anticipated future emissions	For further information, please see the Renewable Energy Development Strategy (2011) of the Lao PDR. These are preliminary estimates, which will be reviewed and updated once technical capacity has been built and more reliable data are made available.
5	Anticipated emission reductions	1,468,000 kt of CO_2 equivalent (by 2025)
6	Plan to achieve the goal	The Renewable Energy Strategy was approved at the national level in 2011. The Ministry of Energy and Mines is the main agency responsible for renewable energy coordination, and its main functions include the following: • Develop an overall renewable energy policy and support the achievement of sustainable development goals. • Set up objectives and goals based on resource potentials, and develop a renewable energy database. • Carry out studies and demonstration projects utilising renewable energy technologies. Other ministries with responsibilities under the Renewable Energy Strategy include the following: • The Ministry of Agriculture and Forestry, in collaboration with the Ministry of Natural Resources and Environment and provincial authorities, will determine and develop policies related to the most effective use of lands for planting crops for fuel and industrial uses, carry out participatory land use planning and local land use zoning, and monitor and enforce the implementation of the policy. • The Ministry of Natural Resources and Environment is responsible for undertaking research on the use of water resources, and will collaborate with the Ministry of Energy and Mines on studies concerning the production of hydrogen fuels. Further, they are responsible for developing and enforcing requirements and guidelines, and minimising the environmental and social impacts of renewable energy development through overseeing initial environmental examinations and carrying out environmental impact assessments. • The Ministry of Science and Technology conducts research and pilots tests on science and technologies developed from different countries, for renewable energy applications. • The Ministry of Industry and Commerce facilitates the importation of equipment and machinery, seeds, and vehicles related to the development of renewable energies, as well as supporting the construction of gas stations for biofuel distribution.

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Table 8.5: *Continued*

No.	Action Plan Focus	Outputs
		• The Ministry of Public Works and Transportation will be responsible for introducing policies that promote the use of alternative fuels in individual vehicles, public transportation systems, freight, and air transport. • The Ministry of Finance determines appropriate tax and duties policies for land use, vehicles, and equipment to be used for renewable energy projects, while at the same time helping to raise funds for renewable energy development. • The Central Bank of the Lao PDR will consider carbon credits and low-interest loans as sources of financing for renewable energy projects and activities, agricultural promotion and fuel crop plantation development, and projects carried out by small and medium-sized enterprises. Regarding implementation, the first step is to assess and update the Renewable Energy Strategy, including the analysis of: • Resources available, identifying gaps and opportunities for improvement in technology selection and sources. Specifically, the gaps that require analysis in the Lao PDR include: (a) political, legal, regulatory, and institutional gaps; (b) economic, financial, and market gaps; and (c) technology, human capacity, and infrastructure gaps. • Current levels of deployment and their management. • Current supply targets and how they are aligned with demand forecasts. • Support policies, such as feed-in tariffs, tax incentives, and import duties. • Market readiness to encourage investment by the private sector. As a result, the Lao PDR's energy focal points and related organisations will be able to comply with all related international agreements with respect to energy supply and trading. Its regulatory system would be strengthened, giving the Lao PDR a more organised and authoritative voice when negotiating with potential partners.
7	Main barriers to implementation	• Lack of reliable data on renewable energy including its subsectors, that is, the actual potential and feasibility of each renewable energy source and optimal locations. • Knowledge and capacity on renewable technologies are limited. • Promotion and investment are limited. • Lack of policy to promote renewable energy technology development, import–export, and subsidy mechanisms.
8	Support required	• Strengthen capacity for research on the potential and feasibility of each renewable energy source and location. • Strengthen financial mechanisms, policy promoting the development of renewable energy, and technologies including its supply chain.
9	Estimated cost	$658.75 million (2007–2030) including investment costs, operation and management costs, and financial costs.

CO_2 = carbon dioxide, kt = kilotonnes, Lao PDR = Lao People's Democratic Republic.

Source: Government of the Lao PDR (2015), *Lao PDR's Intended Nationally Determined Contribution (INDC)*. United Nations Framework Convention on Climate Change. https://www4.unfccc.int/sites/submissions/INDC/Published%20 Documents/Laos/1/Lao%20PDR%20INDC.pdf (accessed 1 October 2018).

Table 8.6: Expansion in the Use of Large-Scale Hydroelectricity

No.	Action Plan Focus	Outputs
1	Description	The Lao PDR has great potential for hydroelectricity generation and has been referred to as 'the battery of Southeast Asia.' Exporting clean energy powers green growth in neighbouring countries and provides foreign exchange earnings and employment in the Lao PDR (e.g. CDM, bilateral offset credit mechanism, and nationally appropriate mitigation actions).
2	Objective	The objective of this activity is to build large-scale hydropower plants to provide clean electricity to neighbouring countries. 2.3 GW will be added by 2020 and total hydropower electricity production will be increased to approximately 5.5 GW by 2020. In addition, the Lao PDR has over 20 GW of additional hydroelectricity capacity to be constructed after 2020.
3	Base year	2015
4	Methodology for assessing base year and anticipated future emissions	The estimate is based on the following assumptions: 85% of hydroelectricity is exported to Thailand and Viet Nam, 1 MW generates 3.5 GWh, 1 GWh produces 3.6 TJ, and the default emission factor is 0.67 tonnes of CO_2 per MWh. This is a preliminary estimate and will need to be reviewed and updated to address consistency and accuracy in analytical methods once more reliable data and information are available.
5	Anticipated emission reductions	16,284 kt of CO_2 per year, once the target is reached in 2020.
6	Plan to achieve the goal	Implementation of the electricity export agreement along with the development of a NAMA, and preparedness for a future carbon market mechanism
7	Main barrier to implementation	Limited budget and access to finance
8	Support required	Capacity building and financial support for strengthening environmental safeguard systems, resettlements, dam safety, climate resilience, and the development of multipurpose financial mechanisms
9	Estimated cost	$320 million

CDM = clean development mechanism, CO_2 = carbon dioxide, GW = gigawatt, GWh = gigawatt-hour, kt = kilotonnes, Lao PDR = Lao People's Democratic Republic, MW = megawatt, MWh = megawatt-hour, NAMA = nationally appropriate mitigation action, TJ = terajoule.

Source: Government of the Lao PDR (2015), *Lao PDR's Intended Nationally Determined Contribution (INDC)*. United Nations Framework Convention on Climate Change. https://www4.unfccc.int/sites/submissions/INDC/Published%20 Documents/Laos/1/Lao%20PDR%20INDC.pdf (accessed 1 October 2018).

Table 8.7: Rural Electrification Programme

No.	Action Plan Focus	Outputs
1	Description	• Rural communities require a clean and secure source of energy, particularly when there is no access to the electricity grid. • By increasing the level of rural electrification, reliance on wood fuel and fossil fuels will be reduced.
2	Objective	The Lao PDR has set a target of making electricity available to 90% of households by 2020. Electrification has already improved from 15% in 1995 to 73% in 2010.
3	Base year	2010
4	Methodology for assessing base year and anticipated future emissions	• Assessing base year and anticipated future emissions: the Nationally Appropriate Mitigation Action (NAMA) on Rural Electrification in Lao PDR, produced with the support of the United Nations Development Programme, lays out plans for the implementation of the NAMA, which will allow the Lao PDR to meet its goal of 90% electrification by 2020. • Emissions are estimated based on the following assumptions: 1,108,609 households (90%) will be electrified by 2020; 60% of the households are in rural areas and consume, on average, 30 liters of kerosene and diesel per year. Therefore, achieving the rural electrification goal would reduce the use of kerosene and diesel by about 19.95 million liters. With the use of default value for net calorific value and emission factors, electrification in the Lao PDR would reduce CO_2 emissions by about 63 kt of CO_2 per year. This is a preliminary estimate and will need to be reviewed and updated to address consistency and accuracy in analytical methods once more reliable data and information are available.
5	Anticipated emission reductions	63 kt of CO_2 per year
6	Plan to achieve the goal	Implementation of the NAMA, with support from the United Nations Development Programme and measures on rural electrification, based on the following five concepts in particular: • Maintenance and expansion of the power supply based on economic efficiency, reliability, and sustainability, to promote economic and social development; • Promotion of electric power development and expansion of electricity exports, to secure finances targeted by the government; • Development and strengthening of laws and regulations to develop the electricity sector effectively through the government, the private sector, or public–private partnerships; • Increasing the nation's capabilities, while developing international-standard techniques, expertise, and experience; and • Achieving sustainable development by identifying impacts and responsibilities related to society and the environment.
7	Main barriers for implementation	• Limited access, scattered resettlement, and lack of an integrated rural infrastructure development plan. • Existing transmission networks are limited. • Limited finance for developing rural electricity systems. • Lack of comprehensive policy and facilitation to access finance and private sector investment.

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Table 8.7: *Continued*

No.	Action Plan Focus	Outputs
8	Support required	• Capacity building and financial mechanism for accessing finance and resource mobilisation • Financial support and investment in electricity grid expansion, system, and facilities
9	Estimated cost	$160 million (for transmission lines only) for the next 5 years.

CO_2 = carbon dioxide, kt = kilotonnes, Lao PDR = Lao People's Democratic Republic.

Source: Government of the Lao PDR (2015), *Lao PDR's Intended Nationally Determined Contribution (INDC)*. United Nations Framework Convention on Climate Change. https://www4.unfccc.int/sites/submissions/INDC/Published%20 Documents/Laos/1/Lao%20PDR%20INDC.pdf (accessed 1 October 2018).

8.4 Implementing Measures

The responsibilities of stakeholders include accomplishing the goals and objectives included in the programmes, projects, and focal tasks of this action plan.

The Ministry of Natural Resources and Environment (MONRE) shall take a leading role in climate change adaptation and GHG reduction in the Lao PDR, while serving as a focal point for coordination to consider partnerships and discussion with international organisations. The MONRE, in addition to being the ultimate authority, shall convert the projects and focal tasks of this action plan into detailed actions to actualise implementation within the ministry. The MONRE will also collaborate and coordinate with other line ministries to execute the projects and focal tasks while ensuring comprehensive understanding within each sector, professional capacity building, planning, mobilising international official development assistance, monitoring, and producing progress reports with regard to project and activity implementation. Moreover, the MONRE will play a role in reducing disaster risk, as the departments under the umbrella of the MONRE are highly important for data and information support. These departments include the Department of Hydrology and Meteorology, Department of Land Management, Department of Climate Change, Department of Water Resource Management, Department of Environment Quality Promotion, Lao National Mekong Committee Secretariat, Natural Resource and Environment Research Institute, and Department of Pollution Control.

Table 8.8: Implementation of Transport-Focused Nationally Appropriate Mitigation Actions

No.	Action Plan Focus	Outputs
1	Description	The systematic development of a road network and provision of buses to meet increasing demand for travel will mitigate GHG emissions while promoting economic development.
2	Objective	The objective of road network development is to provide better networks so that vehicle kilometres travelled will be reduced against business as usual. In addition to a reduction in GHG emissions, the activity will lead to a reduction in nitrous oxide and sulfur oxide emissions, which will have significant co-benefits such as improved air quality that in turn has positive implications for human health.
3	Base year	2007
4	Methodology for assessing base year and anticipated future emissions	The reference scenario is determined as business as usual, that is, the scenario reflecting traffic volume trends between 2007 and project start. The scenario is predetermined and based on transport demand forecast surveys conducted prior to the project's implementation. The Japan International Cooperation Agency-supported NAMA document from which projections are taken employs the 'activity-structure-intensity-fuel' approach to calculate emission reductions ex ante.
5	Anticipated emission reductions	A feasibility study for a Japan International Cooperation Agency-proposed NAMA estimates that emission reductions due to road network development are approximately 33 kt of CO_2 equivalent per year, and emission reductions due to public transport development are 158 kt of CO_2 equivalent per year against business as usual by 2025, using 2007 as a base year for comparison.
6	Plan to achieve the goal	The actions are to be completed as part of a NAMA. Projects in road network development, public transport development, and transport management sectors are planned to be implemented in three phases: short, medium, and long term.
7	Main barriers to implementation	• Uncertain or unclear carbon market and mitigation incentives • Limited budget for road network and transport system improvement • The existing road network is rather complicated and has not been integrated into sustainable urban planning. Improving an existing one might take time and be costly.
8	Support required	• Capacity building on: – Sustainable and integrated urban planning – Law enforcement – Financial models for road planning – Traffic controls – Sustainable and climate-resilient transport and technologies • Access to favourable terms for infrastructure funding
9	Estimated cost	$105 million (until 2020)

CO_2 = carbon dioxide, kt = kilotonnes, Lao PDR = Lao People's Democratic Republic, NAMA = nationally appropriate mitigation action.

Source: Government of the Lao PDR (2015), *Lao PDR's Intended Nationally Determined Contribution (INDC)*. United Nations Framework Convention on Climate Change. https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Laos/1/Lao%20PDR%20INDC.pdf (accessed 1 October 2018).

8.4.1 | Line Ministries

Identified line ministries shall take key responsibilities in the implementation of projects and focal tasks included in the action plan to integrate various programs from different ministries into the strategies, plans, and budgeting of their own sectors with regard to strengthening organisational functions and work methods focused on effective implementation under its authority. During this initial stage, once the action plan is endorsed, it is necessary to coordinate with the MONRE to convert the proposed projects and focal tasks into detailed actions while mobilising financial sources, seeking technical assistance, and sharing lessons learned from other countries.

8.4.2 | Local Authorities, Mass Organisations, the Private Sector, Universities, Development Partners, and the Public Sector

Local authorities shall participate actively in planning and implementing various climate change-related activities within their local areas. The MONRE shall support local authorities in prioritising these activities while addressing constraints in building capacity to respond to climate change and alternative initiatives for GHG reduction and climate change adaptation. Local authorities shall consolidate various projects and focal tasks related to climate change, and integrate them into their socio-economic development plans, followed by participation and reasonable involvement in executing, monitoring, and reporting. Mass organisations and local authorities will conduct outreach programs to disseminate information to the public on topics related to climate change in general, particularly the national strategy and programme on climate change. The private sector should invest more in climate change-related projects, which are priorities assigned by the government for adaptation, and contribute to GHG reduction. The MONRE and other line ministries will collaborate with the private sector in raising public awareness of climate change adaptation by promoting activities such as financial and technological support. Universities and colleges shall endeavour to integrate climate change-related issues into formal curricula and research. The MONRE and other line ministries shall collaborate with universities and colleges in building capacity, ensuring information accessibility, and providing international technical support.

Government line ministries concerned include the National Assembly of Lao PDR, Ministry of Natural Resources and Environment, Ministry of Agriculture and Forestry, Ministry of Public Works and Transport, Ministry of Planning and Investment, Ministry of Education and Sports, Ministry of Energy and Mines, Ministry of Industry and Commerce, Ministry of Finance, Ministry of Foreign Affairs, Ministry of Health, Ministry of Education and Sport, Ministry of Labour and Social Welfare, and Ministry of Technology and Science.

International development partners (e.g. donors and international organisations) should consider and integrate key messages of this action plan into their cooperation plans with government agencies. The government shall promote firm collaboration and coordination with international development partners in implementing climate change-related activities at the national, regional, and international levels. The general public shall enhance knowledge and understanding of climate change-related topics, natural disaster management, and other environmental issues, and should be actively involved in mitigating the adverse impacts of climate change while contributing reasonably to reducing GHGs.

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CHAPTER 9

Indicative Actions, Institutions, and Timeframe for Building a Climate Change Adaptation, Disaster Risk Reduction, and Food Security Roadmap for Myanmar

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This roadmap is intended for the period 2018–2030 and is to be implemented in each of Myanmar's six key sectoral areas. These are: (i) agriculture, fisheries, and livestock; (ii) the environment and natural resources; (iii) energy, transport, and industry; (iv) cities, towns, and human settlements; (v) climate hazards and health; and (vi) education, science, and technology.

The following six action areas have been set up as objectives for each sector: policy, institution, finance, capacity and technology, awareness, and partnership. The activities under each action area range from ongoing projects and sectoral activities that need to be continued and strengthened, to new projects that need to be initiated.

The timeframe is set as 3 years for short term, 6 years for medium term, and 12 years for long term, depending on the nature of work to be done. During each timeframe, the actions to be undertaken are prioritised under three categories based on their importance and the urgency of the need for them. The availability of funds for the actions to be taken is also taken into consideration.

There are 191 actions to be taken under the six key sectoral areas; although this may appear excessively detailed, some of these actions are simple, such as forming a group or conducting a study, and some can be accomplished collectively by carrying out a project in a selected area. In designing the projects, much consideration should be given to including as many of these actions as possible, depending on the funds available. Some actions are included in the ongoing projects, while others are yet to be formulated in terms of projects or programmes. Relevant stakeholders should be invited to a workshop to prepare project proposals to ensure that all of the identified actions are included in a number of project designs.

9.1 Climate-Smart Agriculture, Fisheries, and Livestock for Food Security

9.1.1 | Sectoral Outcome

The sectoral outcome is climate-resilient productivity and climate-smart responses in the agriculture, fisheries, and livestock sectors to support food security and livelihood strategies while also promoting resource-efficient and low-carbon practices.

Table 9.1: Expected Results and Strategic Indicators

Expected Sectoral Results	Strategic Indicators
The agriculture, fisheries, and livestock sectors have integrated climate change into their relevant policies, planning, and budgeting procedures and have put these into practice, depending on local specialties and taking gender considerations into account.	• Number of sectoral polices, plans, research and development strategies, and extension services that integrate climate change and are practiced at the national, subnational, and local levels • Number of officials trained on sector-specific guidelines and tools for integrating climate change into planning and budgeting systems • Number of sectors, geographical areas, and technology-specific institutional arrangements, including a multi-stakeholder engagement framework developed to implement climate-change responses at the national, subnational, and local levels • Number of climate change adaptation projects implemented through externally supported finance and domestic resources • Number of climate-smart technologies and good practices that are in harmony with local requirements and favor small and medium-sized farmers introduced and scaled up in the Central Dry Zone, the Ayeyarwady Delta, and coastal zone and lowland areas • Number of farmers (both men and women) benefiting from the introduction of climate-smart technologies and other responses • Number of multi-stakeholder partnerships that support the scaling up of climate-resilient and low-carbon responses
The agriculture, fisheries, and livestock sectors have adopted climate-resilient and environmentally sound adaptation technologies and climate-smart management practices, supported by international and domestic finance, with special emphasis on small- and medium-scale production needs.	
Institutional coordination and a multi-stakeholder engagement framework have been established and support the implementation of climate-smart responses in the agriculture, fisheries, and livestock sectors, including innovative business models and gender-sensitive approaches.	

Source: MNREC, 2018.

9.1.2 | Objectives for Action Areas

The objectives for the action areas are as follows:

(i) Integrate climate adaptation, disaster risk management, and food security in policies, plans, research and development strategies, and extension services at the national, sectoral, and local levels.
(ii) Establish and reinforce institutional arrangements to plan and implement climate change responses.
(iii) Establish financial mechanisms to mobilise and allocate resources for climate change response and climate-responsive development.
(iv) Increase access to climate-resilient and low-carbon technologies and practices.
(v) Enhance awareness and capacity to promote and implement climate-resilient and low-carbon responses.
(vi) Promote multi-stakeholder partnerships to support and scale up climate-resilient and low-carbon responses.

9.1.3 | Actors

The lead actor is the Ministry of Agriculture, Livestock and Irrigation (MOALI), which includes the following departments: (i) the Department of Agriculture (DOA); (ii) Department of Agricultural Research; (iii) Department of Rural Development; (iv) Department of Planning; (v) Department of Agriculture Land Management and Statistics; (vi) Agriculture Mechanization Department; (vii) Irrigation and Water Utilization Management Department (IWUMD); (viii) Directorate of Livestock, Fisheries and Rural Development; (ix) Livestock Breeding and Veterinary Department; (x) Department of Fisheries; and (xi) Department of Planning.

Other actors are (i) academic and research institutions (ARIs), such as agricultural and forestry universities; (ii) the Ministry of Natural Resource and Environment Conservation (MONREC); (iii) the Environmental Conservation Department (ECD); (iv) regional and state governments for addressing local priorities; (v) the Ministry of Planning and Finance (MOPF); (vi) the Ministry of Transport and Communication (MOTC); (vii) the Department of Meteorology and Hydrology (DMH); (viii) the Ministry of Health and Sports (MOHS); (ix) the Ministry of Industry (MOI); (x) the Ministry of

Education (MOE); (xi) the Ministry of Construction (MOC); (xii) the Ministry of Social Welfare, Relief and Resettlement (MOSWRR); (xiii) local government at the regional, district, and township levels; (xiv) development partners, including the European Union, Department for International Development, Asian Development Bank, Food and Agriculture Organization (FAO), United Nations Development Program (UNDP), and UN Environment Program (UNEP); (xv) farmer and fishery groups and co-operatives; (xvi) national nongovernment organisations (NGOs) (including women's NGOs); (xvii) international NGOs; (xviii) international agencies; (xix) international financing institutions (IFIs); (xx) civil society organisations (CSOs); (xxi) community-based organisations (CBOs); (xxii) the private sector; and (xxiii) the media.

9.1.4 | Climate-Resilient Agricultural Productivity Is Achieved to Support Food Security, Livelihood Strategies, Gross Domestic Product Growth, and Greenhouse Gas Reductions

Objective for Action Area 1: Integrate Climate Adaptation, Disaster Risk Management, and Food Security in Policies, Plans, Research and Development Strategies, and Extension Services at the National, Sectoral, and Local Levels

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Develop guidelines (tools, contents) to mainstream climate change into agriculture, fisheries, livestock, and irrigation.	Guidelines for mainstreaming climate change developed	First	■			MOALI	MONREC (ECD), MOPF
Pilot and promote inclusive and participatory adaptation planning at the local level to integrate climate change in local government, CSO, and CBO agriculture and livelihood plans.	Local adaptation plans prepared at the local level	First	■			MOALI	MONREC, NGOs, CBOs
Develop a climate change research and extension strategy for the agriculture, fisheries, and livestock sectors, including an action plan for a climate-smart agriculture strategy.	Research and extension strategy, including an action plan, developed	Second		■		MOALI	MONREC

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Objective for Action Area 1: ***Continued***

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Develop guidelines and action plan to mainstream gender in climate change-related policies for the agriculture, fisheries, livestock, and irrigation sectors.	Guidelines and action plans on a climate change-related perspective on gender in the respective sectors developed	Third				MOALI	MONREC
Develop training modules for fishers and farmers on how to integrate climate change into local-level planning.	Training module on climate change integration developed	Second				MOALI	MONREC, NGOs, CBOs
Implement efficient water management practices in vulnerable townships and states, including mountainous and flood-prone areas, delta regions, and the Dry Zone.	Water management technologies adopted by farmers	First				MOALI (Department of Agricultural Research)	MONREC (ECD), local government, CSOs, IWUMD
Implement eco-friendly crops and bio-energy schemes targeting climate vulnerable households in Shan State and the Dry Zone.	Farmers have increased access to eco-friendly crops and bio-energy schemes	First				MOALI	PS, MOEE
Identify and implement livelihood diversification activities (both on- and off-farm) in vulnerable areas of Dry Zone, delta, mountainous, and coastal areas, targeting poor and landless households.	Vulnerable households have improved access to livelihood diversification activities	First				MOALI	MONREC, NGOs, CBOs
Develop a mitigation and low-carbon strategy, including a plan for the agriculture, fisheries, and livestock sectors, in line with Myanmar's nationally determined contribution (NDC) and Climate Smart Agriculture Strategy.	National mitigation and low-carbon development strategy and plan in place	First				MOALI	MONREC (ECD), MOPF
Implement information and communications technology (ICT)-based monitoring system and retrofitting works in irrigation systems for effective water management by using geospatial technologies.	Water management technologies practiced by irrigation engineers	First				MOALI (IWUMD)	Local government, international agencies

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 2: **Establish and Reinforce Institutional Arrangements to Plan and Implement Climate Change Responses**

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Establish national-level climate change and agriculture, fishery, and livestock working groups to improve coordination and synergy.	Climate change working groups established	First				MOALI	MONREC (ECD), MOPF
Establish a climate change cell or division within the MOALI.	Climate change cell or division within the MOALI established	First				MOALI	MONREC (ECD), MOPF
Establish institutional platform to exchange learning and share knowledge on climate-smart agriculture, fisheries, and livestock.	Learning and knowledge-sharing forum on climate-smart agriculture, fisheries, and livestock established	First				MOALI	MONREC (ECD), MOPF
Develop terms of reference for a climate change cell and human resource capacity to integrate climate change within the MOALI.	Human resource development plan for climate change capacity building developed	First				MOALI	MONREC (ECD), MOPF
Conduct a gender analysis and develop capacity to integrate gender perspectives into climate change responses to agriculture.	Gender and climate change working groups established and gender analysis developed	Third				MOALI	MONREC (ECD), MOPF
Develop institutional guidelines and strategies for promoting decentralised community institutions for effective climate change response.	Guidelines and strategy for decentralised community institutions developed	Third				MOALI	MONREC (ECD), MOPF
Establish and strengthen cooperatives for farmers, fishers, water users, and herder associations to deal with climate change issues collectively.	Cooperative, associations, and groups capacitated on climate change	First				MOALI	MONREC (ECD), MOPF

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 3: Establish Financial Mechanisms to Mobilise and Allocate Resources for Climate Change Response and Climate-Responsive Development

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Develop, integrate, and legalise a risk-based insurance system to cover the loss of and damage to crops, livestock, and fisheries due to climate-induced disasters.	Risk-based insurance system either integrated into existing legislation or new laws and regulations developed	First				MOALI, MOPF	Local government, farmer groups and cooperatives, private sector
Establish and promote microcredit cooperatives to increase access to financing for small enterprises, benefiting vulnerable households.	Microcredit cooperatives established	First				MOALI	Local government, NGOs CBOs, development partners, private sector
Develop the budget guidelines and spending tracking system within the MOALI to integrate climate change in annual budgeting.	Budget guidelines and spending tracking system developed	Second				MOALI	MOPF, development partners
Identify and promote financial incentive mechanisms—such as loans, microcredit, and grants—targeting vulnerable households in the Dry Zone and delta areas, with gender considerations based on gender analysis.	Farmers have improved access to financial incentive mechanisms	First				MOALI	MOPF, private sector
Integrate climate change economic and investment appraisal criteria—such as cost benefit analysis—into internal MOALI strategy and plans.	Economic and investment appraisal criteria integrated	First				MOALI	MOPF, private sector

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 4: **Increase Access to Climate-Resilient and Low-Carbon Technologies and Practices**

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Identify and promote existing climate-smart agricultural technology and practices such as efficient and improved water management technologies that are suitable for Dry Zone, delta, mountainous, and coastal areas; and prepare the extension materials.	Efficient water management technologies and practices promoted, including micro and drip irrigation, rainwater harvesting, small- and medium-scale irrigation schemes, and mobile water pumping facilities	First				MOALI	Local government, ARIs including private sector, NGOs, CBOs, international agencies
Provide training to farmers and fishers on climate-smart agriculture technologies and practices—such as improved soil and nutrient management, improved cropping, and community aquaculture—with gender considerations based on gender analysis.	Farmer and fisher capacity for climate-smart technology enhanced	First				MOALI	Local government, NGOs, CBOs, international agencies
Establish and promote climate-smart villages that focus on integrated soil and pest management and technology demonstration and generating climate change knowledge.	Climate-smart villages established	Second				MOALI	Local government, NGOs, CBOs, international agencies
Carry out infrastructure design and studies to protect agricultural land in coastal and delta areas from saltwater intrusion.	Infrastructure design and studies carried out	First				MOALI	MOSWRR, MOC
Implement dam instrumentation, hydro-meteorological monitoring, and forecasting models for operating reservoirs in the context of climate change; and monitor reservoir areas using geospatial technologies.	Emergency operation procedure developed	First				MOALI (IWUMD)	MONREC, international agencies
Improve reservoir system performance for sustainable water management under climate change.	Increased water productivity	First				MOALI (IWUMD)	MONREC, international agencies
Establish real-time hydro-meteorological monitoring and warning systems in the reservoir area using ICT and geospatial technologies.	Early warning system established at dam sites and nearby	First				MOALI (IWUMD)	MONREC, international agencies

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Objective for Action Area 4: ***Continued***

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Develop and promote early maturing and heat-tolerant rice varieties to cope with drought and water stress in Dry Zone, delta, and coastal areas.	Suitable stress-tolerant varieties or breeds developed and disseminated in dry, delta, and coastal areas	First				MOALI	Local government, ARIs, NGOs, private sector, international agencies
Improve high-quality seed-producing facilities by encouraging PPP and collaborating with international research organisations.	Farmers can easily access high-quality seeds and their market is driven by demand	High				MOALI (ARIs), private sector	MOE, MOPF, development partners
Promote a community-based seed bank in Dry Zone areas to increase access to resilient seed and planting materials.	Farmers have improved access to climate-resilient seed and planting materials	Third				MOALI	Local government, ARIs, NGOs, private sector, international agencies
Promote stress-tolerant fish and livestock breeds, targeting vulnerable households in the Dry Zone, delta, and coastal areas.	Stress-tolerant breeds identified and promoted	First				MOALI	Local government, ARIs, NGOs, private sector, international agencies
Establish an early warning system, auto rain-gauge, telemetry, and auto water level-monitoring system in the lower delta region; and share the data with relevant international organisations in exchange for information.	Early warning systems, auto rain-gauge, telemetry, and auto water level-monitoring system established	First				MOALI (irrigation)	MONREC, international agencies
Introduce low-emission farming technology and practices, targeting farmers in climate-impacted regions (dry, coastal, delta, and hilly zones; and flood-prone areas), with gender considerations based on gender analysis.	Low-emission farming technology and practices promoted	Second				MOALI	MONREC, international agencies, MOE
Test and promote ecofriendly plans and bioenergy schemes in selected Dry Zone townships.	Dry Zone townships have ecofriendly plans and bioenergy schemes	Second				MOALI	MONREC, international agencies, MOE
Establish three pilot stations for climate change research (crop, fishery, and livestock improvement research).	Pilot stations for crop, fishery, and livestock improvement research established and operating	Second				MOALI	ARIs, MONREC, international organisations
Promote fuel-efficient agro-machineries, residue management, and reduced tillage practices and technology.	Fuel-efficient machineries and systems promoted	Second				MOALI	MONREC, international agencies, MOE

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 5: Enhance Awareness and Capacity to Promote and Implement Climate-Resilient and Low-Carbon Responses

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Establish climate change database management system at the MOALI.	Climate change database management system established	Second				MOALI	Local government, international agencies
Provide training to the MOALI monitoring unit on approaches to improve climate risk analysis and related data monitoring and management.	Training provided to staff of the MOALI monitoring unit	Second				MOALI	Local government, international agencies
Develop flood hazard maps in flood-prone areas to assess the agricultural damage based on climate change projection.	Flood hazard maps developed	First				MOALI	MOTC (DMH), international agencies, MONREC
Build capacity to develop national and regional monitoring and surveillance plans for the fisheries sector.	National and regional monitoring and surveillance system in place	Second				MOALI	MOTC (DMH), international agencies, MONREC
Build capacity to establish more agro-meteorological and hydro-met stations to strengthen weather and climate information and collaborate with international meteorological institutions.	Agro-meteorological and hydro-meteorological stations established Share and exchange meteorological information and improve accuracy in prediction	First				MOALI (DOA, IWUMD)	Local government, international agencies
Carry out training for farmers on using agro-meteorological and climate information.	Farming practices based on agro-meteorological and climate information	First				MOALI (DOA)	Local government, international agencies
Build capacity to carry out hydrological analysis in all flood-sensitive areas.	Hydrological analysis carried out	Second				MOALI (DOA, IWUMD)	MONREC, international agencies

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Objective for Action Area 5: ***Continued***

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Carry out advanced trainings for hydrologic and hydraulic modeling with earth observation systems, and set up technical cooperation with international agencies.	Improved hydrologic and hydraulic analysis	Second		■		MOALI (DOA, IWUMD)	International agencies
Strengthen capacity to improve land use maps of vulnerable townships in the Dry Zone, delta, and coastal areas.	Improved land use maps for climate-vulnerable areas	First	■			MOALI	MOTC (DMH), MONREC
Establish an agriculture information management system and agro-advisory mechanism for improving farmers' access to climate-relevant information.	Agriculture information management system and agro-advisory mechanism established and promoted	First	■			MOALI, MOTC (DMH)	MOIN, local government, NGOs, CBOs, international agencies, media
Carry out climate change awareness-raising and capacity-building activities, targeting extension agents and government staff.	Government staff trained on climate change	Second	■			MOALI	MOI, MOTC, local government, CSOs, media
Provide climate change training for staff of ARIs so they can generate climate-relevant information and knowledge.	Academics and researchers trained on climate change	Third			■	MOALI	MOI, MOTC, local government, CSOs, media
Establish environment clubs or societies in schools and universities and support them to integrate climate change within their activities.	Environment clubs and societies established	Third			■	MOALI	MONREC (ECD), local government, NGOs
Develop farmer-friendly, gender-sensitive training, and awareness-raising materials to address climate change.	Training and awareness-raising materials produced and used	Second			■	MOALI	MOI, MOTC, local government, CSOs, media
Provide awareness and training on improved water, soil-nutrient, pest, and disease management practices, with gender considerations.	Farmers trained on improved management practices	First		■		MOALI	MOI, MOTC, local government, CSOs, media

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 6: Promote Multi-Stakeholder Partnerships to Support and Scale Up Climate-Resilient and Low-Carbon Responses

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Establish national, regional, district, and township-level multi-stakeholder climate change response committees.	Multi-stakeholder climate change response committee established	First	■			MOALI	MONREC (ECD), local government, NGOs
Develop guidelines and regulations to enable private sector and other stakeholder investment on risk financing.	Private sector partnerships for investment in insurance and contract farming promoted	First	■			MOALI	MOPF, private sector
Develop collaborative projects targeting one-third of the most vulnerable households in five states/ regions on an annual basis.	Collective actions promoted amongst different actors to address climate change impacts at the local level	First	■			MOALI	DPs, private sector, CBOs
Establish a national-level, multi-stakeholder engaged risk-based financing mechanism (loss and damage fund and modality) to support climate-vulnerable households.	Multi-stakeholder engaged risk-based financial mechanism established	First			■	MOALI, MOPF	IFIs, private sector, MONREC (ECD)

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

9.2 Sustainable Management of Natural Resources for Healthy Ecosystems

9.2.1 | Sectoral Outcome

The sectoral outcome is natural resource management that enhances the resilience of biodiversity and ecosystem services that support social and economic development and deliver carbon sequestration.

Table 9.2: Expected Results and Indicators

Sectoral Expected Results	Strategic Indicators
Climate change dimensions are incorporated and enforced in environment and natural resource management policies, rules, and regulations.	• Number of policies, strategies, laws, and by-laws that integrate climate change, including resilient and low-carbon provisions • Number of officials trained on sector-specific guidelines and tools for integrating climate change into planning and budgeting systems • Number of sector- and technology-specific mitigation and adaptation action plans implemented in regions or areas with higher deforestation and degradation issues • Number of households, NGOs, and CBOs benefiting from access to, and implementation of, environmentally sound technologies and good management practices, including ecosystem-based adaptation approaches, with training • Number of geographical areas covered and technology-specific institutional arrangements—including multi-stakeholder engagement frameworks—developed to implement climate change responses at the national, subnational, and local levels • Number of climate change projects implemented through externally supported finance and domestic resources that address issues in the natural resources management sector
Environmentally sound technologies and good management practices are adopted for improving and maintaining forest, water, land, and coastal ecosystem health and services.	
Framework for institutional coordination and multi-stakeholder engagement is established and supports access to finance and the implementation of responses for health, environment, and natural resource management.	

Source: MNREC, 2018.

9.2.2 | Objectives for Action Areas

The objectives for the action areas are as follows:

(i) Integrate climate adaptation, disaster risk management, and food security in policies, plans, research and development strategies, and extension services at the national, sectoral, and local levels.

(ii) Establish and reinforce institutional arrangements to plan and implement climate change responses.
(iii) Establish financial mechanisms to mobilise and allocate resources for climate change responses and climate-responsive development.
(iv) Increase access to climate-resilient and low-carbon technologies and practices.
(v) Enhance awareness and capacity to promote and implement climate-resilient and low-carbon responses.
(vi) Promote multi-partnership mechanisms for enhancing climate resilience and low-carbon development in the environment and natural resource management sectors.

9.2.3 | Actors

The lead actor is the MONREC, which includes the following departments: (i) the Forest Department; (ii) Department of Planning, Environmental Conservation Division (ECD); (iii) Dry Zone Greening Department (DGZD); and (iv) National Environmental Conservation and Climate Change Committee (NECCCC).

Other actors are (i) the MOALI (IWUMD); (ii) Ministry of Electricity and Energy (MOEE); (iii) Ministry of Hotels and Tourism (MOHT) (Directorate of Hotels and Tourism); (iv) Ministry of Planning and Finance (MOPF); (v) MOTC (Department of Meteorology and Hydrology [DMH]); (vi) Ministry of Industry (MOI); (vii) Ministry of Home Affairs (MOHA) (Department of General Administration [GAD]); (viii) Ministry of Information (MOIN); (ix) National Water Resources Committee; (x) local government (regional, district, and township); (xi) NGOs, for example, the Myanmar Environment Restoration Network, the Renewable Energy Association of Myanmar, Eco-Conscious Developments, the World Wildlife Fund, the Ecosystem Conservation and Community Development Initiative (Spectrum-Sustainable Development Knowledge Network, Green Lotus, and Forest Resource Environment Development and Conservation Association; (xii) ARIs (Forestry University, departments of botany, arts and science, and environment science); (xiii) development partners; (xix) international agencies; (xx) international financing institutions (IFIs); (xxi) community forestry user groups (CFUGs); (xxii) buffer zone user groups; (xxiii) CSOs; (xxiv) CBOs; (xxv) other groups, such as women's groups; (xxvi) the media; and (xxvii) the private sector.

9.2.4 | Management of Natural Resources for Healthy Ecosystems

Objective for Action Area 1: Integrate Climate Adaptation, Disaster Risk Management, and Food Security in Policies, Plans, Research and Development Strategies, and Extension Services at the National, Sectoral, and Local Levels

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Integrate climate change in the new environment policy and law, and in existing sectoral policies such as forest, water, tourism, and land use.	Climate change integrated in environment, tourism, land use, and forest policy and laws	First				MONREC, MOHT, MOALI	MOPF, development partners
Support the preparation of climate change policies, National Adaptation Plan, Green Growth Strategy, National Appropriate Mitigation Actions, and Low-Carbon Development Strategy.	Climate change adaptation and mitigation policies and strategies developed and legalised	First				MONREC, MOHT, MOALI	MOPF, development partners
Develop climate change vulnerability assessments and local adaptation and resilience plans in all townships and cities.	All townships and cities of Myanmar have vulnerability assessments, or at least simplified vulnerability analysis All townships and cities of Myanmar have local adaptation plans or adaptation and resilience measures integrated into their planning	First				MONREC (ECD), MOC (DUHD)	MOHA (GAD)

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Objective for Action Area 1: ***Continued***

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Integrate gender considerations and guidelines in the NDC implementation action plan, 'reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries' (REDD+), and the National Adaptation Plan.	Climate change adaptation and mitigation policies and strategies developed with a gender perspective	Third				MONREC	MOPF, development partners
Prepare REDD+ and NDC implementation action plan to integrate climate change into the national legal framework and development plans.	NDC and REDD+ policies, strategies and plans integrated in national laws, policies, and development plans	First				MONREC, and individual departments	MOALI, CBOs, NGOs, international agencies, private sector
Integrate climate into guidelines for inventory (forest, greenhouse gases [GHGs]), monitoring (National Forest Monitoring and Information), and mapping.	Guidelines for inventory, monitoring, and mapping developed or updated	First				MONREC	MOALI, MOTC (DMH), MOHA (GAD), MOPF, MOHT
Develop climate screening/ proofing and planning guidelines and tools to climate-proof investments.	Climate screening and planning guidelines and tools developed	Second				MONREC	MOALI, international agencies, MOI, MOEE, MOPF, private sector
Develop/update existing compliance systems (environmental impact assessment (EIA), strategic environmental assessment [SEA], and social impact assessment [SIA]) to include climate risk management and mitigation plans.	An EIA, SIA, and SEA applied to enforce compliance to risk reduction and mitigation plans, for example, in mining, large infrastructure construction, and industry	First				MONREC	MOALI, MOI, MOEE, international agencies, MOPF, private sector
Develop and implement adaptation and mitigation action plans for critical ecosystems including coastal areas, wetlands (such as Inle lake), watersheds, and catchment areas.	Action plans for critical ecosystems developed and implemented	First				MONREC (ECD and other departments)	Local government, CBOs, NGOs, development partners

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Objective for Action Area 1: ***Continued***

			Timeframe			Responsible Institution	
Strategic Policy Actions	**Outputs**	**Priority**	**S**	**M**	**L**	**Lead**	**Support**
Identify and promote successful climate-resilient, ecosystem-based adaptation practices that are suitable for different eco-regions and forest conditions.	Successful climate-resilient, ecosystem-based adaptation practices suitable for different eco-regions and forest conditions identified and promoted	First				MONREC (ECD and other departments)	CBOs, NGOs, development partners
Implement livelihood diversification activities—such as skill-oriented training on enterprise development, value addition, and marketing targeting—to community forestry user group (CFUG) members, including landless, women, and other vulnerable households.	Improved access to livelihood diversification options for forest-dependent communities	First				MONREC, MOALI	MOPF, CBOs, private sector, international agencies
Introduce microfinance and credit facilities to support climate-smart, diversified livelihood options for poor households in vulnerable townships or districts to male and female-headed households.	Microfinance and credit facilities promoted, targeting vulnerable townships and districts to all households, ensuring that female-headed households are included and separately monitored	First				MONREC, MOALI	MOPF, CBOs, private sector, international agencies
Develop policy guidelines and directives to establish gene bank to protect species under threat from climate change.	Forest gene bank policy and guidelines established	Third				MONREC (DOF, ECD)	Local government, NGOs, international agencies
Pilot and scale up REDD+ activities in areas where deforestation and degradation is high and in critical forest areas.	REDD+ actions implemented, contributing to the control of deforestation and degradation	Second				MONREC (DOF, DZGD)	MOALI, international agencies, public sector, private sector

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 2: Establish and Reinforce Institutional Arrangements to Plan and Implement Climate Change Responses

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Initiate meetings and discussion to harmonise and align existing co-ordination mechanisms—such as the Myanmar Climate Change Alliance and the NECCCC—to integrate climate change.	Coordination amongst ministries and institutions in relation to climate change policies improved	First	■			NECCCC, MONREC	ECD
Develop training courses and curriculum on climate change integration, assessment and planning, including monitoring and evaluation.	Forestry professionals' and practitioners' capacity on climate change assessment and planning improved	Second	■			MONREC (DOF, ECD) ARIs	MOALI, MOE, MOHT, MOHA (GAD)
Organise discussion forums to strengthen climate change portfolio within the ECD and its departments.	Climate change department or section established and strengthened within the MONREC	Second	■			MONREC (ECD)	MOPF, development partners
Develop local-level institutional mechanisms to integrate climate change within the subnational and local plan and activities, with a gender perspective.	Decentralised institutional coordination mechanism developed	First		■		MONREC (ECD)	MOPF, development partners

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 3: **Establish Financial Mechanisms to Mobilise and Allocate Resources for Climate Change Response and Climate-Responsive Development**

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Develop fund management and operating guidelines to operationalise an environmental management fund.	Fund management and operating guidelines developed	First				MONREC (ECD), MOPF	Bilateral and multilateral agencies, IFIs, private sector
Develop an innovative climate fund mechanism—such as Payment for Eco-System Services or carbon credits—and guidelines at the national and subnational levels (within MONREC-ECD).	Innovative climate fund established	First				MONREC (DF, DZGD), MOALI	Local government, CBOs, NGOs, international agencies such as the Green Climate Fund (GCF)
Develop a national-level climate financing strategy and roadmap (accessing source and investment areas) to secure investment on climate change.	Strategy and plans to harness international financing to ensure the development of a credits or incentives mechanism	First				MONREC (ECD)	MOPF, MOALI, MOHT
Develop guidelines and procedures for meeting international standards for fund access—for example, the GCF or Adaptation Fund) with gender-sensitive requirements.	Guidelines and procedures for meeting international standards for funds developed	Third				MONREC (ECD)	MOPF, MOALI, MOHT
Develop bankable projects to implement climate change adaptation and mitigation priorities.	Bankable climate change projects developed	First				MONREC (ECD)	MOPF, MOALI, MOHT

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 4: Increase Access to Climate-Resilient and Low-Carbon Technologies and Practices

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Develop, test, and scale up sustainable soil and water management technologies and practices in climate-vulnerable areas.	Alternative technologies and land use practices for managing deforestation and degradation piloted and promoted	First			■	MONREC	Local government, CBOs, CFUGs, MOALI, NGOs
Organise events to improve farmers' technological access to climate-smart technology and practices—for example, improved land management practices such as agroforestry—with gender considerations.	Increased farmer access to climate-smart technologies	First		■		MONREC	Local government, CBOs, CFUGs, MOALI, NGOs
Establish forest gene banks and conservation zones targeting climate-sensitive ecosystems such as mangroves and wetlands.	Gene bank and species conservation zones established	Second			■	MONREC	Local government, CBOs, CFUGs, MOALI, NGOs
Implement energy efficiency plans focusing on biomass conservation—for example, improving fuel-wood use efficiency through technology, energy-efficient stoves, biogas, or bio briquettes—with gender considerations in the most vulnerable townships, targeting a number of households.	Energy efficiency schemes and biomass conservation implemented	First	■			MONREC, MOEE	MOPF, MOEE, CSOs, private sector, international agencies

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 5: Enhance Awareness and Capacity to Promote and Implement Climate-Resilient and Low-Carbon Responses

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Develop plan and materials for climate change awareness and capacity development (for training of trainers).	Climate change awareness and capacity-building plan developed	Second	■			MOE, MONREC (ECD)	MOHA (GAD), MOALI, MOIN, CSOs, international agencies, media, NGOs, local government
Implement training and awareness-raising activities on climate change, targeted at landless, female-headed households and vulnerable communities, including ethnic groups.	Improved public awareness on the importance of ecosystem health and services in light of climate change impacts	Second	■			MOE, MONREC (ECD)	MOHA (GAD), MOALI, MOIN, CSOs, media, local government, NGOs, international agencies
Provide capacity building training on vulnerability and risk assessment (inventory, climate hazard mapping), information management (database system), and dissemination (communication strategy).	The MONREC's capacity to respond effectively to climate change impacts improved	Second		■		MONREC	MOE, MOPF, international agencies, NGOs
Organise capacity-building activities targeted at ARIs to mainstream climate change.	Improved academic and research capacity	First		■		MONREC, MOHA (GAD), ARIs, MOPF	International agencies, private sector
Provide grants for university teachers and students to conduct research on climate change issues within the environment and natural resource management sectors.	Research grants established and operationalised	Second			■	MONREC, MOHT, ARIs	MOPF, MOALI, international agencies
Develop mass communication and dissemination strategy for communicating climate change to local communities with a gender-sensitive communications approach.	Mass communication and dissemination strategy developed	First	■			MONREC, MOIN, media	MOALI, CBOs, development partners

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 6: Promote Multi-Partnership Mechanisms to Support and Scale Up Climate-Resilient and Low-Carbon Responses in the Environment and Natural Resource Management Sectors

			Timeframe			Responsible Institution	
Strategic Policy Actions	Outputs	Priority	S	M	L	Lead	Support
Establish a climate change, environment, and biodiversity working group involving multiple stakeholders.	Working groups on climate change established	Second				MONREC (ECD, DOF), private sector	Local government, CSOs, international agencies, private sector
Support CFUG and other networks' activities to enhance public participation in addressing climate change issues.	Enhanced coordination and networking amongst CFUGs	Second				MONREC	MONREC, CSOs, local government, international agencies such as the World Wildlife Fund
Develop a strategy and proposals for joint actions to access climate finance—for example, through GCF, Adaptation Fund, Least Developed Countries Fund, or the Climate Investment Fund.	Strategy and proposals on climate finance developed	First				MONREC	MOPF, CSOs, donors
Implement joint collaborative project involving the government, NGOs, development agencies, and international partners in targeted climate-sensitive and vulnerable areas of Myanmar.	Joint collaborative projects implemented at the local level	First				MONREC	MOPF, CSOs, donors

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

9.3 Resilient and Low-Carbon Energy Transport and Industrial Systems for Sustainable Growth

9.3.1 | Sectoral Outcome

The sectoral outcome is climate-resilient and low-carbon energy, transport, and industrial systems that support inclusive and sustainable development and economic growth.

Table 9.3: Expected Results and Indicators

Sectoral Expected Results	Strategic Indicators
Energy security for the country is based on generating a large share of its energy from renewable sources and high energy efficiency in domestic, industrial, and other use.	• Number of sectoral laws and norms inspired by sustainability concerns • Implementation of the Green Growth Framework • High share of energy generated from sustainable, renewable sources within the timeframe of the Myanmar Climate Change Strategy and Action Plan
Transport systems are adapted to heightened risks of disasters from new climatic conditions and made sustainable through efficiency and low-carbon technologies. Agricultural products across the country are easily transported to the markets by improving road network infrastructure.	• Number of existing rules and regulations in industrial and transport sectors enforced, to ensure that low-carbon and air quality thresholds are respected at the national and urban levels • Number of incentive schemes in place to support the private sector in transitioning to low-carbon production, investment in renewables, and management of production processes • Number of schemes and programmes that incentivise the introduction of solar power energy generation, biomass, and other sustainable sources of renewable energy
Industrial systems are highly productive and competitive due to their climate-resilient, sustainable, low-carbon, and green characteristics.	• Number of businesses that consider climate change in their business planning to ensure resilience and protect jobs • Number of green jobs created

Source: MNREC, 2018.

9.3.2 | Objectives for Action Areas

The objectives for the action areas are as follows:

(i) Integrate climate change adaptation and disaster risk reduction (DRR) in policies and plans of the energy, industry, and transport sectors at the national, sectoral, and local levels.

(ii) Establish and reinforce institutional arrangements to plan and implement climate change responses.

(iii) Establish financial mechanisms to mobilise and allocate resources for climate-resilient and low-carbon development.

(iv) Increase access to climate-resilient and low-carbon technologies and practices in the energy, transport, and industry sectors.

(v) Enhance awareness and capacity to promote and implement climate-resilient and low-carbon development responses.

(vi) Promote multi-stakeholder partnerships to support and scale up climate-resilient and low-carbon development responses.

9.3.3 | Actors

The lead actors are the MOEE, MOTC, and MOI's Directorate of Industrial Collaboration. The focal agency alternates between the MOEE, MOI, and MOTC. Other actors are (i) the MONREC (ECD); (ii) MOALI; (iii) MOPF; (iv) MOTC (DMH); (v) MOC; (vi) MOIN; (vii) MOHA; (viii) MOSWRR; (ix) local government at the state, regional, district, and township levels, including city development committees (CDCs); (x) the Myanmar Engineering Society; (xi) the private sector (Union of Myanmar Federation of Chambers of Commerce and Industry); (xii) ARIs; (xiii) NGOs; (xix) international agencies; (xx) IFIs; (xxi) CSOs; (xxii) the media; (xxiii) United Nations (UN) agencies (the UN Industrial Development Organization, UNEP, and United Nations Human Settlements Program [UN-Habitat]); and (xxiv) development partners.

9.3.4 | Resilient and Low-Carbon Energy, Transport, and Industrial Systems for Sustainable Growth

Objective for Action Area 1: Integrate Climate Adaptation and Disaster Risk Reduction Into Energy, Transport, and Industry Policies, Plans, Research and Development, and Extension Services at the National, Sectoral, and Local Levels

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Integrate climate change within existing energy policies, plans, and legal instruments (e.g. the EIA and SEA).	Climate change integrated within existing energy policies, plans, and legal instruments (the new National Energy Master Plan in particular) in a way that helps Myanmar reach its NDC targets	First	■			MOEE	MONREC (ECD), MOPF, international agencies
Develop a strategic energy plan and investment portfolio that ensure national security and lower GHG emissions through the promotion of renewable energy technologies.	Strategic energy plan and investment portfolio developed using renewable energy technologies	First		■		MOEE	MONREC (ECD), MOPF, international agencies

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Objective for Action Area 1: *Continued*

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Develop climate-proofing screening guidelines, methods, and tools to integrate climate change risk into investments.	Climate-proofing screening guidelines, methods, and tools developed	First				MOEE	MONREC (ECD), MOPF, international agencies, private sector, CSOs
Integrate climate change into transport sector policies and plans by developing guidelines and regulations for climate-proofing transport infrastructure, port facilities, roads, railways, and bridges.	Climate change considerations reflected in transport sector policies and plans	First				MOTC, MONREC (ECD)	MOPF, CDCs, local government, private sector
Study the supply chain of different agricultural products, especially rice, and introduce a road network infrastructure plan to improve market access and opportunities for farmers.	Supply chain study of agricultural products conducted and improved by highly interconnected road network infrastructure	First				MOC, MOALI, MOTC, local government	MOPF, private sector, MOHA
Integrate climate change in industrial development planning by developing climate-resilient planning guidelines and tools.	Planning guidelines and tools developed	First				MOI	MOPF, CDCs, private sector, MONREC

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 2: Establish and Reinforce Institutional Arrangements to Plan and Implement Climate Change Responses

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Improve institutional mechanisms to better assess and plan climate change investment and interventions.	Institutional mechanisms on assessment strengthened	First				MOEE, MOI, MOALI	PS, MONREC, MOTC, development partners, international agencies
Integrate climate change within existing institutional mechanisms (National Energy Management Committee [NEMC]).	Climate change integrated within existing institutional mechanisms (NEMC)	First				MOEE (NEMC), MONREC	MOI, MOALI
Establish and strengthen a climate change cell within the MOEE.	Climate change cell established and strengthened within the MOEE	First				MOEE (NEMC), MONREC	MOI, MOALI

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 3: To Establish Financial Mechanisms to Mobilise and Allocate Resources for Climate-Resilient and Low-Carbon Development

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Develop a financial investment plan for the energy sector to finance and implement climate-resilient and low-carbon development activities.	Financial mechanisms and guidelines on tax and international finance are developed	First				MOEE, MOPF	MOI, private sector, international agencies
Develop guidelines for including energy efficiency and low-carbon development priorities within the Environmental Management Fund (EMF).	Energy efficiency and low-carbon development integrated within the EMF	Second				MOEE, MONREC, MOI	MOI, MOPF, development partners, private sector, IFIs
Disburse climate change finance for low-carbon and resource-efficient technologies, namely for renewable energy technologies.	Improved public and private sector access to climate finance for low-carbon and resource-efficient technologies, namely, renewable energy technologies such as hydropower (as designated in Myanmar's NDC)	First				MOEE, MONREC, MOI	MOPF, development partners, private sector, IFIs
Allocate revenue from natural resource extraction to a climate change fund, such as the EMF.	Increased allocation to the climate change fund in question (such as the EMF)	First				MOEE	MONREC, MOALI, MOI, private sector, international agencies
Seek international development partners to integrate the road network and implement plans to improve the supply chain of agricultural products.	Farmers have increased access to markets and generate more income	First					

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 4: Increase Access to Climate-Resilient and Low-Carbon Technologies and Practices in the Energy, Transport, and Industry Sectors

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Introduce and promote innovative technology for renewable energy—for example, solar, wind, tidal, and wave)—in the energy, transport, and industry sectors.	Improved access to innovative technology for renewable energy from sustainable sources in the energy, transport, and industry sectors	Second		■		MOEE	MOI, MOE, MOALI, private sector, CSOs
Provide training and exposure to stakeholders on improved technology for energy and waste management to reduce GHG emissions and promote environmental sustainability.	Stakeholders trained on energy and waste management technologies	Second		■		MOI, CDCs	MONREC, MOEE, private sector
Identify and promote energy-efficient and climate-friendly technologies and practices—such as improved cooking stoves, off- and mini-grid energy, and access to biomass—with a gender-sensitive approach.	Energy-efficient technologies and practices promoted	First		■		MONREC, MOEE, MOALI, MOI	MOEE, international agencies
Promote low-emission technologies, such as renewable energy, targeting the energy and industry sectors.	Low-emission and renewable energy technologies promoted	Third			■	MOI, MOPF	MOEE, MONREC, private sector, international agencies

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 5: To Enhance Awareness and Capacity to Promote and Implement Climate-Resilient and Low-Carbon Responses

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Carry out studies looking at climate change impact and implications in the energy, industry, and transport sectors.	Climate change impact studies carried out	First				MOEE	MOI, MOTC, MONREC, MOE, ARIs
Carry out risk assessment of public infrastructure and develop risk reduction and mitigation plans.	Risk assessment of public infrastructure carried out	First				CDCs, MOC	MOEE, MONREC, private sector, international agencies
Prepare training guidelines and module on energy efficiency and low-carbon development of the energy sector.	Training guidelines and module developed	Third				MOEE, MOI, MOALI	PS, MOTC, MONREC, development partners, international agencies
Provide training to government and private sector stakeholders on climate proofing and screening guidelines and methods.	Capacity of the government and private sector on climate proofing and screening developed	Second				CDCs, MOC	MOEE, MONREC, private sector, international agencies
Establish weather and climate information services in cities and towns, including rural areas.	Weather and climate information services established	Second				MOIN, CDCs, MOC	MOTC, (DMH), MOHA (GAD), MOSWRR, MOIN

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 6: To Promote Multi-Stakeholder Partnerships to Support and Scale Up Climate-Resilient and Low-Carbon Responses

			Timeframe			Responsible Institution	
Strategic Policy Actions	Outputs	Priority	S	M	L	Lead	Support
Develop public–private partnership (PPP) procedures and guidelines for private sector investment in low-carbon energy production and consumption in the industrial, construction, and mining sectors, amongst others.	Institutional mechanism and partnership modality developed	First				MOEE, MOI	PS, MOPF, IFIs
Establish linkages and collaboration between local government (CDCs) and international and national actors to increase the number of buses, trains, and cars that use low-emission technologies.	Increased collaboration between local governments, the private sector, and other agencies	Second				MOEE, MOI	MOPF, MONREC, private sector, development partners, MOALI
Develop regulations to promote tax exemptions, loans, and grants as incentives for clean energy investment for private sector and international cooperation.	Regulations to promote tax exemptions, loans, and grants developed	Third				MOEE, MOI	PS, MOPF, IFIs

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

9.4 Resilient, Inclusive, and Sustainable Cities and Towns Where People Can Live and Thrive

9.4.1 | Sectoral Outcome

The sectoral outcome is that all township and city dwellers, including the most vulnerable, are safe from increased risks of rapid- and slow-onset natural disasters and live in sustainable, inclusive, low-carbon, and climate-resilient towns.

Table 9.4: Expected Results and Indicators

Sectoral Expected Results	Strategic Indicators
Town and city residents have access to resilient infrastructure and services that protect them from natural hazards of increased intensity, continue to perform during and after shocks, and are best adapted to the new climatic context.	• Number of local and national spatial and land-use planning frameworks that include climate change considerations from a low baseline • Number of laws, policies, and by-laws for urban management and development that include climate change, from a low baseline • Number of new, converted, retrofitted infrastructure, basic services, and buildings that are climate change responsive, from a low baseline • Number of town planners, architects, and engineers who can help townships and cities plan and manage climate change considerations from a low baseline • Number of township and city climate change action plans based on ecosystem adaptation or other approaches that support the development of green cities • Number of real estate developers and private industries who integrate climate change in their development projects
Climate change resilience, low-carbon development, and social inclusivity approaches are defining elements of urban planning and development, providing mitigation and adaptation co-benefits.	
New buildings are designed and constructed to be energy- and resource-efficient and resilient to natural hazards and disasters; they emit less carbon and produce savings from reduced energy consumption, thus providing equity and affordability.	

Source: MNREC, 2018.

9.4.2 | Objectives for Action Areas

The objectives for the action areas are as follows:

(i) Ensure that legal, policy, and normative instruments for urban development and management integrate climate adaptation and DRR.
(ii) Build climate change-responsive institutional and decentralised processes in urban settings.
(iii) Increase the human resource capacities and awareness of CDCs and townships to address climate change.
(iv) Build financial capacities for addressing climate change at the local level, using multiple sources of funding.
(v) Increase access to technology for urban climate resilience.
(vi) Promote public–private and civil society partnerships at the town and city levels for climate change resilience and sustainable urban development.

9.4.3 | Key Actors

The focal agency is the Ministry of Construction (MOC) (Department of Urban and Housing Development), and the lead actors are the MOC (Department of Urban and Housing Development), CDCs, and townships.

Other actors include the following: (i) the MOHA (GAD); (ii) MOEE; (iii) MOTC; (iv) MONREC; (v) Relief and Resettlement Department (RRD); (vi) National Committee for Environmental Conservation and Climate Change; (vii) State and Regional Committees for Environmental Conservation and Climate Change; (viii) CDCs, including (a) the Mandalay City Development Committee, (b) Yangon City Development Committee, and (c) Nay Pyi Taw Development Committee; (ix) township development committees; (x) the UN (UN-Habitat, UNEP, and UN Industrial Development Organization); (xi) development partners; (xii) local government (regional, district, and township); (xiii) NGOs; (xiv) CSOs; (xv) CBOs, including local ward and neighbourhood groups; (xvi) international technical experts (ITEs); (xvii) international technical support (ITS); (xviii) the private sector, including the Union of Myanmar Federation of Chambers of Commerce and Industry and other business associations; and (xix) the Myanmar Engineering Society.

9.4.4 | Climate-Resilient, Inclusive, and Sustainable Towns and Cities Where People Can Live and Thrive

Objective for Action Area 1: Integrate Climate Adaptation and Disaster Risk Reduction into Urban Development and Management Legal, Policy, Normative, and Planning Instruments

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible institution	
			S	M	L	Lead	Support
Mainstream climate change adaptation and mitigation into the legal and policy framework for urban development and management.	All main urbanisation policies—the National Urban Policy, Housing Framework, and National Spatial Development Framework—include climate change	First	■			MOC	CDCs, MOHA (GAD)

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Objective for Action Area 1: ***Continued***

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible institution	
			S	M	L	Lead	Support
Develop by-laws at the township and city levels that incentivise low-carbon development and require climate-resilient development.	By-laws in place for every township	Third				CDCs	MOE, MOEE, private sector
Integrate energy efficiency, environmental considerations, and disaster resilience into building regulations.	Existing building regulations reviewed for opportunities to integrate energy efficiency and disaster resilience Myanmar National Building Code adopted within 1 year, integrating energy and water supply efficiency provisions, green buildings, and hazard-sensitive construction EIAs applied systematically as needed	Third				MOC	CDCs, MOHA (GAD)
Develop climate change and disaster risk management action plans at the urban and local levels by incorporating lessons learned from the previous disaster, particularly Cyclone Nargis (2008).	Existing plans reviewed and gaps to be addressed by climate change and disaster risk management plans identified Climate change adaptation, mitigation, and disaster risk management plans exist in each CDC Greater Yangon plan integrates climate change and disaster risk management	First				MOC	Local ward and neighbourhood groups, ITEs
Undertake climate risk assessments for essential public buildings and emergency services, and introduce new public disaster shelters in disaster-prone townships.	Risk assessment of public infrastructure carried out, and risk reduction and mitigation plans developed in main cities and towns and new public buildings in disaster-prone townships Training provided to government and private sector stakeholders on climate-proofing and screening guidelines and methods Climate-smart building codes and regulations reinforced	First				CDCs, MOC	MOE, MOEE, MONREC, private sector, international agencies

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 2: Build Climate Change-Responsive Institutional and Decentralised Processes in Urban Settings

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Strengthen urban institutional processes that promote sustainable transport.	Feasibility studies for urban public transport developed at the city level Urban public transport plans developed for implementation in collaboration with the private sector, and financing identified Public transport authorities established in urban areas to develop and implement mass transit systems	First				CDCs	MOC
Strengthen local governance ability to address climate change with focal points for climate change adaptation and resilience.	Local governance processes reviewed to assess roles in addressing climate change Townships and CDCs have nominated focal points for climate change	Third				MOHA (GAD), CDCs	MOC, ITEs

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 3: Increase Human Resource Capacities and Awareness of City Development Committees and Townships to Address Climate Change

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Improve urban authorities' capacity to use basic technology for data collection, data management, and geographic information systems (GIS) in preparing for disasters.	Assessment of capacity gaps carried out and action plan developed Local authorities access and receive training on skills to use a number of tools E-governance system reactivated to promote GIS mapping and other good practices	Second				MONREC (ECD, DOF) DMH, RRD, MOC, MOHA, CDCs	CDCs, international agencies, ITS
Strengthen capacity of local government officials to assess vulnerability and plan for climate change adaptation by highlighting the lessons from previous climate disasters.	Training on assessing vulnerabilities, climate change impacts, and adaptive measures provided for staff, especially in the most vulnerable townships	First				MONREC (ECD, Forest Department, DMH), RRD, MOC, MOHA, CDCs	CDCs, international agencies, ITS

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Objective for Action Area 3: ***Continued***

Strategic Policy Actions	Outputs	Priority	Timeframe S	Timeframe M	Timeframe L	Responsible Institution Lead	Responsible Institution Support
Increase sectoral capacity for effective liquid and solid waste management.	Existing systems reviewed and action plan for improvement and scale up devised Financing for water and solid waste management systems identified, including for planned urban expansion Adequate liquid and solid waste management systems to service the urban population	Third			■	CDCs, utility companies	MOC, private sector
Increase town planning capacities to integrate climate change into spatial strategic urban and land-use planning.	National town planners lead CDCs' strategic urban plans and land-use plans integrating climate change Training provided to government and private sector stakeholders on climate-proofing and screening guidelines and methods	Second			■	ECD, Forest Department, DMH, RRD, MOC, MOHA, CDCs	CDCs, international agencies, ITS
Revise existing educational curricula to include climate change (particularly for engineering and architecture students at the university level).	Existing curricula reviewed to identify entry points for including climate change University and technical institute curricula for engineering, architecture, and planning integrate climate change and DRR techniques New curricula developed and rolled out to engineering and architecture courses	First	■			MOE, MOC	Universities, international agencies
Implement campaigns to raise community awareness of the likely impacts of climate change and basic DRR techniques by incorporating lessons learned from previous climate-induced disasters.	Training provided to heads of 100 households to capacitate them to provide ongoing information on DRR measures to their own communities	Second	■			CDCs, NGOs	CSOs, private sector, neighbourhood wards

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 4: Build Financial Capacities to Address Climate Change at the Local Level, Using Multiple Sources of Funding

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Increase budgeting at the local level for climate change adaptation and mitigation.	Feasibility studies for township-level budgeting for climate change adaptation and mitigation carried out; financing plans for townships developed Agreed percentage of CDCs' annual budget allocated to climate change activities	First				CDCs	MOC
Increase the capacity of local authorities to access additional sources of funding, including national and international climate financing.	CDCs and townships access national and international finance for local resilience initiatives	Third				CDCs	Private sector, international agencies, international climate funds

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 5: Increase Access to Technology for Urban Climate Resilience

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Assess technology gaps for addressing and monitoring climate change adaptation and mitigation, including disaster-resilient buildings and technologies such as urban ecosystem-based adaptation interventions and nature-based solution for green cities.	Assessment of technology gaps carried out and action plan developed Local authorities trained, supported, and capacitated to understand measures and technologies to employ for adaptation and mitigation	Second				CDCs	MOC
Pilot cost-effective adaptation and mitigation technologies that also promote green cities in line with Myanmar's plan for greening cities.	Local authorities have knowledge of cost-effective green technologies and access to an evidence base on how they can contribute to climate action	Third				CDCs	MOC; ECD

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 6: Promote Public–Private and Civil Society Partnerships at the Town and City Levels for Climate Change Resilience and Sustainable Urban Development

Strategic Policy Actions	Outputs	Priority	Timeframe S	M	L	Responsible Institution Lead	Support
Establish multi-stakeholder partnerships and participation and debate mechanisms in local climate action at the township level.	Functioning multi-stakeholder groups exist at the township level engaging on climate change impacts, adaptation, and sustainability, promoting low-carbon and sustainable investments	First			■	GAD, RRD, DMH, CDCs, private sector, CBOs, NGOs	NGOs, CSOs
Establish PPPs to encourage investments in climate-resilient infrastructure, low-carbon developments through zoning, planning, and incentive mechanisms.	Private sector sensitised through forums and business cases Procedures in place for private sector projects to follow building regulations and codes and invest in energy- and water-efficient systems, low-carbon construction, and urban industrial and commercial ventures	First			■	Private sector, MOC, ECD, CDCs	CDCs, MOHA, MONREC

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

9.5 Climate Risk Management for People's Health and Wellbeing

9.5.1 | Sectoral Outcome

The sectoral outcome is that communities and economic sectors are able to respond to and recover from climate-induced disasters, risks, and health impacts and build a healthy society.

9.5.2 | Objectives for Action Areas

The objectives for the action areas are as follows:

(i) Ensure that legal, policy, and normative instruments on DRR, social protection, and health integrate climate adaptation and DRR.

Table 9.5: Expected Results and Indicators

Sectoral Expected Results	Strategic Indicators
Climate risk management system is well established, robust, and nationally integrated to respond effectively to the increased intensity and impact of risks and hazards on people's health and wellbeing.	• Number of climate risk management systems developed, including risk-informed policy development and planning guidelines, tools, and framework • Number of local communities, local government, and CSOs with access to risk mapping, early warning systems, and disaster-resilient technologies for disaster preparedness and emergency management and response
Myanmar has improved social protection, gender consideration, and risk finance capacity to prepare for and recover from potential loss and damage resulting from climate change.	• Number of states and townships with capacity for climate risk management planning • Number of social protection policies, strategies, budgeting, and plans that integrate climate change • Number of private sector companies, development partners, government bodies, CSOs, and international communities who allocate a share of resources to social protection and resilience-building activities
Myanmar's health system is improved and can deal with climate-induced health hazards and support climate-vulnerable communities to respond effectively to disaster and health hazards from climate change.	• Number of states and townships that integrate climate change in their budgeting system to finance climate risk management and social protection activities at the national and subnational levels • Number of laws, by-laws, policies, and plans within the health sector that integrate climate change • Number of health professionals and government staff with capacity for climate risk and disaster mapping, early health hazard detection, and forecasting and resilience planning • Number of households in climate-vulnerable states or regions and townships with access to improved health and sanitation practices and resilient health infrastructures

Source: MNREC, 2018.

(ii) Build climate change-responsive institutional and decentralised settings.

(iii) Increase human resource capacities and awareness of communities, governments, the private sector, and CSOs to address climate-induced risk and disasters.

(iv) Build financial capacities for addressing climate change at the local level, using multiple sources.

(v) Increase access to technology for climate risk management and improved health and wellbeing.

(vi) Promote public–private and civil society partnerships at the national and subnational levels for climate change resilience and sustainability.

9.5.3 | Actors

The lead actors are (i) the MOSWRR; (ii) MOTC (DMH); and (iii) MOHS (Department of Public Health).

Other actors are as follows: the National Disaster Management Committee and its members; MOHA (the police, GAD, and fire service); MONREC (ECD, Remote Sensing and GIS Survey Department); MOALI (IWUMD); MOPF; MOC; MOIN; MOE; local government (state, district, township); representatives from line ministries with DRR and climate change-adaptation activities; the DRR Working Group; the UN (UNDP, FAO, UN-Habitat, UN International Children's Emergency Fund, and UNEP); the Japan International Cooperation Agency; the Asian Development Bank; NGOs; international NGOs; CSOs; CBOs; the private sector; development partners; international agencies; the media; and universities.

9.5.4 | Climate Risk Management for People's Health and Wellbeing

Objective for Action Area 1: Integrate Climate Adaptation and Disaster Risk Reduction into Disaster Risk Reduction, Social Protection and Health, Legal, Policy, and Normative Instruments

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Review existing policies, strategies, and guidelines to identify gaps and scope for integrating climate change.	Review paper developed, looking into existing policies, strategies, and guidelines	First	■			MOSWRR, MOHS, MONREC	MOTC, MOALI, MOHA
Integrate climate change into DRR, social protection, gender equality, and health policies and plans for risk-informed policy development and planning.	DRR, social protection, and health policies and plans integrate climate change	First	■			MOSWRR, MOHS, MONREC	MOTC, MOALI, MOHA

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Objective for Action Area 1: ***Continued***

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Provide support to townships or districts to develop and update disaster preparedness plans to include climate change risks and hazards.	Climate change integrated into local-level plans and responses	Second				MOSWRR, DMH	Local government, NGOs, CBOs, international agencies
Implement DRR and climate change adaptation activities and scale these up in vulnerable townships in the delta, Dry Zone, coastal, and mountainous regions.	DRR and climate change adaptation activities implemented in vulnerable townships	First				MOSWRR, DMH	Local government, NGOs, CBOs, international agencies
Update and implement multi-hazard preparedness and response plans to include climate-induced disasters.	Existing multi-hazard preparedness response plan updated to include climate change	First				National Disaster Management Committee, MOSWRR, MOALI, MOHS	GAD, local government, development partners, CSOs, CBOs
Implement activities to reduce climate-induced, water-related health hazards through increased access to safe drinking water, improved sanitation, and behaviour change communication.	Increased access to safe drinking water and improved sanitation for climate change-vulnerable households	First				MOHS	NGOs, CBOs, local government, development partners
Pilot social protection measures—such as social transfers, livelihood diversification, weather-indexed crop insurance, and access to credit and assets—in five vulnerable regions.	Social protection measures piloted	First				MOSWRR	MOPF, development partners, MONREC, MOALI, local government NGOs, private sector

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 2: Build Institutional and Decentralised Processes to Plan and Implement Climate Change Responses

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Strengthen disaster management committees for effective preparedness and response, including additional human resource development in the context of climate change.	Improved capacity of disaster management committees for integrating climate change	Third	■			MOSWRR, MONREC (ECD)	MOTC, MOHA (GAD), local government
Conduct health vulnerability assessment and develop health adaptation planning to address climate change impacts.	Up-to-date knowledge on key risks to the health sector	First		■		MOHS	
Carry out study to explore national, regional, and district linkages and potential mechanisms for climate risk management.	Study conducted	Third	■			MONREC, MOSWRR, MOTC (DMH)	MOHA, MOALI, local government, international agencies
Develop new institutional mechanism for effective early warning system and communication.	New institutional mechanism set up	Third	■			MONREC, MOSWRR, MOTC (DMH)	MOHA, MOALI, local government, international agencies
Strengthen the National Disaster Management Technical Centre in Hintada to provide technical support on climate-induced risk and climate change modules.	National Disaster Management Technical Center strengthened with climate change modules	First		■		MOSWRR	MONREC, MOTC, MOPF, MOHA

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 3: Build Financial Capacities to Address Climate Change at the Local Level, Using Multiple Sources of Funding

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Integrate climate change within national and subnational DRR planning and budgeting.	Climate change integrated in national and subnational DRR planning and budgeting systems	First				MOSWRR, MOPF	IFIs, MOTC, MONREC (ECD)
Provide training and exposure visits to build capacity of relevant institutions to improve financial management capacity to explore and manage funds for DRR and climate change adaptation.	Training and exposure visits organised for government officials	Third				MOSWRR, MOPF	International agencies, private sector, MONREC (ECD), MOTC (DMH), IFIs, CSOs
Mobilise a national contingency fund to support responses to climate risk and disasters.	National contingency fund mobilised to include climate change	First				MOSWRR, MOPF	IFIs, MOTC, MONREC (ECD)

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 4: Increase Access to Climate-Resilient and Low-Carbon Technology and Practices for Climate Risk Management and Health

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Provide training to government staff on ICT and other skill-based areas for effective climate change adaptation and DRR responses.	Number of trainings organised	Second				MOSWRR, MOTC (DMH)	International agencies, MOHS, MONREC (ECD), MOI, Union of Myanmar Federation of Chambers of Commerce and Industry

continued next page

Objective for Action Area 4: ***Continued***

			Timeframe			Responsible Institution	
Strategic Policy Actions	Outputs	Priority	S	M	L	Lead	Support
Develop early warning system that is accessible 24 hours a day to increase public access to weather and climate-related forecasts.	Early warning system strengthened	First				MOTC (DMH), MOSWRR, MOALI, MONREC	MOI, international agencies
Improve the efficiency of existing systems by modernising equipment, instruments, and tools (e.g. in ocean and marine contexts).	Improved quality of early detection and forecasts	Second				MOTC (DMH)	Union and state governments, CSOs, international agencies, MOHA
Set up water, air, and food assessment laboratory or facilities in the MOHS and in three major cities.	Water, air, and food assessment laboratory or facilities established	Third				MOHS, CDCs, MONREC (ECD)	International agencies
Retrofit and climate-proof critical infrastructure—including schools and hospitals—in climate-vulnerable townships.	Critical infrastructure retro-fitted and climate-proofed	Second				MOSWRR, MOPF	MOTC, international agencies, MOHS, MOC, local government, NGOs
Train government officials and development practitioners in scientific and technical skills, such as vulnerability assessment and risk and hazard mapping.	Government officials trained on vulnerability assessment and risk mapping	Second				MOTC (DMH)	MONREC, MOALI, MOSWRR, local government, development partners
Set up national and subnational-level (in delta, Dry Zone, coastal, flood, and mountainous regions) integrated surveillance systems for climate-sensitive diseases, with metrology data for an early health warning system.	Disease surveillance systems established	Third				MOHS departments	MOTC (DMH), development partners, CSOs

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 5: Increase Awareness and Capacity of Relevant Ministries to Carry out Climate Risk Management Effectively

			Timeframe			Responsible Institution	
Strategic Policy Actions	Outputs	Priority	S	M	L	Lead	Support
Provide training to local communities on shelter management, and search and rescue in the context of climate change.	Communities trained on shelter management, and search and rescue	First				MOSWRR	MOC, local government, development partners, CBOs
Provide training and exposure to DMH staff for climate change research.	Training and exposure visit for DMH staff	Third				MOTC (DMH)	MONREC, MOHS, international and regional collaboration
Raise awareness of the health impacts of climate change, and provide training on mainstreaming climate change in health programming and planning.	Training and exposure visit for national and local government health officials	Third				MOHS	
Establish research grants for the DMH, sectoral agencies, and university students to build their capacity to generate knowledge and evidence that is useful for climate risk management.	Research grants established and made available	First				MOSWRR, MOTC	MOHA, development partners, NGOs, CBOs
Incorporate climate change and health modules in school, university, and training curricula.	Climate change and health modules available and integrated into school, university, and training curricula	Second				MOHS, MOE	MONREC

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 6: Promote Public–Private and Civil Society Partnerships at the National and Subnational Levels for Climate Change Resilience and Sustainability

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Form new or revitalise and upgrade existing district-, township-, state-, and national-level multi-stakeholder disaster risk management committees, integrating climate change within their portfolios.	Multi-stakeholder disaster risk management committees set up and strengthened at all levels	Second				MONREC (ECD), MOTC (DMH), MOSWRR	Local government, private sector, CSOs, development partners
Set up a network and DMH links with international and regional networks to exchange information and knowledge on climate and disaster forecasting.	Regional and international networks and links set up	Second				MOTC (DMH), MOSWRR	MOIN, MONREC, ECD, international agencies
Design and implement multi-stakeholder projects on climate risk management in climate-vulnerable areas.	Multi-stakeholders engaged in designing and implementing projects	First				MOSWRR, DMH	MOPF, MONREC, local government, development partners, private sector, CSOs
Develop multi-stakeholder, social-protection, and resilience-building projects for the Green Climate Fund and Adaptation Fund targeting the most vulnerable townships in Dry Zone, delta and coastal areas.	Projects for the Green Climate and Adaptation Funds developed	First				MOSWRR	MOPF, MONREC, MOHS, local government, private sector, CSOs, UN

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

9.6 Education, Science, and Technology for a Resilient Society

9.6.1 | Sectoral Outcome

The sectoral outcome is strengthened education, awareness, and technological systems that foster a climate-responsive society and human capital to design and implement climate-resilient and low-carbon development solutions for inclusive and sustainable development.

Table 9.6: Expected Results and Indicators

Sectoral Expected Results	Strategic Indicators
Capacity of actors in the education sector is developed to integrate principles of sustainability, low-carbon development, and resilience into the curricula at the primary, secondary, and tertiary levels. Capacity of actors in the science, technology, and education sectors is developed to generate research and build and use climate information systems. Institutional capacity and multi-stakeholder partnerships are enhanced to access and manage climate financing to ensure climate-responsive education, science, and technology.	• Number of policies, strategies, and action plans in the education, science, and technology sectors that integrate climate change • Number of primary, secondary, and higher-level institutions that integrate climate change in their curriculum, courses, and teaching materials • Number of university graduates and researchers trained and enabled to carry out independent and innovative work on climate change • Number of ICT materials—including research and extension products such as research papers, theses, policy papers, and technical working papers—that reflect climate change issues and solutions • Number of university professors, lecturers, schoolteachers, and university graduates who can help the government and private sector consider climate change in their planning and management • Number of households in climate-vulnerable states and townships that are aware of the consequences of climate change and can identify response measures • Increase in the share of climate financing for information, knowledge, research, and capacity building from the government, development agencies, international organisations, and other sources • Number of networks and partnerships amongst different actors set up to promote climate-responsive education, science, and technology • Number of joint collaborative projects to strengthen education, science, and technology to promote climate resilience and low-carbon development strategies and actions at the national and subnational levels.

Source: MNREC, 2018.

9.6.2 | Objectives for Action Areas

The objectives for the action areas are as follows:

(i) Ensure that legal, policy, and normative instruments in education, science, and technology integrate climate adaptation and DRR.
(ii) Build climate change-responsive institutional and educational processes.
(iii) Increase human resource capacities on climate research and knowledge management and build climate change awareness in communities, governments, the private sector, and CSOs.
(iv) Build financial capacities for strengthening climate information services, using multiple sources.
(v) Increase access to climate information services, research, and technological innovations.
(vi) Promote multi-stakeholder partnerships at the international, national, and subnational levels for climate change education, science, and technology.

9.6.3 | Actors

The lead actor is the MOE, including the following departments: (i) Human Resource and Educational Planning; (ii) Department of Educational Research, Planning and Training; (iii) Basic Education; and (iv) Higher Education.

Other actors include the following: (i) the Department of Research and Innovation; (ii) MOIN (Department of Information, Department of Public Relations); (iii) MOSWRR (Department of Relief and Resettlement); (iv) MOPF; (v) MOALI; (vi) MOTC (DMH); (vii) MONREC (ECD); (viii) research institutes under different ministries; (ix) ARIs, including the Mandalay Technological University (Faculty of Bio-Technology), Yangon Technological University (University of Distance Education), Yangon University (Department of Geography), and University of Agriculture (University of Forestry); (x) local government (regional or state, district, and township); (xi) the UN (United Nations International Children's Emergency Fund, UN-Habitat, UNEP, and UNDP); (xii) the European Union; (xiii) CSOs; (xiv) the Climate Technology Centre Network, under the United Nations Framework Convention for Climate Change; (xv) the public and private sectors, including the media; and (xvi) social groups for youth, children, women, and other social groups.

9.6.4 | Education, Science, and Technology for a Resilient Society

Objective for Action Area 1: Integrate Climate Adaptation and Disaster Risk Reduction in Education, Science, and Technology Legal, Policy, and Normative Instruments

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Develop a new science and technology strategy that integrates climate change.	New strategy on science and technology developed	First				MOE	MONREC (ECD), international agencies
Revise the curricula and syllabi of all of the main universities and schools to integrate climate change.	New curricula developed integrating climate change	Second				MOE, ARIs	MONREC (ECD), MOPF
Integrate climate change in education sectoral planning systems at the national and local levels by developing guidelines and tools.	Climate change integrated in education sectoral planning systems	Second				MOE	MOPF, MONREC (ECD)

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 2: Build Climate Change-Responsive Institutional and Educational Processes

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Set up climate change coordination mechanisms in the education sector to establish better linkages and synergy.	Coordination mechanism set up	First				MOE, MOPF	MONREC (ECD), ARIs, development partners
Form new or revitalise existing organisations to mobilise women, youth, children, and vulnerable groups to ensure engagement on climate change.	Institutional mechanism formed or revitalised	Third				MOE	Other government agencies, local government, NGOs, donors
Develop strategies to strengthen the MOE's capacity to integrate climate change within institutional portfolios.	Strategy on developing the MOE's institutional capacity to manage climate change developed	Third				MOE	Other government agencies, local government, NGOs, donors

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 3: Build Financial Capacities to Strengthen Climate Information Services, Using Multiple Sources of Funding

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Set up a climate change research fund and develop guidelines to enhance education and research climate change.	Climate change research fund set up and guidelines developed	First				MOE, MONREC (ECD)	MOPF, international agencies
Finance projects on climate change-related education, capacity, and research.	Climate change-related projects implemented	First				MOE, MONREC (ECD)	Relevant ministries, international agencies
Develop and circulate budget guidelines for climate change integration in education, science, and technology.	Budget guidelines for climate change developed	Second				MOE, MOPF	MONREC (ECD), local government, CSOs

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 4: Increase Access to Climate Information Services, Research, and Technological Innovations

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Implement multi-disciplinary technology and research-focused projects on climate change.	Multidisciplinary technology and research projects on climate change implemented	First				MOE, ARIs	MOPF, MONREC (ECD), international agencies
Develop and promote a number of ICT events and materials to disseminate information on climate-resilient technology to youth, children, women, and other vulnerable social groups.	Improved ICT systems at the national and subnational levels	Second				MOIN	MONREC (ECD), MOC, DMH, international agencies

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 5: Increase Capacities for Climate Research and Knowledge Management and Raise Climate Change Awareness in Communities, Government, the Private Sector, and Civil Society Organisations

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Develop, package, and distribute public awareness-raising materials on climate change.	Public awareness-raising materials developed and provided to members of the public	Second				MOIN, MOE	MONREC, MOE, CSOs, media, private sector, local government
Provide training to all relevant ministries to raise awareness on how to integrate climate change resilience into programme and project cycles.	Capacity of ministerial staff on climate change enhanced	First				MOE	GAD, MONREC (ECD), international agencies
Conduct training courses for schoolteachers on climate change.	Schoolteachers sensitised on climate change	First				MOE MONREC (ECD)	NGOs, international agencies
Provide training on conducting on climate change research to ARIs and professionals.	Capacity of ARIs is strengthened	Third				MOE	GAD, MONREC (ECD), international agencies
Organise events to increase the media's awareness on climate change.	Training and awareness-raising activities for the media organised	Third				MOIN	MONREC (ECD), local government, state and private media, CSOs

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Objective for Action Area 6: Promote Multi-Stakeholder Partnerships for Climate Change Education, Science, and Technology at the International, National, and Subnational Levels

Strategic Policy Actions	Outputs	Priority	Timeframe			Responsible Institution	
			S	M	L	Lead	Support
Set up a climate change working group within the MOE to support climate change awareness, capacity building, and technology transfer.	Multi-stakeholder partnership modality and mechanism set up	First				MONREC, MOPF	Development partners, CSOs, private sector
Organise joint climate change science and technology fairs at the national and regional or state levels.	Climate change science and technology fairs organised	Third				MONREC, MOPF	MOPF, private sector, international agencies
Implement joint government–donor–CSO–private sector events on climate science, education, and technology, targeting vulnerable areas.	Joint collaborative project implemented	Third				MONREC, MOPF	Private sector, international agencies
Set up media and private sector networks for climate change information and knowledge exchange.	Networks amongst the media and private sector set up	First				MOIN	MOSWRR, MONREC, local government, media, private sector, NGOs, development partners

Note: S = short term (1–3 years); M = medium term (1–6 years); L = long term (1–12 years).

Acronyms

ARI	academic and research institutions
CBO	community-based organisation
CDC	city development committee
CFUG	community forestry user group
CSO	civil society organisation
DMH	Department of Meteorology and Hydrology
DOA	Department of Agriculture
DRR	disaster risk reduction
DZGD	Dry Zone Greening Department
ECD	Environment Conservation Department
EIA	environmental impact assessment
EMF	Environmental Management Fund
FAO	Food and Agriculture Organization
GAD	Department of General Administration
GCF	Green Climate Fund
GHG	greenhouse gas
GIS	geographic information system
ICT	information and communications technology
IFI	international financing institution
ITE	international technical expert
ITS	international technical support
IWUMD	Irrigation and Water Utilization Management Department
MCCA	Myanmar Climate Change Alliance
MOALI	Ministry of Agriculture, Livestock and Irrigation
MOC	Ministry of Construction
MOE	Ministry of Education
MOEE	Ministry of Electricity and Energy
MOHA	Ministry of Home Affairs
MOHS	Ministry of Health and Sports
MOHT	Ministry of Hotels and Tourism
MOI	Ministry of Industry
MOIN	Ministry of Information
MONREC	Ministry of Natural Resources and Environmental Conservation
MOPF	Ministry of Planning and Finance

MOSWRR	Ministry of Social Welfare, Relief and Resettlement
MOTC	Ministry of Transportation and Communication
NDC	nationally determined contribution
NECCCC	National Environmental Conservation and Climate Change Committee
NEMC	National Energy Management Committee
NGO	nongovernment organisation
NSDP	National Sustainable Development Plan
REDD+	reducing emissions from deforestation and forest degradation
RRD	Relief and Resettlement Department
SEA	strategic environmental assessment
SIA	social impact assessment
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UN-Habitat	United Nations Human Settlements Program

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CHAPTER 10

Disaster Resilience and Climate Change Adaptation in Viet Nam

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10.1 Background

Viet Nam is a strip of land shaped like the letter 'S' bordered by China to the north, the Lao People's Democratic Republic and Cambodia to the west, the East Sea to the east, and the Pacific Ocean to the east and south. The country's total length from north to south is 1,650 kilometres (km). Its width (east–west) is 600 km at its widest point in the north, 400 km at its widest point in the south, and 50 km at its narrowest point. Its coastline is approximately 3,260 km long and its inland border is 4,510 km long. The country is located in both a tropical zone and a temperate zone. Viet Nam is one of the countries most affected by natural disasters and climate change. Storms and floods are the most frequent and severe natural disasters affecting Viet Nam.[1] Severe droughts, the intrusion of saline water, landslides, and other natural disasters are also hindering the country's development. Extreme disasters have been occurring more frequently in recent years, causing increasing levels of damage to the population and significantly impacting the economy (United Nations Development Programme, 2015).

In response to this accelerating trend of disasters and climate change, the Government of Viet Nam and the Communist Party of Viet Nam have approved policies, strategies, and relevant policies with major objectives, tasks, and requirements for the entire country, each region, and each economic sector. Viet Nam's agricultural sector plays a central role in the country's economy. However, it also is the most vulnerable sector in the context of climate change and natural disasters. Therefore, it is highly necessary to develop an adaptation roadmap for disaster resilience and climate change.

[1] Each year, Viet Nam has been enduring 10–12 typhoons, which have caused 74 floods, on average, in the river systems.

10.2 Overview of Viet Nam's Current Policy System on Climate Change and Disaster

10.2.1 | The Objectives of the Communist Party of Viet Nam in Responding to Climate Change

In light of the challenges posed by climate change and rising sea levels, the Communist Party of Viet Nam approved an early Central Resolution on Active Response to Climate Change, Strengthening Natural Resources Management and Environmental Protection.[2]
The resolution outlines the primary goals, targets, and tasks for the country as well as each economic sector in the context of climate change. According to the resolution, necessary responses to climate change include (i) capacity building for forecasting, warning, active prevention and mitigation, and adaptation to climate change; (ii) promoting measures to prevent and control the impact of high tides, inundation, and salinity intrusion due to rising sea levels; (iii) mitigating greenhouse gas (GHG) emissions; and (iv) protecting and developing natural ecosystems to enhance the absorption of GHGs.

10.2.2 | Government Strategies

The government has also issued three relevant strategies: (i) the Sustainable Development Strategy for Viet Nam 2011–2020, (ii) the National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020,[3] and (iii) the National Strategy on Climate Change.[4]

The objective of the Sustainable Development Strategy for Viet Nam 2011–2020 is 'mitigating and responding to climate change, disaster prevention.' Its tasks are (i) building and strengthening the adaptive capacity and adaptability of people and natural systems to protect natural resources in the context of climate change, (ii) improving quality of life, (iii) ensuring environmental security and sustainable development, (iv) raising awareness and responsibilities, and (v) building capacity for responding to climate change and disaster prevention among stakeholders (Government of Viet Nam, 2012).

2 Resolution No. 24/NQ/TW dated 3 June 2013.
3 Decision No. 172/QD-TTg dated 16 November 2007.
4 Decision No. 2139/QĐ-TTg dated 5 December 2011.

The National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020 includes the following statements:

(i) Disaster management includes preparedness for, response to, and recovery from the consequences of disasters to ensure sustainable socioeconomic development, national security, and defense systems.
(ii) Government agencies, social organisations, economic organisations, the armed forces, citizens, and foreign organisations and individuals living in the territory of Viet Nam all are duty-bound to engage in disaster prevention, response, and mitigation.
(iii) Disaster prevention, response, and mitigation are joint actions by the government and citizens that effectively utilise state resources as well as all possible resources from the community, national and international organisations, and individuals.
(iv) Disaster prevention, response, and mitigation shall be integrated into the socioeconomic development master plans and plans of every region and sector, as well as nationwide.
(v) Disaster prevention, response, and mitigation shall be prioritised to ensure disaster preparedness, while the impacts of global climate change, storm surges, and other extreme climate phenomena continue to be studied to determine appropriate response actions.
(vi) Disaster prevention, response, and mitigation shall succeed and apply traditional experience and learned lessons, and combine them with modern knowledge and technologies through international cooperation (Government of Viet Nam, 2007).

The main goals of the National Strategy on Climate Change related to climate change adaptation and disaster resilience are (i) to build the capacity of the entire country and simultaneously implement measures to adapt to the impacts of climate change and reduce GHG emissions, thus ensuring the safety of life and property while promoting sustainable development; and (ii) to enhance the capacity of people and natural systems to adapt to climate change, while developing a low-carbon economy to protect and improve the quality of life, ensuring national security and sustainable development in the context of global climate change, and actively working with the international community to protect the global climate system.

This strategy has four specific objectives:

(i) to ensure food security, energy security, water resources security, poverty reduction, gender equality, social security, public health, livelihood improvement, and the protection of natural resources in the context of climate change;
(ii) to develop a low-carbon economy with green growth as the main trend in sustainable development, mitigate GHG emissions, and increase GHG absorption capacity (which have gradually become compulsory indicators of socioeconomic development);
(iii) to raise awareness, assign responsibility, build the capacity of related parties to respond to climate change, develop scientific and technological potentials, boost the quality of human resources, create institutions and policies, develop and use financial resources to improve the competitiveness of the economy and Viet Nam's position, take advantage of opportunities for socioeconomic development offered by climate change, and develop and scale up the lifestyle of the country's population through a climate-friendly consumption pattern; and
(iv) to contribute actively to the international community in responding to climate change, and strengthen Viet Nam's international cooperation activities to respond effectively to climate change.

The tasks of the strategy include the following:

(i) respond proactively to natural disasters, monitoring changes in the climate, implementing early warning systems, and reducing losses due to natural disasters;
(ii) ensure the security of food and water resources;
(iii) respond actively to rising sea levels in vulnerable areas;
(iv) protect and develop forests sustainably, while enhancing GHG absorption and conserving biodiversity;
(v) mitigate GHG emissions to contribute to protecting the global climate system;
(vi) strengthen the leading role of the state in responding to climate change;
(vii) build a community to respond effectively to climate change;
(viii) develop advanced science and technology to respond to climate change;
(ix) strengthen international cooperation and integration to enhance national standing in climate change issues; and
(x) diversify financial resources and focus on effective investment (Government of Viet Nam, 2011).

10.2.3 | Disaster Resilience and Climate Change Response in Laws

The Resolution No 24–NQ/TW approved some relevant laws such as the Law on Land, Law on Environmental Protection, Law on Irrigation, and Law on Forestry, and integrated articles or chapters regarding climate change response into these laws. In general, according to the current regulations and requirements of the laws, when designing relevant planning and plans, such as land use planning and environmental protection planning, policymakers should consider the factors of climate change and response measures.

10.2.4 | Climate Change Response Plan for the Agricultural Sector

After the government approved the National Strategy on Climate Change, the Ministry of Agriculture and Rural Development also issued a climate change response plan for the agricultural sector in Viet Nam. The plan focused on the following five objectives:

(i) Strengthen institutional capacity, policy, science, and technology for responding to climate change in agricultural and rural development in 2016–2020 with a vision to 2050 towards sustainable agriculture.

(ii) Increase value added, improve livelihoods, and protect the environment and the population from the negative impacts of climate change.

(iii) Mobilise resources and the participation of organisations and individuals at home and abroad to implement activities to adapt to climate change and reduce GHG emissions in the fields of cultivation, husbandry, aquaculture, forestry, irrigation, salt production, and rural development in the agricultural and rural development sector for 2016–2020 with a vision to 2050 to maintain the industry growth rate at 20%, reduce the poverty rate, and reduce GHG emissions by 20% in each 10-year period.

(iv) Take initiative in coping with and preventing natural disasters, preventing floods and saltwater intrusion, consolidating river and sea dykes, and ensuring the safety of reservoirs, civil works, and technical infrastructure to mitigate natural disasters in the agriculture and rural development sector in the context of climate change for 2016–2020, with a vision to 2050.

(v) Develop human resources, strengthen international cooperation, and participate in international negotiations to raise the position of the agriculture and rural development sector in 2016–2020, with a vision to 2050 with regard to responses to climate change.

The plan also outlined the following tasks: (i) improve and develop policies and mechanisms; (ii) build information and communication capacity; (iii) review, adjust, and manage the planning of agriculture and rural development to respond to climate change; and (iv) strengthen international cooperation in response to climate change. In particular, the plan detailed tasks for each agricultural subsector, including cultivation, livestock, fisheries, forestry, irrigation, and the salt industry.

10.3 Organisational System and Relevant Stakeholders

At the national level, Viet Nam has two committees, the National Climate Change Committee and Central Steering Committee for Natural Disaster Prevention and Control, in addition to the Ministry of Agriculture and Rural Development, that are responsible for coordinating natural disaster responses and reporting to the Prime Minister. The National Committee on Climate Change was established in 2012. The president of the committee is the Prime Minister and its vice-presidents are the Deputy Prime Minister and the Minister of Natural Resources and Environment. The committee is composed of ministers and leaders of relevant agencies and directors of research institutes. It is responsible for advising the Prime Minister in decision making related to studying, proposing, directing, coordinating, and cooperating on climate change-related issues; addressing important multi-sectoral and multi-ministerial problems; and managing the national programme on climate change; as well as implementing international cooperation on climate change.

There are 18 ministries and other government agencies concerned with climate change and natural disasters in Viet Nam.[5] In addition to the Ministry of Natural Resources and Environment and the Ministry of Agriculture and Rural Development, other line ministries and government agencies also have functions and responsibilities related to climate change and natural disasters. At the local level, the Provincial People's Committee,

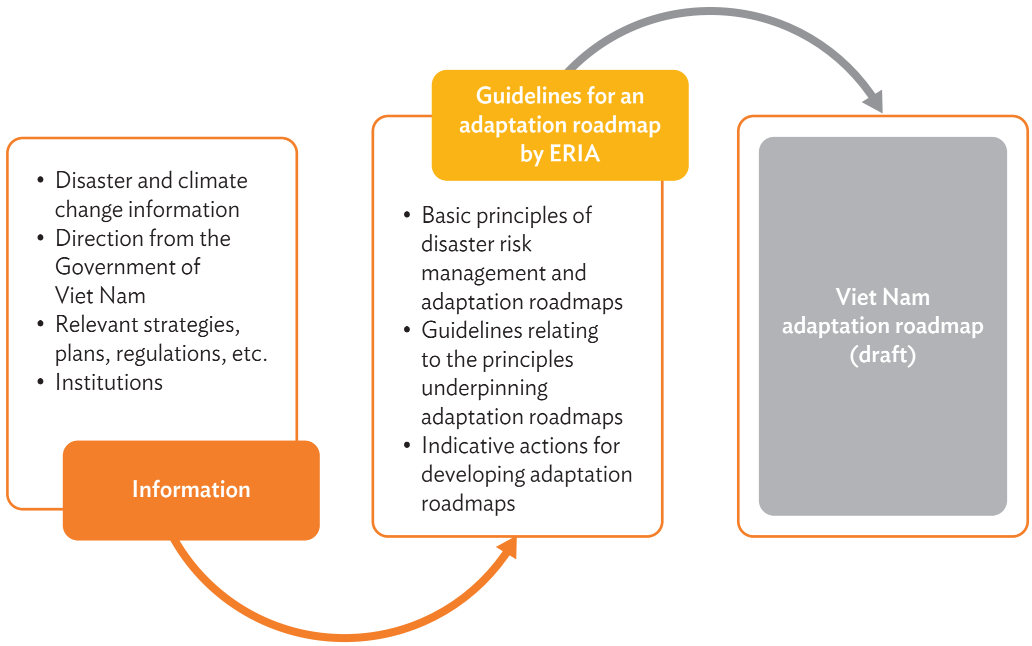
5 These are the Ministry of National Defense; Ministry of Public Security; Ministry of Information and Communications; Ministry of Education and Training; Ministry of Natural Resources and Environment; Ministry of Agriculture and Rural Development; Ministry of Health; Ministry of Industry and Trade; Ministry of Science and Technology; Ministry of Labor, War Invalids and Social Affairs; Ministry of Finance; Ministry of Transport; Ministry of Planning and Investment; Committee for Ethnic Affairs; Ministry of Foreign Affairs; Ministry of Justice; Ministry of Construction; Ministry of Culture, Sports and Tourism; Ministry of Home Affairs; State Bank of Viet Nam; Committee for Ethnic Minority Affairs; Voice of Viet Nam; Viet Nam News Agency; Viet Nam Television; Viet Nam Social Security; Viet Nam Academy of Science and Technology; and the Viet Nam Academy of Social Sciences.

District People's Committee, and Commune People's Committee are delegated to implement and control government policies on climate change and natural disasters. In addition, the Vietnam Farmers' Union, Vietnam Women's Union, Central Committee of the Ho Chi Minh Communist Youth Union, and nongovernment organisations also play relevant roles in responding to climate change and natural disasters.

10.4 Disaster Resilience and Climate Change Adaptation Roadmap in Viet Nam

The Viet Nam Disaster Resilience and Climate Change Adaptation Road Map was developed based on the goals of the Communist Party of Viet Nam, strategies on disaster prevention and climate change response, and the guidelines of the Economic Research Institute for ASEAN and East Asia on disaster resilience and climate change adaptation (Figure 10.1). This is illustrated in Appendix 10.1.

Figure 10.1: Principles and Steps to Develop the Draft of Viet Nam's Roadmap



ERIA = Economic Research Institute for ASEAN and East Asia.

Source: Authors.

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Appendix 10.1: Indicative Actions, Institutions, and Timeframes for the Adaptation Roadmap in Viet Nam

Strategic Policy Choices/Actions	Main Stakeholder	Relevant Stakeholders	Timeline
A. Promote public awareness			
1. Develop regional and subregional programmes on DRR and climate change impacts, causes, and best adaptation practices.	MONRE	MARD, provincial authorities	1–3 years
– Raise awareness, responsibilities, and capacity for responding to climate change and disaster prevention among stakeholders.	MONRE	MARD, Provincial People's Committee	1–3 years
– Establish programmes to build capacity for forecasting, warning, active prevention and mitigation, and adaptation to climate change.	MONRE	Provincial authorities	
2. Develop sectoral guidelines and training on public participation in adaptation programmes.	MONRE	MOIT, MARD, MOET	1 year
– Develop SMART programme and training.	MONRE	MOIT, MARD, MOET	1 year
– Develop detailed programme and training on each agricultural sector (cultivation, fisheries, forestry, the salt industry, etc.).	MARD	MONRE, local's people committee	1 year
3. Devise gender-specific strategies to deliver the DRR and climate risk information.	MOLISA	Vietnam Women's Union, MONRE, MARD	1–3 years
– Integrate gender into climate change and disaster programmes, planning at the national and local levels, and agricultural sector (cultivation, fisheries, forestry, etc.).	MOLISA		1–3 years
4. Share local knowledge with environmental and sectoral agencies to disseminate examples of public participation improving adaptation responses.	Commune, district, and provincial people's committees	Viet Nam Television, Voice of Viet Nam, Viet Nam News Agency	1–3 years
B. Improve scientific agencies			
1. Develop and regularly update public online databases on disaster and climate risk indicators.	National Climate Change Committee, Central Steering Committee for Natural Disaster Prevention and Control	MONRE, MARD	5 years

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Appendix 10.1: ***Continued***

Strategic Policy Choices/Actions	Main Stakeholder	Relevant Stakeholders	Timeline
– Promote measures to prevent and control the impact of high tides, inundation, and salinity intrusion due to sea-level rise.	MONRE	MARD, relevant institutes	1–5 years
– Proactively respond to natural disasters, monitor climate, and provide early warning systems to reduce losses due to natural disasters.	MARD	MONRE, relevant institutes	1–5 years
2. Upgrade and expand targeted research and educational programmes and/or sectoral research training for scientists and institutions, among others.	MOST	MARD, MONRE, MPI, MOIT, GSO	1–3 years and continuous
– Enhance the application of information and communications technology in the agricultural sector.	MARD	MOST, local authorities	1–3 years and continuous
3. Publicise the regional knowledge centre and create satellite offices to disseminate relevant information to affected communities.	Provincial People's Committee; District People's Committee; Commune People's Committee, local NGOs	MARD, MONRE	
4. Maximise the effectiveness of current acts and programmes by developing clear procedural guidelines regarding climate change adaptation.	MARD	MONRE, MPI, MOIT, Provincial's People Committee	Continuous
C. Set feasible standards or benchmarks for structural measures			
1. Review best international practice procedures for infrastructure standard setting, develop national guidelines, and strengthen or expand the application of zoning concepts in setting national standards.	VAST, VASS	Relevant institutes	1–3 years
2. Strengthen the instruments for social and economic impact assessment of new infrastructure by developing a clear methodology drawing on best international practices, adjusted to national and local contexts.	MPI	MOST, MONRE, VASS, VAST	1–7 years
3. Provide necessary climate and economic information, collaborate on the analysis, and facilitate consultation with industry.	MPI	MONRE, MARD, MOIT	1–3 years
4. Provide information on social and community impacts of the proposed standards.	Universities, institutes[a]	Local authorities	1–3 years and continuous

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Appendix 10.1: ***Continued***

Strategic Policy Choices/Actions	Main Stakeholder	Relevant Stakeholders	Timeline
D. Develop new programmes to strengthen non-structural measures			
1. Develop a focussed and well-packaged programme for the most vulnerable locations that integrate targeted structural measures with non-structural measures, including a funding mechanism for scaling up.	63 provincial people's committees; NGOs	MONRE, MARD, MOST, MPI	
2. Develop a set of regulatory incentives to support voluntary initiatives, using existing good practices.	MARD	MONRE, MPI, MOIT	3 years
3. Provide training and capacity building to policymakers and private-sector operators for better no-regret adaptation management focussing on international best practices that are locally appropriate.	MONRE	MARD, MOST, MOET, MOIT, universities, institutes[a]	7 years and continuous
4. Periodically update sectoral guidelines for monitoring and adding new sectors of growing impact.	MARD	MONRE, Provincial People's Committee	Continuous
E. Improve cross-sectoral coordination			
1. Strengthen existing formal mechanisms such as strategic environmental assessment and environmental impact assessment statements and Sustainable Development Goals to involve environmental authorities in designing structural and non-structural measures.	MONRE	MARD, MPI, MOIT	1–3 years
2. Coordinate the development of a strategic adaptation framework for using global environmental financing instruments.	MOF	MPI, MONRE, MARD, MOIT	1–5 years
3. Remove tariff and non-tariff barriers related to key stable food items.	MOIT	MARD, MONRE	1–3 years
4. Empower local governments to oversee regional climate change adaptation programmes and foster cross-sectoral coordination.	Sectoral agencies and civil society		
5. Develop sectoral guidelines to overcome specific identified gaps and facilitate uptake of best practices.	MONRE	MARD, MOIT, MPI	1–3 years

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Appendix 10.1: ***Continued***

Strategic Policy Choices/Actions	Main Stakeholder	Relevant Stakeholders	Timeline
F. Augment financial resources			
1. Explore innovative financing instruments including insurance programmes, catastrophe bonds, and other risk-transfer products to support future developments via a global climate change agenda.	Local financial institutions, insurance companies, and international financial institutions		1–5 years
2. Strengthen and enhance the domestic financial market to allow financial institutions to mobilise finance from and transfer risks to the market, while enhancing financial inclusion.	MOF, State Bank of Vietnam	MARD, MOIT	1–3 years
3. Develop a consistent budgetary framework for integrating disaster and climate risks and set it as input into consistent and realistic delivery mechanisms related to the most vulnerable sectors, communities, or households in a transparent way.	MOF	Ministry of Trade, MARD	1–3 years
4. Link trade and business promotion incentives to adaptation financing, ensure heavy representation within regional and international adaptation funding institutions, and help shape allocation decisions.	MOIT	MPI, Provincial People's Committee	1–3 years
5. Develop and implement medium-term capacity strengthening action plans, as well as a training and staffing plan to meet growing mandates.	MPI	MONRE, MARD, MOIT, MOST, etc.	1–5 years
G. Strengthen capacity for regional cooperation			
1. Introduce an enhanced methodology for DRR and climate prediction at the regional level, strengthen early warning systems for international river basins, and carry out economic impact assessments of collective cross-border actions.	Vietnam Institute of Meteorology, Hydrology and Climate Change	Relevant institutes, universities	1–3 years
2. Share and promote regional best practice examples of mainstreaming adaptation practices in sectoral planning.	ASEC		Short to medium term (1–5 years)
– Strengthen international cooperation and integration to enhance national standing in climate change issues.			
3. Provide the technical and human resources needed for effective management of cross-border climate change impacts, and make clear the roles and responsibilities of all parties involved in collective actions.	MOFA	MONRE, MARD	Short to medium term (1–5 years)

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Appendix 10.1: *Continued*

Strategic Policy Choices/Actions	Main Stakeholder	Relevant Stakeholders	Timeline
4. Develop a network of regional centres within appropriate existing institutions to provide high-quality training and knowledge to produce a high standard of professionalism across countries.	ASEC	MONRE, MARD, MOIT, MOFA	Continuous
5. Establish an ASEAN Climate Change Adaptation Centre to accommodate the translation of climate policies, climate technologies, and climate education as well as data analysis, and incorporate these in national development plans.	ASEC	MOFA	Medium to long term

ASEAN = Association of Southeast Asian Nations, ASEC = ASEAN Development and Management Consulting, DRR = disaster risk reduction, MARD = Ministry of Agriculture and Rural Development, MOET = Ministry of Education and Training, MOF = Ministry of Finance, MOFA = Ministry of Foreign Affairs, MOIT = Ministry of Industry and Trade, MONRE = Ministry of Natural Resources and Environment, MOST = Ministry of Science and Technology, MPI = Ministry of Planning and Investment, NGO = nongovernment organisation, VASS = Vietnam Academy of Social Sciences, VAST = Vietnam Academy of Science and Technology.

[a] E.g. the National Economic University, Hanoi Agriculture and Rural University, Vietnam National University, Institute of Strategy and Policy on Natural Resources and Environment, Institute of Policy and Strategy for Agriculture and Rural Development, Central Institute for Economic Management, and Vietnam Institute of Economics.

Source: Authors' compilation.

PART

III

Guidelines for Policy and Decision Makers and Other Key Players on Adaptation Roadmaps

CHAPTER 11

Guidelines for Policy and Decision Makers and Other Key Players on Adaptation Roadmaps

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PURPOSE

These policy guidelines have been developed to inform policymakers and key players on the distributional impacts of disasters and climate change, to support them in developing adaptation roadmaps for incorporation into national and local development plans, from the perspective of food security and resilience.

Two research studies by the Economic Research Institute for ASEAN and East Asia—'Reducing the Vulnerability of Global Value Chains' and 'Distributional Effects of Disasters and Climate Change on Food Security'—demonstrated new knowledge on risk-based approaches to building resilient economic systems and mainstreaming adaptation processes in sectoral planning. The present guidelines for adaptation roadmaps are based on the findings of these two studies, and were developed using the experience gained and operational knowledge shared by government officials during the policy dialogues held at various stages of these studies. The guidelines are intended to help Association of Southeast Asian Nations (ASEAN) governments and other relevant stakeholders implement policies, plans, and operational procedures that result in integrating adaptation to climate variability and disaster risks into national and local development planning, decision making, and operations as an integral and sustainable part of the development process.

I Introduction

Basic Principles of Disaster Risk Management and Adaptation Roadmaps

These guidelines focus on the mainstreaming of disaster risk and adaptation concerns, rather than adaptation *per se*. Outlining some basic principles for adaptation roadmaps can provide a useful foundation for considering the mainstreaming process.

(i) Adaptation to disaster risks and climate change is, in large part, a continuous, dynamic process that reduces the exposure of the production system.
(ii) Adaptation must reflect both recurrent historical disaster events and new risks associated with climate change.
(iii) Exploring and undertaking actions to adapt to current disasters and climate extremes as well as variability is useful, both in dealing with today's problems, and as an essential step toward building long-term resilience to and withstanding pending changes in the climate.
(iv) Many disaster and climate change response strategies contribute positively to the attainment of the Sustainable Development Goals, sound environmental management, and wise resource use; they are also appropriate responses to climate variability and other present-day and emerging stresses on social, cultural, agricultural, industrial, economic, and environmental service systems.
(v) Effective management of climate-related risks prevents precious resources from being squandered on disaster recovery and rehabilitation.
(vi) While many disaster risks and climate-related losses are manifested locally, measures to alleviate them have important national and international dimensions.
(vii) If adaptation is reactive instead of anticipatory, the range of response options is likely to be narrower and adaptation may well prove more expensive, socially disruptive, and environmentally unsustainable.
(viii) The life expectancies of many development plans and projects currently under consideration require due consideration to be given to future disaster risks and changing climate conditions.
(ix) It is easier to enhance the ability of ecosystems to cope with disasters and climate change if they are healthy and not already stressed and degraded.
(x) Adaptation requires the enhancement of institutional capacity, development of expertise, and building of knowledge. All of these take time.

(xi) People will, through their own resourcefulness or out of necessity, adapt to disasters and climate change based on their understanding and assessment of the anticipated or observed effects, and on the perceived options for and benefits of response. Such adaptations will be adequate, effective, and satisfactory in many cases; and insufficient in others.

(xii) When such adaptation is not satisfactory or successful, such as under certain circumstances, an external entity, such as a central or local government, may need to facilitate the adaptation process to ensure that obstacles, barriers, and inefficiencies are addressed appropriately.

The Meaning of Adaptation Roadmaps and Mainstreaming of Disaster Risks

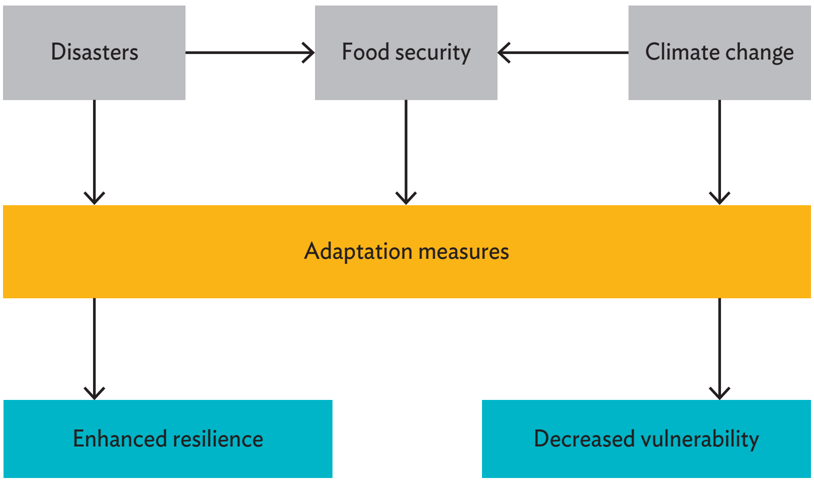
In the context of addressing climate change and disaster-related issues, the term 'adaptation roadmap' is used to describe the integration of policies and measures to address disaster risk and climate change in new and ongoing policies, plans, and actions. Constructed over a period of time, these roadmaps aim to enhance the effectiveness, efficiency, and longevity of initiatives directed at reducing disaster risks all while contributing to resilient economic development.

Mainstreaming or integrating disaster risks into sectoral policies such as agricultural development, food security, and health care also endeavours to address the complex tensions between economic policies aimed at immediate issues, and aspects of disaster risk reduction (DRR) and climate policy aimed at longer term concerns. These tensions often become most apparent when choices have to be made about the disbursement of limited government funds, such as a choice between supporting industrial development, education, and health care programmes on the one hand, and funding DRR and climate change adaptation (CCA) initiatives on the other. Indeed, mainstreaming is largely about reducing such tensions and conflicts, and avoiding the need to make choices by identifying synergistic, win-win situations. Thus, mainstreaming focuses on 'no regrets' adaptation measures that are consistent with sound environmental management and wise resource use, and are thus appropriate responses to natural hazards and climate variability, including extreme events. Such measures are beneficial and cost effective, even if no climate change occurs.

Reasons to Mainstream Adaptation

Even in the near future, climate change and disasters are likely to impose untenable social, environmental, and economic costs. Most of the region is already experiencing disruptive conditions consistent with many of the anticipated adverse consequences of climate change, including extensive coastal erosion, drought, flooding and associated landslides, coral bleaching, and higher sea levels. The risks associated with the full spectrum of disasters, from extreme events to the consequences of long-term changes in the climate, should be managed holistically as an integral part of national development planning and management (see Figure 1).

Figure 1: Optimal Response to Disaster and Climate Risks

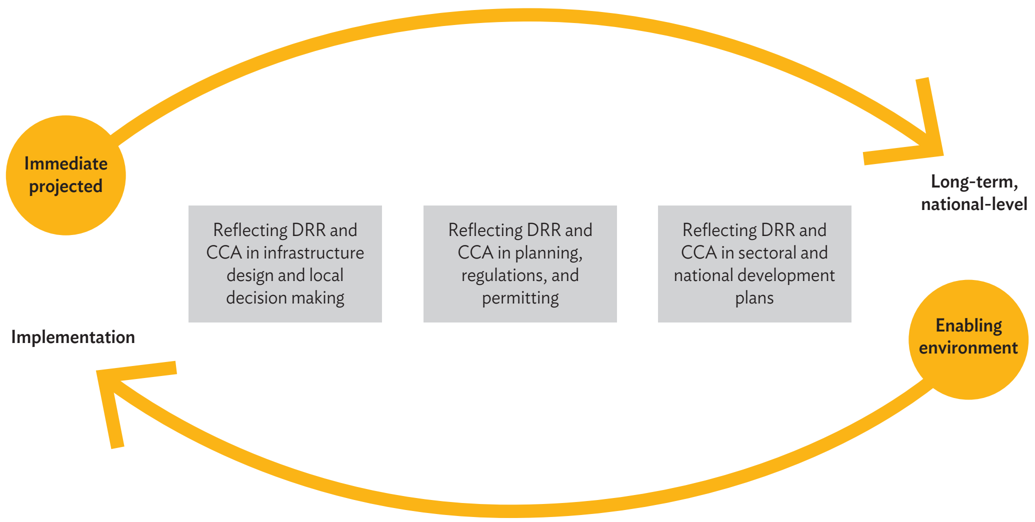


Source: Authors.

Disaster resilience, food security, and CCA planning could also be achieved through a combination of measures. By combining separate plans or legal frameworks from disaster resilience planning, food security planning, and CCA planning, it is possible to establish national frameworks that are more than just the sum of all three separate plans or legal frameworks. The aim is to decrease vulnerabilities and increase resilience to all three threats simultaneously. Vulnerabilities vary due to environmental properties, risk exposure, landscape features, population pressures, and the educational background of the concerned people, among other factors. Resilience is the ability to cope with threats and relates to the endogenous power of people from within the region. This varies widely based on their wealth or disposable income, and their ability to organise relief from within the region. Economic considerations are key to reduce costs and avoid duplications by independent teams working on separate plans.

Most countries already have policies and plans to manage financial, human health, biosecurity, agricultural, transport sector, and energy supply risks. Climate-induced disasters and climate change and variability should be included in the national risk management portfolio. National and state development plans and sector plans should include disaster risk management strategies and CCA measures to ensure that risks are reduced to acceptable levels. These measures and the related strategies will help strengthen decision-making processes by requiring that specific programmes and projects include plans and measures to manage risks associated with extreme events and with climate change and variability. The overall goal should be to manage, holistically and as an integral part of national development planning, the risks associated with the full spectrum of weather, climate, and oceanic hazards, from extreme events to the consequences of long-term climate change (see Figure 2).

Figure 2: Linkages Between Longer Term Policies and Short-Term Projects



CCA = climate change adaptation, DRR = disaster risk reduction.
Source: Authors.

Referring to Figure 2, it is important to consider interacted nature and planning between national and local levels, which is often influenced by regional level coordinated action at the ASEAN region. Therefore, the planning should include immediate or short-term measures and decision making at the local level, and long-term policies at the national level. The declared interests of food security, DRR, and CCA can be formulated as territorial or sectoral plans or regulations of agriculture, the food industry, retailers, or consumers.

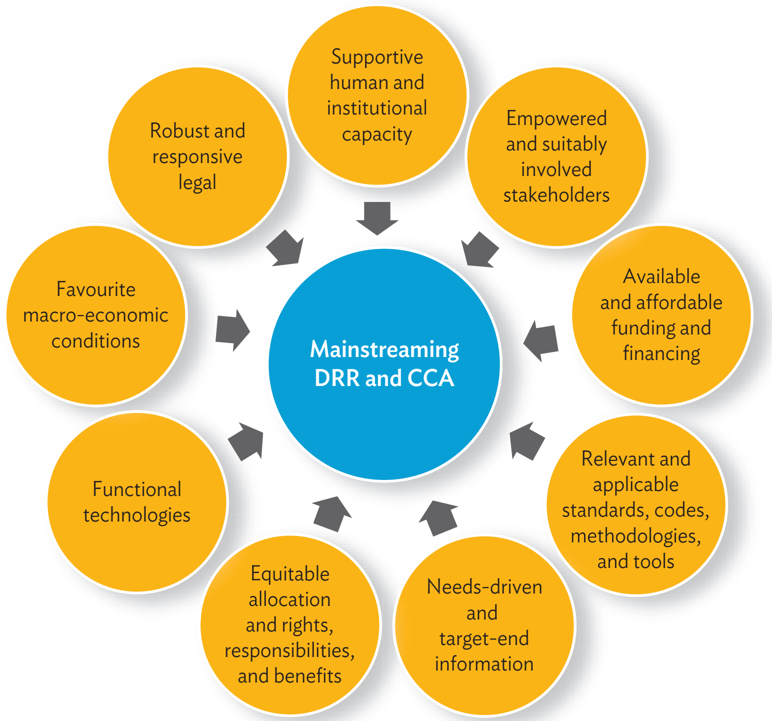
The 'scaling issue', that is, selecting a local or regional area of concern, is essential to judge whether an issue poses an immediate threat to local people, or is indicative of a long-term regional problem. Although remote, sparsely populated locations in particular can be seen as unimportant for regional decision making, non-reactions on a local scale are likely to grow into a larger regional problem later on. Therefore, it is best to solve local challenges immediately to achieve greater resilience at the regional level. If all ASEAN countries were to do so, the ASEAN region could achieve a combination of high disaster resilience, effective climate protection, and optimal food security. Thus, the aims expressed in international frameworks like the Sustainable Development Goals 2030 (United Nations [UN], 2015a), the Paris Accord (UN Framework Convention on Climate Change, 2015), or the Sendai Framework for Action (UN, 2015b) can be addressed simultaneously, thus contributing further to overall sustainability, peace, and economic stability.

Practical Components of Adaptation Roadmaps

Adaptation roadmaps reach many stakeholders at the practical, applied level. There are two main practical components to the development of an adaptation roadmap: (i) creating and strengthening an enabling environment for adaptation; and (ii) integrating adaptation planning and implementation into new and existing development policies, plans, and actions.

An 'enabling environment' for adaptation roadmaps comprises the systems and capabilities that foster the adaptation process, including innovations in information generation and communication; the revitalisation of traditional practices; the application of human knowledge and skills, policies, financing, legislation, and regulations; markets; and decision-support tools. These provide the context within which infrastructure projects and related industrial initiatives occur, and ensures that they are effectively implemented.

Figure 3: Multiple Dimensions of Adapting to Disaster Risks and Climate Variability



CCA = climate change adaptation, DRR = disaster risk reduction.
Source: Authors.

The multiple dimensions of the enabling environment are outlined in the following guidelines (see Figure 3):

(i) support human and institutional capacity building;
(ii) empower weaker stakeholders in particular, and give them a voice in the mainstreaming process;
(iii) find available and affordable funding or financing for benign actions;
(iv) collect a toolkit with relevant and applicable standards, codes, and methodologies;
(v) provide needs-driven and final output-related information;
(vi) allocate rights, responsibilities, and benefits equitably;
(vii) provide functional and affordable technologies;
(viii) allocate public funds under favourable macroeconomic conditions; and
(ix) stipulate a robust and responsive legal regime.

Longer term interventions at the national and subnational levels, often with support from the international community, are needed to create and strengthen an enabling environment.

II Guidelines Relating to the Principles Underpinning Adaptation Roadmaps

This section provides 20 itemised considerations for policymakers and key players to develop adaptation roadmaps for incorporation into national and local development plans. The guidelines encompass three elements: scope, time, and interest. First, the ASEAN regional adaptation plan should ideally cover each country's national development plan, which in turn covers local adaptation plans. This may allow for more specific measures to counter disaster threats and climate risks. Second, a timeline needs to be determined to target and maximise the implementation benefits. Lastly, the guidelines focus on enhancing the resilience of food security systems to disaster risks and climate change impacts.

Guideline 1: Document the relevant major risks to the economy and society resulting from environmental issues, disaster risks, and climate variability and change characterising these in terms of the damage that they are expected to cause, as well as the associated economic costs and social consequences.

Guideline 2: Organise and strengthen institutions in ways that:

(i) enhance communication among disaster and climate risk assessors, adaptation policymakers, and other stakeholders, including citizens;
(ii) reduce the likelihood of conflict and duplication of efforts when managing disaster and climate-related risks;
(iii) lessen the chances of mistrust and misunderstanding between decision and policymakers and other stakeholders in adaptation activities; and
(iv) overall, help to provide consistent, defensible, and useful advice to decision and policymakers with respect to adaptation roadmap priorities and practices.

Guideline 3: Wherever possible and practical, make use of existing data and information, and information management systems. While this may require additional initial efforts to source and harmonise dispersed and disparate sets of information, it is likely to strengthen existing information management systems instead of marginalising them.

Guideline 4: Enhance and employ relevant and experienced in-country expertise in the technical and policy dimensions of adaptation to climate change. Seek international cooperation and regional approaches wherever required.

Guideline 5: Enhance the enabling environment for adaptation roadmaps when legislation and regulations that facilitate CCA and DRR are introduced and strengthened, and when the compliance monitoring and enforcement capabilities of relevant regulatory agencies are improved.

Guideline 6: Wherever possible and practical, make use of existing decision-support tools and regulatory instruments to guide selection and facilitate the implementation of adaptation measures (Box 1). This is likely to strengthen existing tools and regulations, rather than weakening them through confusion and inadequate enforcement.

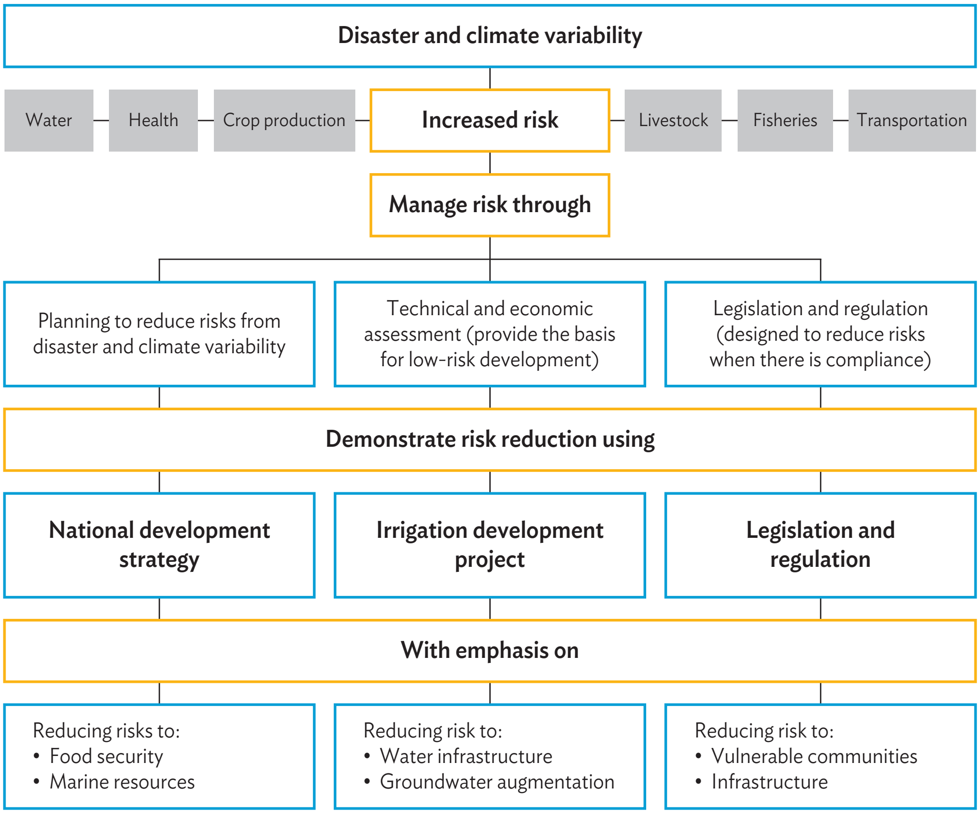
Box 1: Existing Decision-Support Tools

- Strategic environmental assessment
- Environmental impact assessment
- ‘Strengths, weakness, opportunities, threats’ analysis
- ‘Clients, actors, Weltanschauung, owners, and environment’ approach (Checkland, 1981)
- Scenario analysis (‘Scenario Analysis in Risk Management’) (Hassani, 2016)
- Local Agenda 21 and ecological restructuring approaches (Lyle, 1994; ICLEI, 1995)
- Building codes

Guideline 7: Identify motivations that drive various stakeholders to engage in the adaptation process, and replicate these motivations in other players through education, training, and other initiatives.

Guideline 8: Build the willingness and ability of communities to adapt continuously to new circumstances and challenges, and to realise this increased potential. High levels of awareness, motivation, and empowerment within the public and private sectors and in civil society will help ensure that people, communities, and wider societies are able to adapt continuously to new circumstances and challenges. Incorporating customary knowledge related to disaster management and active community involvement in adaptation roadmaps will create a chain of actions towards resilience and sustainability that is embedded in local culture. This requires a long-term approach to developing and delivering comprehensive and targeted awareness-raising and educational programmes.

Figure 4: A Decision Support Tool – Risk Assessment Framework



Source: Authors.

Guideline 9: Encourage banks and other lending institutions to finance adaptation and resilience activities. Help reduce barriers by promoting institutions, arrangements, and mechanisms that can provide innovative financing, including microfinance, crop insurance, green finance, secured loans, leasing arrangements, and public–private partnerships, thereby allowing adaptation to proceed without government intervention.

Guideline 10: Decisions as to when and how to adapt to disaster risks and climate change variability should be based on credible, comparable, and objective information. Ideally, the measurements and assessments required to provide this information will be made using internationally recognised, but locally adapted, methodologies and tools, thereby helping to ensure comparability among data collected by different assessors.

Guideline 11: Adaptation activities should be based on cooperation to bring about desired changes, using bottom-up and top-down approaches. This calls for enduring partnerships at all stages of the adaptation process, ensuring the active and equitable participation of private and public stakeholders, including business, legal, financial, and other stakeholders.

Guideline 12: Transfer and use of inadequate, unsustainable, or unsafe technologies for adaptation must be avoided. Technology recipients should be able to identify and select technologies that are appropriate to their actual needs, circumstances, and capacities and are classed as 'sustainable technologies'—i.e. climate smart, economically viable, and socially acceptable (Box 2).

Box 2: Examples of Inadequate and Unsustainable Practices

Coastal protection:

- *Inadequate:* The weight of rocks making up a breakwater is insufficient relative to the energy of the significant wave.
- *Unsustainable:* Sea walls often accelerate erosion on adjacent, unprotected areas of the coast.
- *Unsafe:* A breakwater may, in some instances, exacerbate the volume and speed of seawater overtopping the foreshore area.

Agricultural productivity:

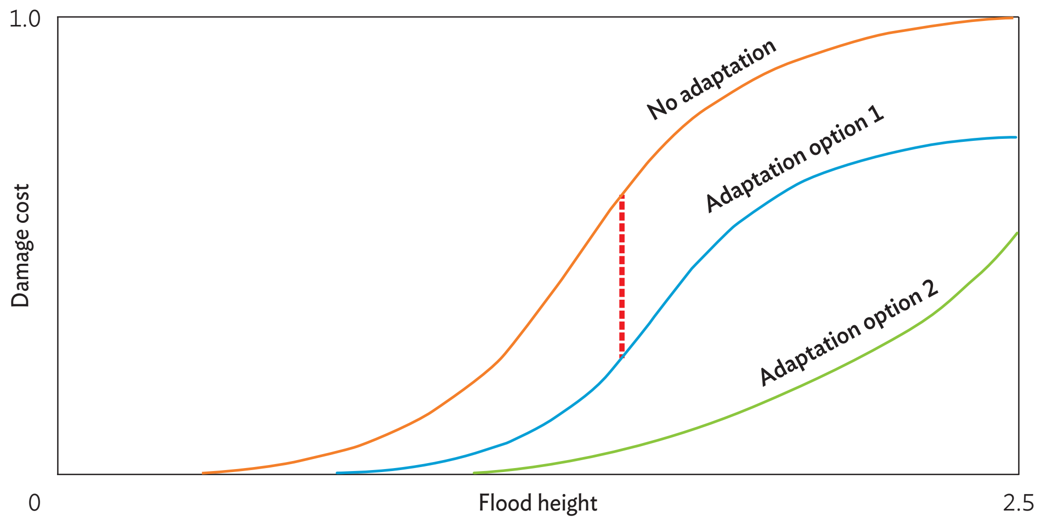
- Monoculture cultivation may decrease soil quality.

Guideline 13: Ensuring macroeconomic conditions that favor successful adaptation activities include those that foster economic transparency. Such conditions are needed to ensure that disaster and climate-related risks are not masked or compensated for by hidden subsidies and thereby transferred to the wrong parties. Involvement of the private sector in adaptation (e.g. investors and other players in the finance sector) will be encouraged by macroeconomic conditions that include low inflation; stable and realistic exchange and interest rates; pricing that reflects the true marginal and fully internalised costs of materials, energy, labour and other inputs; deregulation; free movement of capital; operation of competitive markets; open trade policies; trade facilitation; and transparent foreign investment policies.

Guideline 14: Any risks that present generations find unacceptable should not be imposed on future generations. Policymaking, planning practices, and industrial development activities should ensure that all future generations will be able to enjoy every important aspect of life, including peace and security, a healthy environment, a small risk of preventable catastrophe, conservation of knowledge, stable governance, a good life for children, opportunities for living, gender equity, and justice.

Guideline 15: Successful adaptation to climate variability and disasters requires programmatic approaches that provide institutional and operational support for individual projects. A sound economic analysis will help minimise the limitations resulting from the short-term and narrow nature of projects, thus reducing administrative and related burdens and providing much more control over the direction taken by individual projects. These approaches also increase the possibility of sustaining the benefits of a project, even after funding has ceased, and expedites the proposal development and approval processes, as well as implementation.

Figure 5: Hypothetical Cost–Benefit Analysis of an Adaptation Measure



Source: Authors.

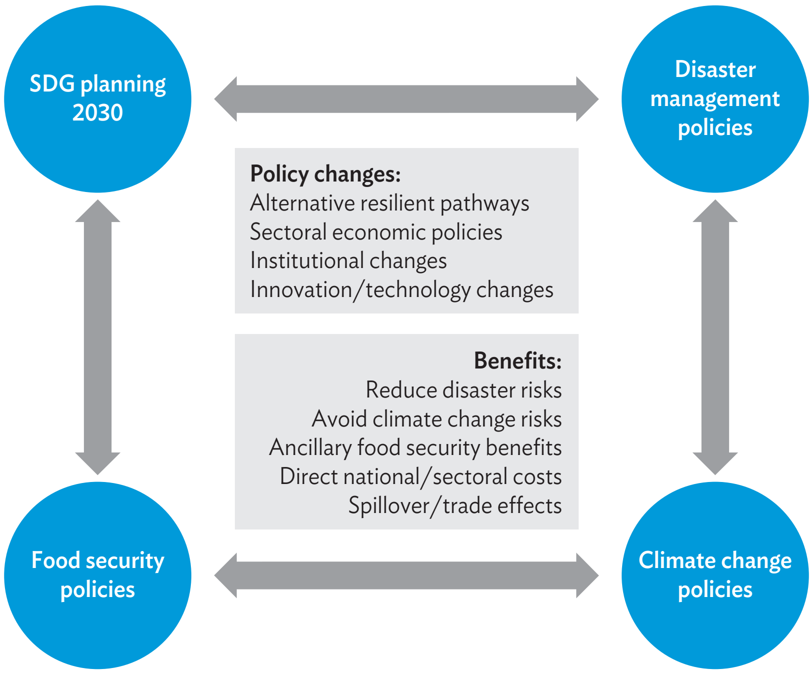
Guideline 16: Emphasis must be placed on coordinating activities—taking advantage of synergies, minimising duplication, and avoiding redundancies—in order to complement other development efforts. Priority should be given to adaptation activities that deliver tangible and visible benefits, rather than exploratory studies. This can help offset the fact that climate change is often perceived as a longer term issue, while other challenges, including disaster recovery, food security, human settlement, infrastructure, water supply, sanitation, education, and health care, require more immediate attention (Box 3).

Box 3: Adaptation Roadmaps Built by Network Groups

National Adaptation Roadmaps contain certain activities that deliver outputs and outcomes that are at least equal in relevance and value to those provided by mainline ministries. The Yale climate connection group provides updated information on and explanations of the climate, climate adaptation, and disaster risk reduction for relevant stakeholders and the public (Yale Climate Connections).

Guideline 17: A commitment should be made to the ongoing practice of monitoring, reviewing, and strengthening the targets of the Sustainable Development Goals 2030 and their interlinkages with DRR, climate change, and food security. Methods used to monitor and report should emphasise transparency, consistency, and accountability, while fostering continued improvement in the efficiency with which outcomes are delivered, and their contribution to sustainable national development.

Figure 6: A Monitoring Framework for Enhanced Resilience



SDG = Sustainable Development Goal.

Source: Authors.

Guideline 18: Regional institutions provide a foundation for effective adaptation at the national level. The establishment of regional institutions with expert considerations and sustained by country ownership and support are important for maintaining momentum in disaster resilience and CCA. They also serve as a repository for documented experience, data acquisition and analysis, and learning experiences that provide essential historical data and information for future generations.

Guideline 19: Emphasis should be placed on minimising the distributional negative impacts of disasters and climate change. Policy recommendations for the ASEAN member states' adaptation roadmap should be developed in line with ASEAN Socio-Cultural Community (ASCC) blueprint, which is a politically binding implementation framework for a sustainable and resilient ASEAN (ASEAN Secretariat, 2016a).

Guideline 20: Countries should pledge their continued commitment to follow in the spirit of the ASEAN Agreement on Disaster Management and Emergency Response, which has effectively facilitated regional cooperation between and among ASEAN member states (ASEAN Secretariat, 2016b). As the legally binding regional agreement, it has directly contributed to the enhancement of disaster risk resilience and CCA.

III Indicative Actions for Developing Adaptation Roadmaps

Table 1: Indicative Actions, Institutions, and Timeframe for Building Adaptation Roadmaps

Key Issue	Strategic Policy Choices And Actions	Responsible Institution	Timeline
Promote public awareness	Develop national and subregional programmes on DRR and climate change impacts, causes, and best adaptation practices.	Line ministries	Short to medium term (1–3 years)
	Develop sectoral guidelines and training on public participation in adaptation programmes.	Line ministries	Short term (1 year)
	Devise gender-specific strategies to deliver DRR and climate risk information.	Ministry of Environment and other disaster-related agencies	Short term (1–3 years)
	Share local knowledge with environmental and sectoral agencies to disseminate examples of when public participation has improved adaptation responses.	Local government, media, and civil society	Short term (1–3 years)
Improve scientific capacity	Develop and regularly update a public online database on disaster and climate risk indicators.	Ministry of Environment, and other disaster- and climate change-related agencies[a]	Short to medium term (1–5 years)
	Upgrade and expand targeted research and educational programmes and/or sectoral research and training for scientists, institutions, and others.	Sectoral ministries and the National Statistics Bureau	Short term, then continuous

continued next page

Table 1: *Continued*

Key Issue	Strategic Policy Choices And Actions	Responsible Institution	Timeline
	Publicise regional knowledge centres and create satellite offices to disseminate relevant information to affected communities.	Academia and civil society	Short term (1–3 years)
	Maximise the effectiveness of current acts and programmes by developing clear procedural guidelines regarding climate change adaptation add-ons.	Sectoral ministries and local governments	Continuous
Set feasible standards and benchmarks for structural measures	Review international best practice procedures for infrastructure standard-setting, develop national guidelines, and strengthen or expand the application of zoning concepts in setting national standards.	Ministry of Public Works and academia	Medium term (1–5 years)
	Strengthen the instruments of social and economic impact assessment of new infrastructure by developing a clear methodology drawing on best international practices and adjusted to national and local contexts.	Sectoral ministries	Long term (1–7 years)
	Provide necessary climate and economic information, collaborate on analysis, and facilitate consultation with the industry sector.	Planning commission and sectoral agencies	Short term (1–3 years)
	Provide information on the social and community impacts of the proposed standards.	Civil society and academia	Short term (1–3 years)
Develop new programmes to strengthen non-structural measures	Develop a focused and well-packaged programme for the most vulnerable locations that integrates targeted structural measures with non-structural measures, including a funding mechanism for scaling up.	Planning commission and sectoral agencies	Medium term (1–5 years)
	Develop a set of regulatory incentives to support voluntary initiatives using existing good practices.	Ministry of Environment	Continuous
	Provide training and capacity building to policymakers and private-sector operators for better no-regret adaptation management that focuses on international best practices that are locally appropriate.	Sectoral ministries and academia	Medium term (1–7 years)
	Periodically update sectoral guidelines for monitoring and adding new sectors of growing impact.	Local governments and nongovernment organisations	Continuous

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Table 1: *Continued*

Key Issue	Strategic Policy Choices And Actions	Responsible Institution	Timeline
Improve cross-sectoral coordination	Strengthen existing formal mechanisms such as strategic environmental assessments, environmental impact assessment statements, and Sustainable Development Goals to involve environmental authorities in designing structural and non-structural measures.	Ministry of Environment	Short term (1–3 years)
	Coordinate the development of a strategic adaptation framework for using global environmental financing instruments.	Ministry of Environment	Medium term (1–5 years)
	Remove the tariff and non-tariff barriers related to key staple food items.	Ministry of Trade	Short term (1–3 years)
	Empower local governments to oversee regional climate change adaptation programmes and foster cross-sectoral coordination.	Sectoral agencies and civil society	Short term (1–3 years)
	Develop sectoral guidelines to overcome specific identified gaps and facilitate the uptake of best practices.	Sectoral agencies	Short term (1–3 years)
Augment financial resources	Explore innovative financing instruments, including insurance programmes, catastrophe bonds, and other risk-transfer products to support future developments via the global climate change agenda.	Local financial institutions, insurance companies, and international financial institutions	Medium term (1–5 years)
	Strengthen and enhance the domestic financial market to allow financial institutions to mobilise finance from and transfer risks to the market, while enhancing financial inclusion.	Ministry of Finance and Central Bank	Short term (1–3 years)
	Develop a consistent budgetary framework for integrating disaster and climate risks, and input it into consistent and realistic delivery mechanisms related to the most vulnerable sectors, communities, or households in a transparent way.	Ministry of Finance	Short term (1–3 years)
	Link trade and business promotion incentives to adaptation financing by appropriate level of representation so that regional and financial adaptation funding institutions can shape the allocation and deployment of resources.	Ministry of Trade, Ministry of Investment, and Planning Commission	Short term (1–3 years)
	Develop and implement medium-term capacity strengthening action plans, as well as training and staffing plans to meet growing mandates.	Ministry of Finance and the Central Bank	Medium term (1–5 years)

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Table 1: *Continued*

Key Issue	Strategic Policy Choices And Actions	Responsible Institution	Timeline
Strengthen capacity for regional cooperation	Introduce an enhanced methodology for DRR and climate prediction at the regional level, strengthen early warning systems for international river basins, and carry out economic impact assessments of collective cross-border actions.	Academics from advanced economies	Short term (1–3 years)
	Share and promote regional best practice examples of mainstreaming adaptation practices in sectoral planning.	ASEC	Short to medium term (1–5 years)
	Provide the technical and human resources needed for effective management of cross-border climate change impacts, and make clear the roles and responsibilities of all parties involved in collective actions.	Ministry of Environment and Foreign Affairs	Short to medium term (1–5 years)
	Develop a network of regional centres within appropriate existing institutions to provide high-quality training and knowledge and create a high standard of professionalism across the countries.	ASEC	Continuous
	Establish an ASEAN Climate Change Adaptation Centre to accommodate translation for climate policies, climate technologies, and climate education as well as data analysis for incorporation with national development plans.	ASEC	Medium to long term

ASEAN = Association of Southeast Asian Nations, ASEAN Development and Management Consulting Ltd., DRR = disaster risk reduction.

[a] Disaster and climate change-related agencies include the Meteorological Agency, Disaster Management Agency, and Ministry of Public Works, among others.

Note: Short term = 1–3 years; medium term = 1–5 years; long term = 1–7 years.

Source: Authors.

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