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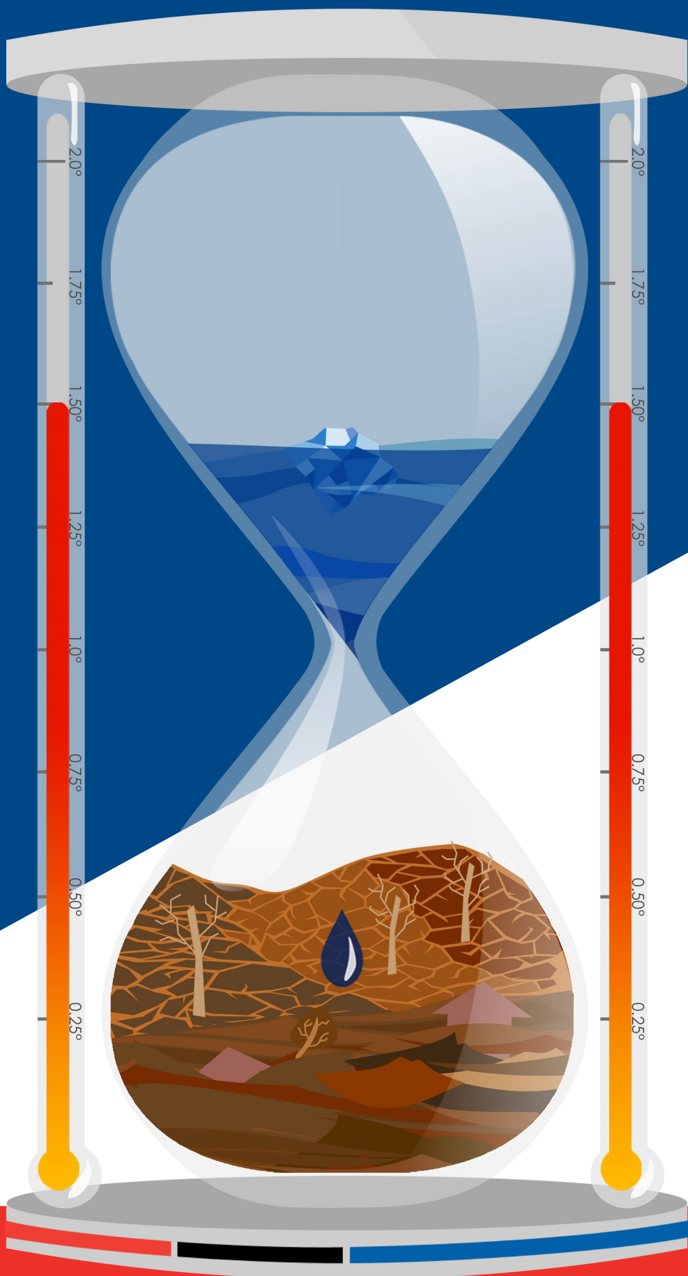

2nd edition

2nd edition

Time is Running Out:

Why ASEAN Must Act Now against Climate Emergencies

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ASEAN RISK MONITOR AND DISASTER MANAGEMENT REVIEW

ARMOR

2nd edition

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ARMOR

INTRODUCTION

Time is Running Out: Why ASEAN Must Act Now against Climate Emergencies

This 2nd edition of the ASEAN Risk Monitor and Disaster Management Review (ARMOR), Time is Running Out: Why ASEAN Must Act Now against Climate Emergencies, aims to advance the publication's objective of providing authoritative information specifically regarding the ASEAN region. The region has a growing need for critical analysis and synthesis of data to inform policy decisions and disaster management operations. With ARMOR, the AHA Centre addresses this need and supports the implementation of the ASEAN Vision 2025 on Disaster Management by taking ownership of knowledge, ensuring application of disaster management science, and providing a platform for emerging researchers to contribute collectively to disaster management in the region. The AHA Centre also acts as the network coordinator for developing disaster management standards and facilitating a platform for knowledge exchange for the next generation of regional disaster management leaders.

The 1st edition of ARMOR, Bridging Science & Decision Making, provided a baseline that the 2nd edition builds on to identify changes and patterns that occurred over the past year, leading to evidence-based conclusions and recommendations for specific Member States and their individual circumstances. The 2nd edition uses both historical data and the most up-to-date information, trends, and risk profiles of the ASEAN countries with regards to climate change and disasters. ARMOR bridges the gap between science and policy by consolidating knowledge from the data, showcasing best practices, and inspiring further innovations in the areas of risk monitoring and disaster management. This includes highlighting the latest research tools and initiatives that ASEAN countries can employ to improve their data collection and analysis, as well as make informed decisions in policy development.

Real and Present Danger: What Does a 1.5°C Increase Mean to ASEAN? summarises the latest assessments and outlook of climate change impacts in the ASEAN region and includes overviews of important points from subsequent chapters.

The Threat-Multiplier: Climate Change and Disaster Riskscape in ASEAN builds on the importance of disaster risk assessment in the region, outlining how each country's risk profile has changed over time and since the previous ARMOR report.

Food at Risk: The Repercussions of Climate Change and Drought in the Lower Mekong Region explores the relationship between drought and food insecurity in the Lower Mekong region, demonstrating how the available tools in the affected countries can help improve decision-making processes and address impacts of drought resulting from climate change.

Understanding Drought: When to Sound the Alarm? discusses the challenges posed by drought and how to apply a proactive approach through the use of risk assessments, early warning services, risk financing, and adaptive capacity.

One Year Down: The State of ASEAN's Flood and Drought Early Warning Systems evaluates the implementation of early warning systems for flood and drought in the ASEAN region and proposes a model for assessing them.

When Early Actions Save Lives: Anticipating Instead of Reacting with Forecast-based Financing discusses how the region can address the various impacts of climate change through a proactive approach called Forecast-based Financing rather than relying on traditional reactive approaches.

Three Weeks' Notice: Forecasting Extreme Weather Events with Subseasonal-to-Seasonal Climate Prediction illustrates the potential applications for disaster preparedness of bridging shorter-term weather forecasts with seasonal predictions in the ASEAN region.

Where to Go? Finding Durable Solutions for Disaster-Displaced Persons in Southeast Asia addresses the indirect consequences of climate change by discussing durable solutions to population displacement in Southeast Asia.

Finally, **Policies Tackling Climate Risks: Is ASEAN Moving to the Right Direction?** turns to national and regional policies in ASEAN, discussing how they fit into the bigger picture of modern climate agreements and frameworks.

This 2nd edition of ARMOR represents a vital second step in establishing a consistent initiative in the ASEAN region. The AHA Centre recognises the many contributions from numerous individuals and organisations that made this publication possible and hopes that future editions of ARMOR will continue to prove the value of such collaborations in addressing the regional challenges of climate change.

ARMOR

2nd edition

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Acronyms and Abbreviations

A

AADMER	ASEAN Agreement on Disaster Management and Emergency Response
ACC	Anomaly Correlation Coefficient
ACDM	ASEAN Committee on Disaster Management
ADB	Asian Development Bank
ADInet	ASEAN Disaster Information Network
AED	ASEAN Economic Community
AHA Centre	ASEAN Coordinating Centre for Humanitarian Assistance on disaster management
AJDRP	ASEAN Joint Disaster Response Plan
AMS	ASEAN Member States
APSC	ASEAN Political-Security Community
ARC	African Risk Capacity insurance agency
ARDEX	ASEAN Regional Disaster Emergency Response Simulation Exercise
ARMOR	ASEAN Risk Monitor and Disaster Management Review
ASCC	ASEAN Socio-Cultural Community
ASEAN	Association of Southeast Asian Nations
ASEANCOF	ASEAN Climate Outlook Forum
ASEAN-DRFI	ASEAN Disaster Risk Financing and Insurance
ASIS	Agricultural Stress Index System
ASMC	ASEAN Specialised Meteorological Centre
AU	African Union
AWGCC	ASEAN Working Group on Climate Change

C

CC	coping capacity
CCA	climate change adaptation
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
CMORPH	CPC-MORPHing technique v1
CO2	carbon dioxide
CREWS	Climate Risk and Emergency Warning System
CVF	Climate Vulnerable Forum

D

DREF	Disaster Relief Emergency Fund
DRF	disaster risk financing
DRR	disaster risk reduction
DRRM	disaster risk reduction management

E

E	exposure
EAP	Early Action Protocol
ECMWF	European Centre for Medium-Range Weather Forecasting
ECP	Extended Concentration Pathway
EDI	Effective Drought Index
ENSO	El Niño Southern Oscillation
ESCAP	Economic and Social Commission for Asia and the Pacific
EWEA	Early Warning Early Action
EWS	Early Warning System

F

FAO	Food and Agriculture Organization
FbA	Forecast-based Action
FbF	Forecast-based Financing

G

G77	Group of 77
GADAS	Global Agricultural and Disaster Assessment System
GDP	gross domestic product
GHG	greenhouse gas
GIS	Geographic Information System
GRC	German Red Cross
GWP	Global Water Partnership

H

H	hazard

I

IbF	Impact-based Forecasting
ICRC	International Committee of the Red Cross
IDMC	Internal Displacement Monitoring Centre
IDP	Internally displaced person
IFRC	International Federation of Red Cross and Red Crescent Societies
IMHEN	Viet Nam Institute of Meteorology, Hydrology and Climate Change
INDC	Intended Nationally Determined Contribution
INFORM	Index for Risk Management
IOD	Indian Ocean Dipole
IPC	Integrated Food Security Phase Classification
IPCC	Intergovernmental Panel on Climate Change

J

JRC	Joint Research Centre

K

KBDI	Keetch-Byram Drought Index

L

Lao PDR	Lao People's Democratic Republic
LDC	Least Developed Countries
LST	Land Surface Temperature
LT	lead time
LTGG	long-term global goal

M

MAI	Moisture Availability Index
MHE	multi-hazard exposure
MHR	multi-hazard risk
MJO	Madden-Julian Oscillation
MRC	Mekong River Commission

N

NAP	National Action Plan
NCEP	National Centers for Environmental Prediction
NDC	Nationally Determined Contribution
NDMO	national disaster management organisation
NDVI	Normalized Difference Vegetation Index
NEA	National Environment Agency
NGO	non-governmental organisation
NLRC	Netherlands Red Cross
NMHS	National Meteorological and Hydrological Services
NRC	Norwegian Refugee Council

O

OCHA	Office for the Coordination of Humanitarian Affairs
OECD	Organisation for Economic Co-operation and Development

P

PDC	Pacific Disaster Center
PMI	Indonesian Red Cross Society
PNRI	Percentage of Normal Rainfall Index
PRC	Philippine Red Cross

R

RCP	Representative Concentration Pathway
RCRC	International Red Cross and Red Crescent Movement
RDCYIS	Regional Drought and Crop Yield Information System
RFC	Reason for Concern
RHEAS	Regional Hydrologic Extremes Assessment System
RIMES	Regional Integrated Multi-Hazard Early Warning System for Africa and Asia
ROC	Relative Operating Characteristic
RVA	Risk and Vulnerability Assessment

S

S2S	subseasonal-to-seasonal
SEADRIF	Southeast Asia Disaster Risk Insurance Facility
SFDRR	Sendai Framework for Disaster Risk Reduction
SKK	shelter-strengthening kits
SPEI	Standardized Precipitation Evapotranspiration Index
SPI	Standardized Precipitation Index
SR 1.5°C	Special Report Global Warming of 1.5°C
SRSP	shock-responsive social protection

T

TC	tropical cyclone
TMD	Thai Meteorological Department
TWG	technical working group

U

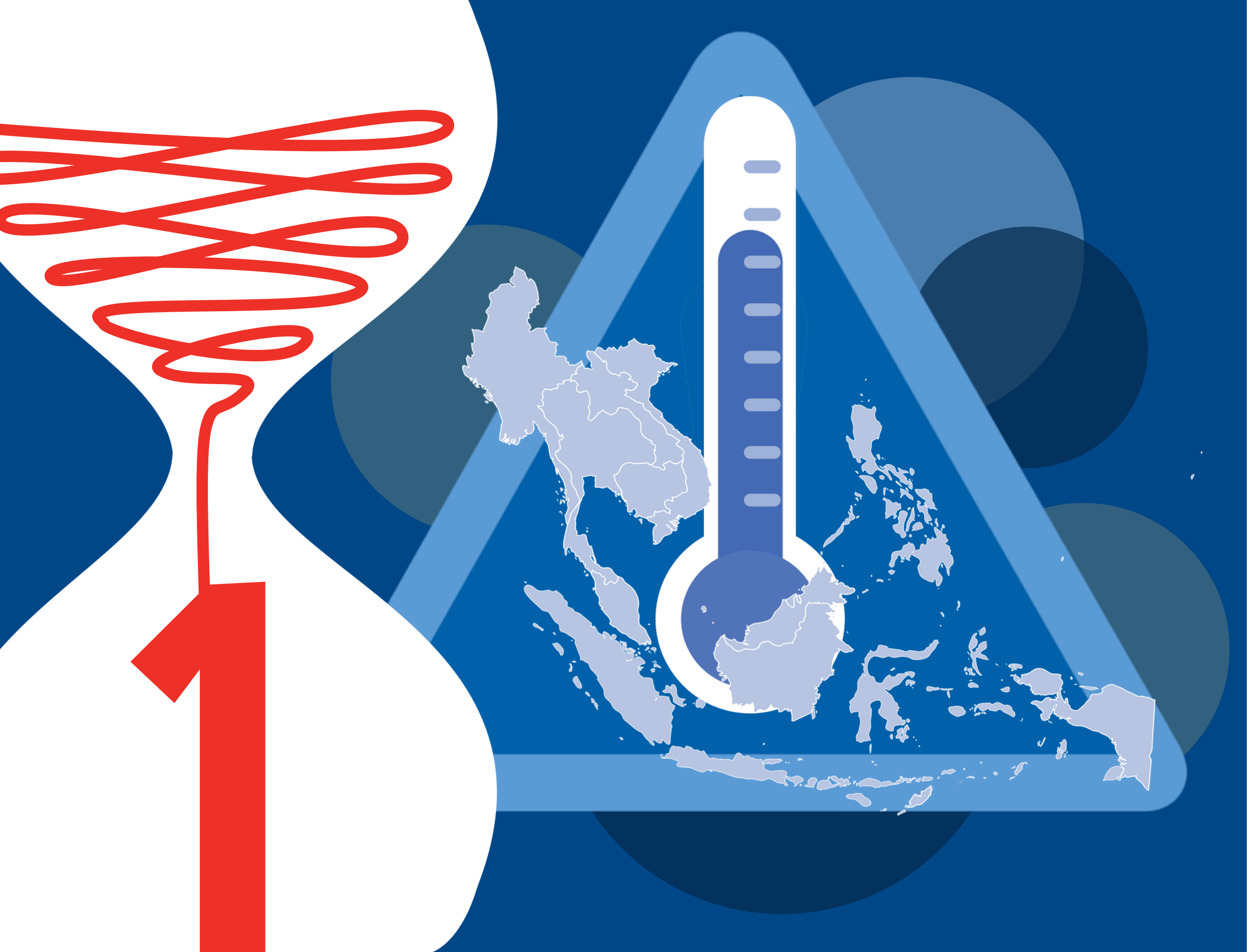
UHI	urban heat island
UN	United Nations
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations International Children's Fund
UNISDR	United Nations International Strategy for Disaster Reduction (now UNDRR)
USAID	United States Agency for International Development

V

V	vulnerability
V20	Vulnerable Twenty
VNRC	Viet Nam Red Cross Society

W

WFP	World Food Programme
WGI	Worldwide Governance Indicators
WMO	World Meteorological Organization
WPF	Weather Philippines Foundation



Real and Present Danger: What Does a 1.5°C Increase Mean to ASEAN?

By Mizan Bustanul Fuady Bisri

ARMOR

Abstract

This article summarises the latest assessments and outlook of climate change impacts in the Association of Southeast Asian Nations (ASEAN) region. As climate change poses a growing threat to the survivability of humankind, this article focuses on the set of actions that most urgently require adjustment in the humanitarian operations and preparedness of ASEAN and its Member States as a regional mechanism. The study primarily reviews the Intergovernmental Panel on Climate Change's (IPCC) Special Report Global Warming of 1.5°C (SR 1.5°C), research articles published after the SR 1.5°C, and the ASEAN Risk Monitor and Disaster Management Review (ARMOR) 2nd edition. The updated research articles collection includes a total of 122 articles on climate change risks and impacts in Southeast Asia published in 2019 and 2020. This study retrieved them from the Scopus database to review their relevance to humanitarian operations preparedness.

This review highlights two main areas in which improvements could enhance the potential implementation of the recommendations contained in the 2nd edition of ARMOR. The first area consists of addressing the need for integrated knowledge management of climate change impact and adaptation measures, disaster risk reduction (DRR), and humanitarian operations. The second area involves recognising the urgency of scaling down climate change projections and modelling to the regional level for enhanced disaster monitoring, analysis, and intelligence.

Keywords: climate change, 1.5°C, regional implications, knowledge management, disaster intelligence

1.1 Introduction

Climate change represents an urgent threat to human civilisation and the planet, leading an overwhelming majority of countries around the globe to adopt the Paris Agreement in December 2015 with the central aim of pursuing efforts to limit the global average temperature rise to 1.5°C above pre-industrial levels (United Nations, 2015). Through the United Nations Framework Convention on Climate Change (UNFCCC), these countries invited IPCC to compile a report on the impacts of global warming of 1.5°C and related global greenhouse gas (GHG) emissions pathways.

At the 21st session of the Conference of the Parties in December 2015, 195 nations adopted the Paris Agreement. The landmark agreement's primary goal is to strengthen the global response to the threat of climate change by "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" (United Nations, 2015).

The first UNFCCC document to discuss a limit to global warming of 1.5°C was the Cancun Agreements adopted at the 16th session of the Conference of the Parties in 2010. The agreements included a long-term global goal (LTGG) of holding "the increase in global average temperature below 2°C above pre-industrial levels" and established a process for periodically reviewing the adequacy of the LTGG with regards to both the ultimate objective of the UNFCCC and the overall progress made towards reaching the LTGG (UNFCCC, 2010). The Cancun Agreements also recognised the need to consider further lowering the limit of global average temperature rise to 1.5°C based on available scientific knowledge. While preparing the 6th Assessment Report for release in 2022, the IPCC has released the SR 1.5°C (IPCC, 2018) to bridge the gap between periods of the regular scientific assessment reports. The SR 1.5°C elaborates on the impacts of global warming of 1.5°C and related global GHG emission pathways, as well as the implications of strengthening the global climate change response, actions towards sustainable development, and efforts to eradicate poverty.

The SR 1.5°C states with high confidence that the global climate has significantly changed compared to the pre-industrial period (IPCC, 2018). There are several lines of evidence that these changes have had impacts on organisms and ecosystems, as well as on human systems and well-being. Human-induced warming had already reached nearly 1°C above pre-industrial levels at the time of writing of the SR 1.5°C. By the 2006–2015 decade, human activity had warmed the planet by 0.87°C (±0.12°C) compared to pre-industrial times. As the global temperature was rising by 0.2°C (±0.1°C) per decade, human-induced warming reached 1°C above pre-industrial levels around 2017. If this pace of warming continues, the global temperature will reach 1.5°C above pre-industrial levels around 2040 (Figure 1.1). While the overall intention of strengthening the global response to climate change is clear, the Paris Agreement does not specify the precise meaning of "global average temperature" or exactly which period in history is "pre-industrial."

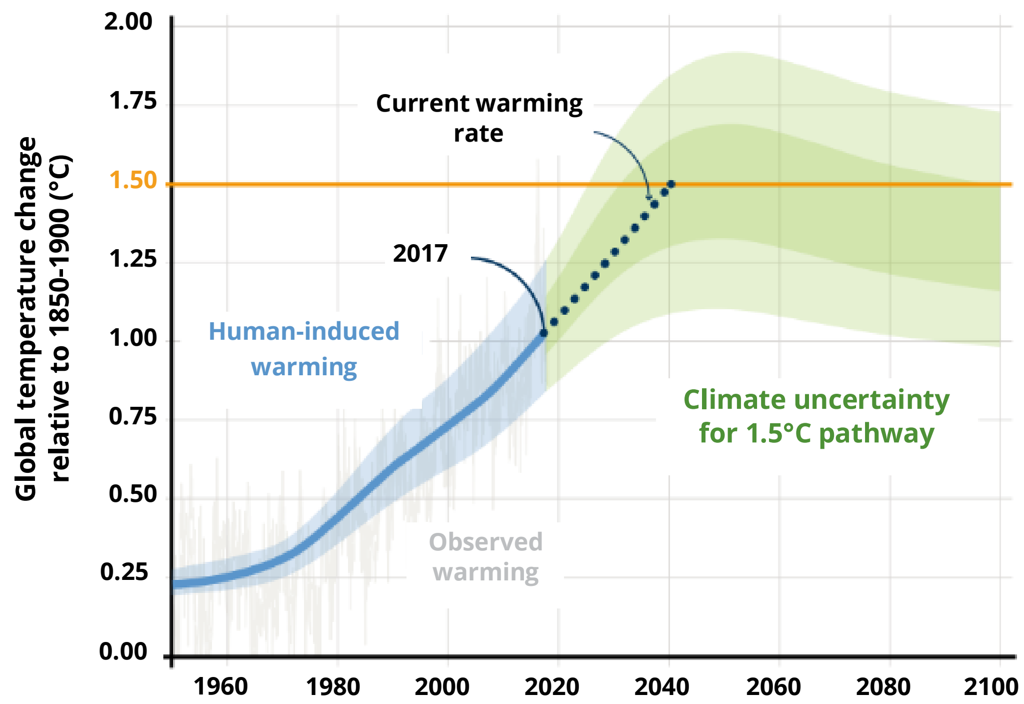


Figure 1.1

Current and projected global warming trends (source: IPCC, 2018).

The SR 1.5°C aimed to provide clarity on both terms to help answer the question of how close the current global situation is to 1.5°C of warming. The specification of the pre-industrial reference period and the method of calculating the global average temperature can alter scientists' estimates of historical warming by around two-tenths of a degree Celsius. Such differences become significant in the context of a global temperature limit just half a degree above the current temperature. As long as the chosen definitions are consistent, then they do not affect the resulting understanding of how human activity influences the climate.

The SR 1.5°C clarifies scientifically the climate change trajectories that the world is facing and positions itself to reinforce the implementation of climate change mitigation, including efforts to reduce GHGs due to human activity. It also defines two key concepts to help explain climate change adaptation (CCA) and its interaction within the broader context of DRR. In relation to climate change, it defines "impact" as the "effects of climate change on human and natural systems", which may have beneficial or adverse outcomes for health and well-being, livelihoods, services, infrastructure, ecosystems and species, and economic, social, and cultural assets. (IPCC, 2018, p. 26). It also defines climate change "risk" as "the potential for adverse consequences from a climate-related hazard," as well as "the potential for adverse consequences of adaptation or mitigation responses to climate change". The SR 1.5°C states that "risk" applies to both human and natural systems and results from the interactions between the vulnerability and exposure of the affected system and the climate hazard. Thus, risk links the likelihood of exposure to a hazard with the magnitude of its impact, and it is crucial to scrutinise scientific updates on climate change risk, its potential impact, and insight on CCA for regional-level programming in ASEAN.

This article summarises the latest assessments and outlook of climate change impact associated with the ASEAN region. It focuses on the impacts that most urgently require adjustment for the humanitarian operations preparedness of ASEAN as a regional mechanism. Accordingly, it does not elaborate on the equally important topic of climate change mitigation (efforts to reduce emission from greenhouse gasses). Materials reviewed in this article are limited to the documents released as part of the IPCC's SR 1.5oC, peer-reviewed journal articles published in 2019–2020, and other chapters in this 2nd edition of ARMOR.

1.2 Summary of Updates on the Anticipated Climate Change Impacts in ASEAN

As the scientific evidence of climate change risk and impact continues to evolve, the SR 1.5°C reframed five reasons for concern (RFCs) against climate change impact: (1) unique and threatened systems, (2) extreme weather events, (3) distribution of impacts, (4) global aggregate impacts, and (5) large-scale singular impacts (IPCC, 2018). All the RFCs use a "confidence level" to indicate the extent to which scientific modelling agrees on the potential impact or risk due to climate change. The upper portion of Figure 1.2 shows high to very high risk (with high confidence) that climate change will have direct impacts on unique and threatened systems if global temperatures rise above 1.5°C. It also shows high risk (with moderate confidence) that climate change will impact occurrences of extreme weather events and moderate to high risk (with high confidence) that climate change will result in an unequal distribution of impacts for different countries and communities.

The lower portion of Figure 1.2 provides further insight into the potential impacts and risks for several natural, managed, and human systems. The graphic shows that scientific evidence already results in a very high confidence level that warm-water corals will experience high to very high risk of impacts from climate change (IPCC, 2018). This result represents an urgent matter as ASEAN countries are home to significant coral hotspots. Similarly, the SR 1.5°C also shows moderate to high confidence levels with regards to potential risks for other systems relevant to ASEAN, including small-scale low-altitude fisheries, terrestrial ecosystems, coastal flooding, and fluvial flooding.

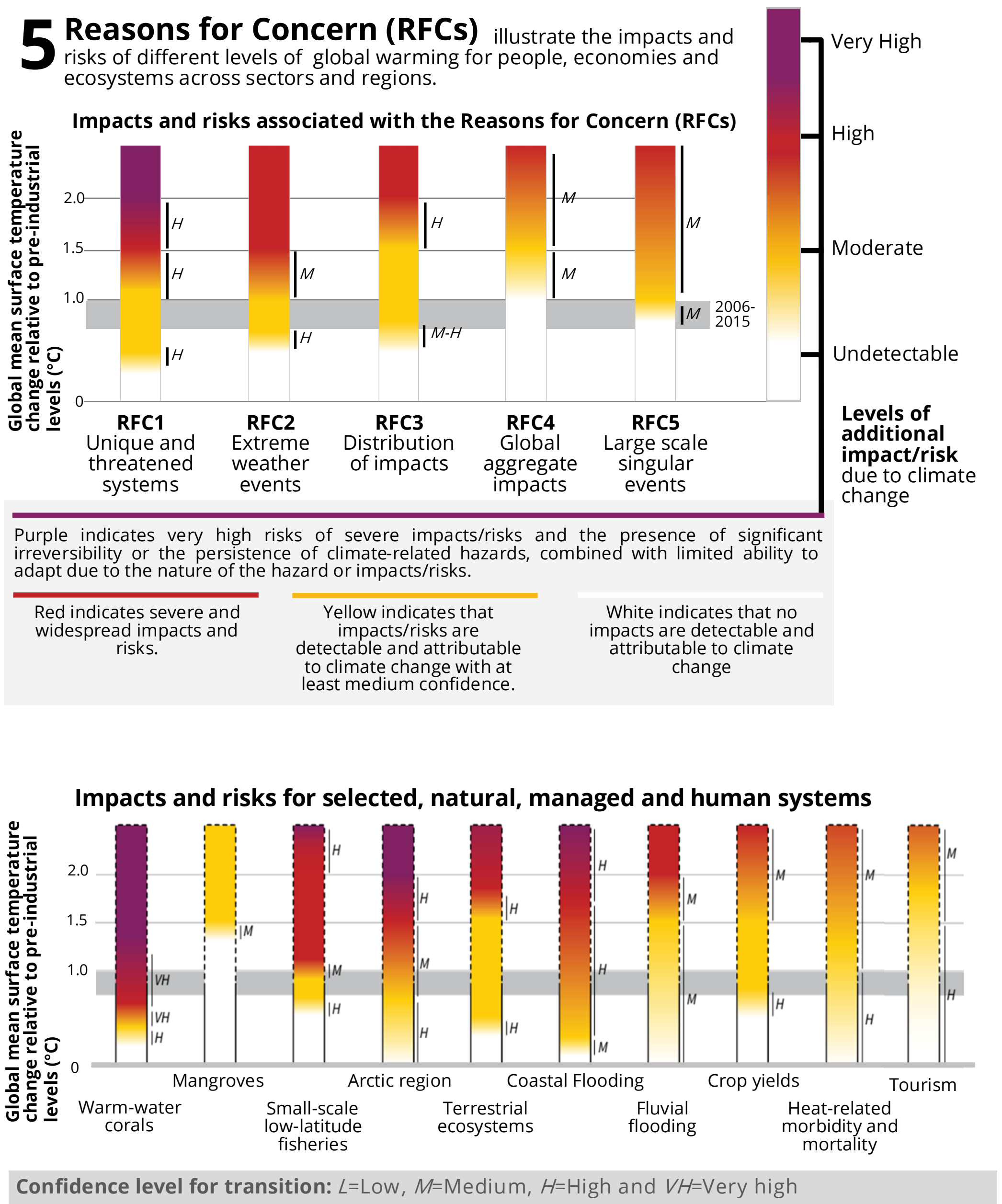


Figure 1.2

Impact, risk, and confidence levels associated with RFCs and selected natural, managed, and human systems (source: IPCC, 2018).

It is critical to provide analytics for these five RFCs in the ASEAN region based on regionally aggregated data at the national and subnational levels. Each RFC and its level of confidence in Figure 1.2 primarily relates to the potential impact on coastal communities and landscapes. These areas are of natural concern to the ASEAN region since nine out of 10 ASEAN countries depend on the ocean and coastal ecosystems for socioeconomic development. At the same time, Southeast Asia holds significant opportunities for “blue carbon” programmes through the conservation and restoration of its mangrove ecosystems (Jakovac et al., 2020). Setting carbon prices between USD 3 and USD 13 per ton of CO2 could avoid the release of up to 15.51 Pg of CO2 into the atmosphere. Using this method to restore mangroves can lead to the sequestration of up to 0.32 Pg of CO2 globally. This example shows that some RFCs in human and natural systems in the ASEAN region can support not only CCA programming but also climate change mitigation efforts such as GHG emission reduction.

The high risk of impact on coastal flooding and small-scale low-latitude fisheries is in part a result of sea level rise. A recent publication indicates that, depending on the degree of emissions reduction, global sea level rise could reach between 50 cm and 2 m by 2100 (Kulp & Strauss, 2019). Globally, this may lead to significant population displacement due to flood risk (International Displacement Monitoring Centre, 2019). For example, an optimistic scenario of sea level rise in combination with substantial ground surface elevation will still leave Viet Nam and Thailand with higher tide lines in the future. In turn, this sea level rise would threaten from 23% to 31% of Viet Nam’s population and 15% to 18% of Thailand’s population (Kulp & Strauss, 2019). Furthermore, Kulp and Strauss (2019) estimate that a higher-emissions scenario would potentially cause one-third of the population in Viet Nam to be permanently under the high tide line. Forced displacement due to climate change impact is a real threat for coastal areas of the ASEAN region. Equally important is the potential impact of coastal flooding for fisheries activities of coastal communities, which can affect the fisheries-based food production and overall crop yield in the ASEAN region (Lassa, Lai, & Goh, 2016).

Determining the effect of sea level rise and coastal flooding also requires understanding the outlook of coastline changes in Southeast Asia. A recent study assesses the coastline changes of Southeast Asian islands in 2000–2015 based on Landsat remote sensing images (Zhang & Hou, 2020). It shows that the coastline of Southeast Asian islands remained stable but showed considerable variability in estuaries, bays, and straits. Furthermore, out of 9,035 islands in the assessment, approximately 10% witnessed locational changes in coastlines, resulting in net reductions of nearly 86 km2 in area and 50,000 km in centroid displacement. Furthermore, the coastline length increased by 532 km from 148,508 km in 2000 to 149,040 km in 2015. However, this constitutes a decrease in natural coastlines by 2503 km, while artificial coastlines increased by 3035 km. This change shows that the temporal and spatial changes in coastlines were the result of interactions between natural processes and human activities, and consequently coastal management is necessary as part of climate change adaptation.

Figure 1.2 also shows gaps in scientific evidence, making it difficult to clearly confirm the potential impact of climate change to mangroves, crop yields, tourism, and heat-related morbidity and mortality at the global level. However, this does not signify that risk is absent in these areas. Instead, regional stakeholders should inquire as to whether the current rate of research in ASEAN communities is sufficient. For instance, Lassa et al. (2016) noted that there is a limited amount of peer-reviewed publications on the subject of climate change impacts on crop yields. Hence, recent research networks' initiatives to foster more research on agricultural-sector climate change impact analysis require promotion and strengthening to increase access to key policymakers at national and regional levels (Hellin et al., 2020). By fostering this collaboration, policymakers can take into account more novel study in agriculture sectors. For instance, the research by Soriano and Herath (2019) downscaled various climate model towards the Philippines to show how it affects paddy farming. The study found an increasing temperature for all months, decreasing rainfall and increased risks of water deficits for future dry seasons, and increasing rainfall and increased risks of excess runoff for future wet seasons (Soriano & Herath, 2019).

Tourism is another key sector for many ASEAN countries in which research is still limited in providing strong evidence for how climate change will affect the sector (Nguyen, 2019). Only anecdotal and micro-level studies are available at the moment, such as a recent review showing that potential climate change impacts will provide difficult complications for Luang Prabang in balancing development and tourism investment against the environmental threshold of the city (Fumagalli, 2020).

For humanitarian preparedness in the region, the three main concerns of ASEAN under the current changing climate are the increasing frequency and severity of tropical cyclones (TCs), the increasing frequency of droughts, and the direct changes to the overall riskscape of the region. Dimailig, Landicho, Hughey, Green, and Morath (2020) provide a brief country breakdown on the potential impacts for ASEAN countries under a warming climate. Subregional analysis within ASEAN is also critical for future risk monitoring and assessment in the region. For example, although Figure 1.2 indicates medium to high confidence in the RFC of fluvial and coastal flooding, a more recent study suggests that already more than 75% of particles transported in suspension in the Lower Mekong River resulted in an over-siltation in dams and exacerbated erosion of the muddy mangrove coast (Le et al., 2020). The associated Lower Mekong River Basin includes the ASEAN countries of Cambodia, Lao People's Democratic Republic, Myanmar, Thailand, and Viet Nam. Research also confirms that in the upper stream of Lower Mekong River Basin there is a vertical difference of climate change impacts on vegetation (Ouyang, Wan, Xu, Wang, & Lin, 2020). Ouyang et al. (2020) concluded that under future drier and warmer climate conditions, the Normalized Difference Vegetation Index in the upper stream of Lower Mekong River Basin with higher elevation may worsen with increased soil erosion and decreased streamflow, while the Normalized Difference Vegetation Index in the downstream area will improve. Due to the large amount of water and biomass in this basin, higher temperatures will accelerate the decomposition of forest foliar litter. Thus, more organic carbon and forest diffuse pollution will discharge into the water, potentially affecting the water quality of the entire basin.

It is also crucial to limit global warming to 1.5°C above pre-industrial levels (compared to a 2°C increase) to mitigate the risk of increases in heavy precipitation events on a global scale. This need is particularly pertinent to Southeast Asia as it is one of the regions that will experience the largest increases in heavy precipitation events for 1.5°C to 2°C global warming (Roxy et al., 2019; Singh & Qin, 2020). Furthermore, TCs are likely to decrease in frequency but with an increase in the proportion of very intense TCs, although with limited evidence and low confidence (Barros et al., 2014). A global temperature rise of 2°C would also likely lead to more heavy precipitation, both during TCs and on an aggregate global scale, compared to a rise of only 1.5°C (Hoegh-Guldberg et al., 2018). In the context of Southeast Asia, a strong correlation exists between rainfall in the region and global rainfall patterns based on the ocean-atmosphere interactions, which indicates an increasing rainfall extreme over the region (Roxy et al., 2019; Singh & Qin, 2020). This highlights the second RFC in Figure 1.2, indicating a moderate to high level of additional risk of extreme weather events due to climate change.

Kossin, Knapp, Olander, and Velden (2020) confirmed via numerical models the link between an increase in TC intensity and the warming of global temperatures (Figure 1.3). Looking at 40 years of data allowed the researchers to identify signals beyond the internal climate variability noise. For example, they found increases and trends in the exceedance probability and proportion of "major" TCs with intensities in the Saffir-Simpson categories 3 to 5. These results are consistent with theoretical expectations and trends from numerical simulations in warming scenarios. In summary, the study showed that a given TC is 8% more likely to fall under the major event category in the decade of 2020–2030 compared to the previous decade. Thus, it is imperative to improve preparedness against TCs as almost all of the associated damages and mortalities result from such major TC events. However, difficulties in detecting significant intensity trends in the observations compromise the confidence in the link between TC intensity and global warming, making it crucial to update the assessment in this context periodically and at the regional level. This is particularly crucial for the Southeast Asia region as its climate shows a large range of variability scales, from extreme events to interannual variability. For example, the implications of Kossin et al. (2020) need further analysis in conjunction with the result of regional downscaling for Southeast Asian region. The regional downscaling simulations suggest that from March to November in the northern South China Sea and Pacific there may be a significant weakening of wind speed from climatological to daily scales (summer monsoon to extreme values) for regions and periods of initially strong values, associated with a 40–50% decrease of TC frequency (Herrmann, Ngo-Duc, & Trinh-Tuan, 2020).

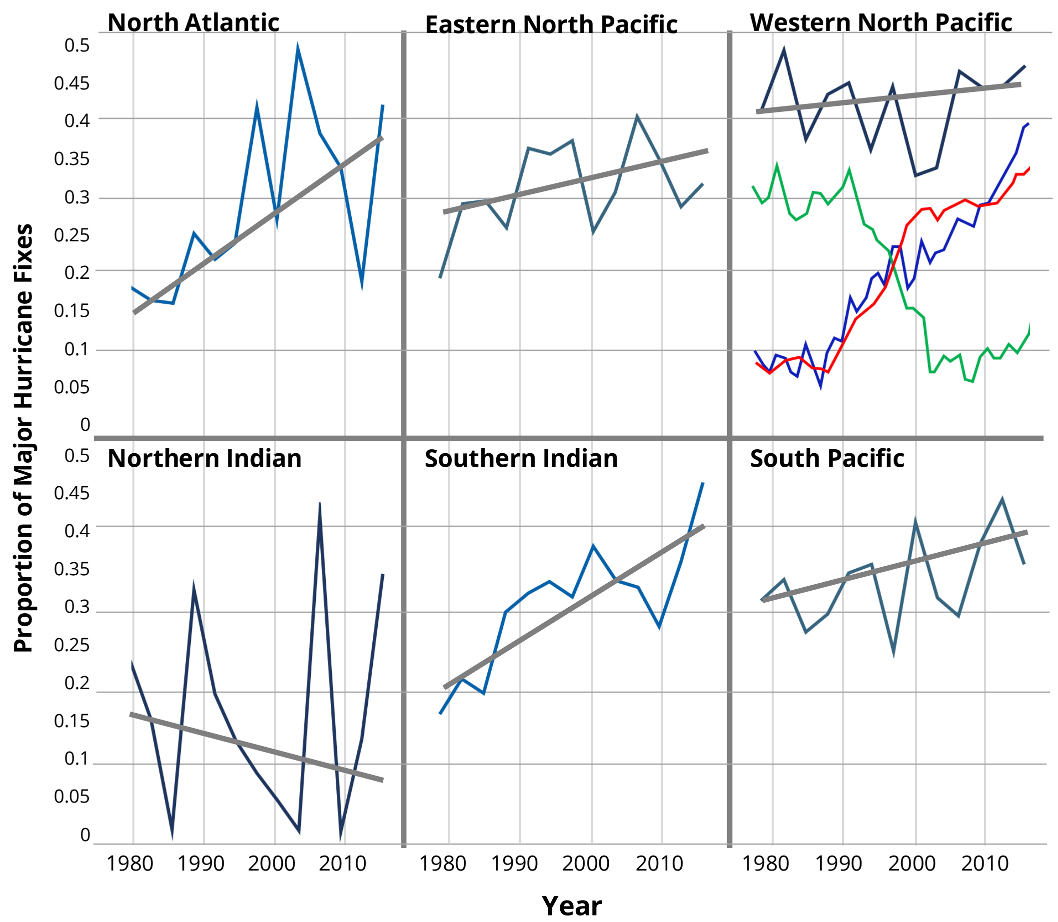


Figure 1.3

Time series of fractional proportion of major global TCs in individual ocean basins 2010–2017 (source: Kossin et al., 2020, p. 5).

Dimailig et al. (2020) state that the percentage of the national population with exposure to TC risk in the ASEAN region ranges from 69% in Malaysia to 100% in Thailand. The countries with the largest population exposed to TCs are the Philippines (75 million people), Thailand (67 million people), and Viet Nam (74 million people). This exposure may also increase due to the recent tropical storm pathways moving northward from Australia that have started to directly influence coastal communities in southern Java, western parts of Sumatra, and south-eastern parts of Indonesia (Meteorology, Climatology, and Geophysical Agency, n.d.).

With regards to the long-term impact of climate change on drought frequency and intensity, the overall trends indicate an upward pattern in the ASEAN region that will increase proportions of the affected population (Nirmalasari, 2019; ESCAP, 2019; Dutta, 2020; Hale & Downes, 2020; Li, 2020). One factor causing the upward trend is the rate of temperature rise of 0.14°C to 0.20°C per decade since the 1960s, coupled with a rising number of hot days and warm nights and a decline in cooler weather (Barros et al., 2014). Consequently, these factors lead to increasing heatwave risk. The study on the heatwave trends in Southeast Asia in 1978–2018 found that heatwaves are becoming more frequent, longer-lasting, and more intense with more steeply increasing trends in the Malay and Indochina Peninsulas (Li, 2020). For the region, the humidity level has substantial role in changing heatwaves trends in different sub-regions of Southeast Asia and calls for attention to the associated risk of increasing nighttime temperatures during heatwaves (Li, 2020).

Additionally, the El Niño phenomenon has a strong influence on the increase in frequency of drought in the ASEAN region (Dutta, 2020). The 2014/2016 El Niño event severely affected Cambodia, eastern parts of Indonesia, central and southern parts of the Philippines, and north-eastern parts of Thailand, which together accounted for around 10% of the population in the ASEAN region (ESCAP, 2019). The Standardized Precipitation Index for January 2020 showed severe to extreme conditions prevailed towards the south of Cambodia, Indonesia, Malaysia, Thailand, and Viet Nam, indicating that the outlook may continue to worsen (Dutta, 2020). Drought severity in Southeast Asia is also likely to see geographical shifts in upcoming years, implying that the past drought hotspots in the region will persist while new ones potentially emerge (ESCAP, 2019; Dutta, 2020). Hence, water shortage is another risk stemming from drought in the region. A recent study in North Borneo shows that the Northeast Monsoon has caused extreme drought and thus greatly affected water levels in dams on the north and northeast coasts of Borneo. The effects include medium- to high-risk in terms of water insecurity, with only two of the water dams being water-secure (Payus et al., 2020). Similarly, there is recent evidence on the potential increase of drought occurrences and water shortages along the Tonle Sap Lake Basin in Cambodia (Oeurng et al., 2019).

1.3 Conclusions and Recommendations

This review identifies two key implications for the ASEAN regional humanitarian operations preparedness. First, there exists a necessity for integrated knowledge management on climate change impact and its adaptation measures, DRR, and humanitarian operations. Second, there is also an urgent need for scaling down climate change projections, modelling, and impact assessments to the regional level for enhancing disaster monitoring, analysis, and intelligence. Both implications are crucial for bringing the discussion down to the regional level. Achieving this goal will depend on the analysis of aggregated national-level data, the chain of analytics from climate change projections of potential impacts and increases in disaster risks, and the identification of greater synergy between CCA and DRR.

Creating an integrated knowledge management platform will be crucial for bridging various policy processes, ideas, and actions across CCA and DRR. If such a platform can contribute to reaching the goal of limiting global warming to 1.5°C rather than 2°C, it would simultaneously help maximise mitigation and adaptation synergies, minimise trade-offs, and ultimately reduce climate change impacts and related social inequalities (Roy et al., 2018). The platform needs to first address the need for more scientific evidence on future climate change projections downscaling for parts of the ASEAN region, as this step one for CCA planning. Li, Zhang, and Babovic (2019), for instance, show that the degree of uncertainty still persists upon downscaling of several emission scenarios against the precipitations projection, and hence more modelling is necessary for guiding an appropriate adaptation plan in Singapore.

Adaptation options specific to national contexts will have benefits for sustainable development and poverty reduction if global warming remains under 1.5°C. The synergies between sustainable development and adaptation actions that reduce the vulnerability of human and natural systems include ensuring food and water security, reducing disaster risks, improving health conditions, maintaining ecosystem services, and reducing poverty and inequality. However, adaptation can also result in trade-offs or maladaptations with adverse impacts for sustainable development (de Coninck et al., 2018). For example, poor design or implementation of adaptation projects in a range of sectors can increase GHG emissions and water use, increase gender and social inequality, undermine health conditions, and encroach on natural ecosystems. Adaptations that pay attention to poverty and sustainable development can help reduce these trade-offs.

A wide range of adaptation options is available to reduce risks and enhance the resilience of natural and managed ecosystems. Some adaptation strategies include ecosystem-based adaptation, ecosystem restoration, biodiversity management, sustainable aquaculture, investment in physical and social infrastructure, and employing local and indigenous knowledge. Additionally, coastal defence and hardening can reduce the risks of sea level rise, while efficient irrigation, social safety nets, and disaster risk management can reduce risks to health, livelihoods, food, water, and economic growth, especially in rural landscapes. In urban areas, useful practices include green infrastructure, sustainable land use and planning, and sustainable water management. Overall, the application of integrated knowledge management at the ASEAN regional level can help avoid a false sense of security as well as maladaptation. Knowledge management can also clarify how to translate each country's CCA programmes and projects crafted under their National Adaptation Plans into results to lower their disaster risk level (UNFCCC, n.d.).

From the point of view of ASEAN's institutional operations, integrated knowledge management for DRR and CCA strengthens preparedness for a regional humanitarian response. It is also a strategy in which multiple sectoral policy processes can find common grounds, allowing them to avoid major rearrangement of ASEAN bodies and mandates. Integrated knowledge management naturally sustains an informed policy process through research on DRR and CCA, resulting in several benefits. For example, it can form an integral part of strengthening existing regional platforms for cross-sectoral collaboration, provide evidence as part of monitoring progress in the implementation of climate and DRR regional policy statements and targets, and showcase ASEAN Member States' presence in various DRR and CCA global venues while simultaneously highlighting the gaps in national and regional capacities and funding for climate and disaster resilience-building (Tanyang, 2020). Integrated knowledge management for DRR and CCA might form part of the next ASEAN Agreement on Disaster Management and Emergency Response Work Programme, with potential implementation by the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre). This arrangement would be a slightly easier approach in comparison to the recommendation by Petz and Rum (2020) that advocates for closer operations between the AHA Centre and the ASEAN Working Group on Climate Change.

Disaster monitoring, analysis, and intelligence activities must keep pace with climate change impact projections and modelling by taking advantage of the availability of subseasonal to seasonal (S2S) climate projections (Rahmat, Turkington, Kang, Rafisura, & Srinivasan, 2020). Chin, Arsadita, and Puapun (2020) also elaborate on the current situation, prospects, and challenges of building a more robust flood and drought early warning system for the ASEAN region. Their recommendation includes focusing on data availability related to leading and concurrent indicators (Hale & Downes, 2020).

S2S projections strengthen the assessment of risk by bridging weather forecasts on the scale of days to seasonal predictions on the scale of months. S2S combines the two into a two-week to two-month projection that has more detailed spatial and temporal information, making it ideal for updating potential exposure and vulnerability of the exposed areas in the ASEAN region. Practically, this requires even closer coordination between the ASEAN Specialised Meteorological Centre in charge of the S2S and the AHA Centre doing the disaster monitoring and analysis. The two entities will need to go beyond the current practice of information sharing via meetings in favour of daily and automated connectivity. This improved connectivity might entail an S2S data feed for immediate risk profile updates and an interface between systems employed by the ASEAN Specialised Meteorological Centre and the AHA Centre.

The S2S projections should also assist with a direct regional risk assessment based on ASEAN's national and subnational data. One of the missing pieces in the climate change discussion, which hinders increased actionable CCA and DRR efforts, is a regional process for harmonised presentation of information about climate impacts at the national level. Currently, countries have many different approaches, and their methods and assumptions can lack transparency. In response to this, the United Nations Environment Programme promotes the Country-Level Impacts of Climate Change initiative to create a common process that enables countries to communicate climate impacts at the regional and international levels.

As of 2020, Viet Nam is the only ASEAN country which has committed to this process. ASEAN entities can further evaluate the region to determine whether a common Country-Level Impacts of Climate Change initiative is feasible. In turn, this approach can yield a better regional-level impact assessment based on national-level data. It can also link modelling of climate change impact to the risk assessment of potential catastrophic events. At a practical level, the Climate Impact Viewer tool provides a potential point of reference for ASEAN entities to develop a similar instrument and take advantage of S2S data in the region (AP-PLAT, n.d.).

These changes comprise a prerequisite in the case that the AHA Centre or other ASEAN entities aim to transition to a forecast-based system of regional humanitarian preparedness and response. Zingg et al. (2020) discuss the mechanism of Forecast-based Financing (FbF) in the context of its implementation in the Philippines as another integral part of the Early Warning and Early Action approach. FbF employs the idea of a customisable Early Action Protocol with four main components: trigger, early actions, financing mechanism, and delivery. Together, they form a plan for triggering proactive actions and automatic release of humanitarian aid during the time leading up to a severe hazard event. The immediate recommendation of this article is to translate those four FbF components into part of an ASEAN regional preparedness and response mechanism. In contrast, the current implementation of the ASEAN Agreement on Disaster Management and Emergency Response requires a request of assistance from an ASEAN country experiencing the effects of a disaster. Thus, the current ASEAN disaster response mechanism requires a disaster to occur and reach a certain level of severity to trigger the response process, rather than relying on early actions to prevent the most severe impacts of the disaster. This approach can and should change if ASEAN plans to move to a forecast-based, regional humanitarian response. An enhanced disaster monitoring, analysis, and intelligence service of the AHA Centre can fulfil this need by ensuring appropriate absorption of climate projections, modelling, and downscaling. Doing so as a first step will redefine the regional-level risk scenario, triggering early action by ASEAN entities for the benefit of the potentially affected population in the region.

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The Threat-Multiplier: Climate Change and Disaster Riskscape in ASEAN

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ARMOR

Abstract

As one of the most disaster-prone regions in the world, Southeast Asia is highly at risk to the effects of climate change. Weather-related hazard events have dominated the region's disaster profile over many years. Climate change is likely to exacerbate the frequency, severity, duration, and geographic scale of extreme weather events, thus worsening the region's disaster risk. This article aims to describe how climate change will impact each element of disaster risk in the region, including multi-hazard exposure (MHE), vulnerability (V), and lack of coping capacity (CC).

Keywords: Disaster risk, climate change, ASEAN

2.1 Introduction

Southeast Asia is one of the most disaster-prone regions in the world, accounting for one in every 10 natural disasters during the past 120 years (Emergency Events Database, 2020). This high frequency is primarily due to the region's geographic location between the Pacific and Indian Oceans, resulting in tropical cyclones (TCs), monsoonal flooding, and other seasonal cascading hazards. Several tectonic plates also surround the region, leading to significant threats of earthquakes, volcanic eruptions, and tsunamis. The diverse range of socioeconomic and environmental vulnerabilities and CCs further adds to the complexity of disaster risk in Southeast Asia.

The Association of Southeast Asian Nations (ASEAN) Disaster Information Network (ADInet) recorded a total of 1,899 disaster events in the 10 ASEAN Member States from July 2012 to May 2020 (Table 2.1). These disasters affected more than 147 million people, displacing more than 18 million, resulting in almost 84,000 casualties (dead, injured, and missing), and amounting to at least USD 17 billion in damages.

ASEAN Member States	TSUNAMI	VOLCANO	EARTH-QUAKE	DROUGHT	LAND-SLIDE	STORM	WIND	FLOOD	SUBTOTAL
Brunei Darussalam	-	-	-	-	1	-	-	3	4
Cambodia	-	-	-	1	-	7	1	6	15
Indonesia	2	28	43	28	119	21	196	731	1,168
Lao PDR	-	-	1	-	2	4	1	13	21
Malaysia	-	-	2	-	6	6	1	88	103
Myanmar	-	-	3	1	9	19	6	38	76
Philippines (the)	-	5	19	2	19	67	32	78	222
Singapore	-	-	-	-	-	-	1	3	4
Thailand	-	-	2	11	5	35	22	70	145
Viet Nam	-	-	-	3	20	48	20	50	141
SUBTOTAL	2	33	70	46	181	207	280	1,080	1,899

Table 2.1

Distribution of disaster events in the ASEAN region (by Member State and hazard), showing that Indonesia has the largest number of records for all types of hazards except storms, for which the Philippines ranks first (source: ADINet, 2020).

During the past eight years, hydrometeorological hazards (floods, winds, storms, landslides, and droughts) have consistently accounted for at least 90% of annual disasters (Figure 2.1). Flood, which affects all ASEAN Member States, persists as the most frequent type in the region, while TCs are the most destructive in terms of total impact on the population and the economy. Underestimation of drought continues to be common due to its slow-onset nature, causing indiscernible development and often indirect consequences. The complexity of drought makes it difficult to identify and monitor and magnifies its threat of cascading, wide-ranging, recurrent, and long-lasting effects.

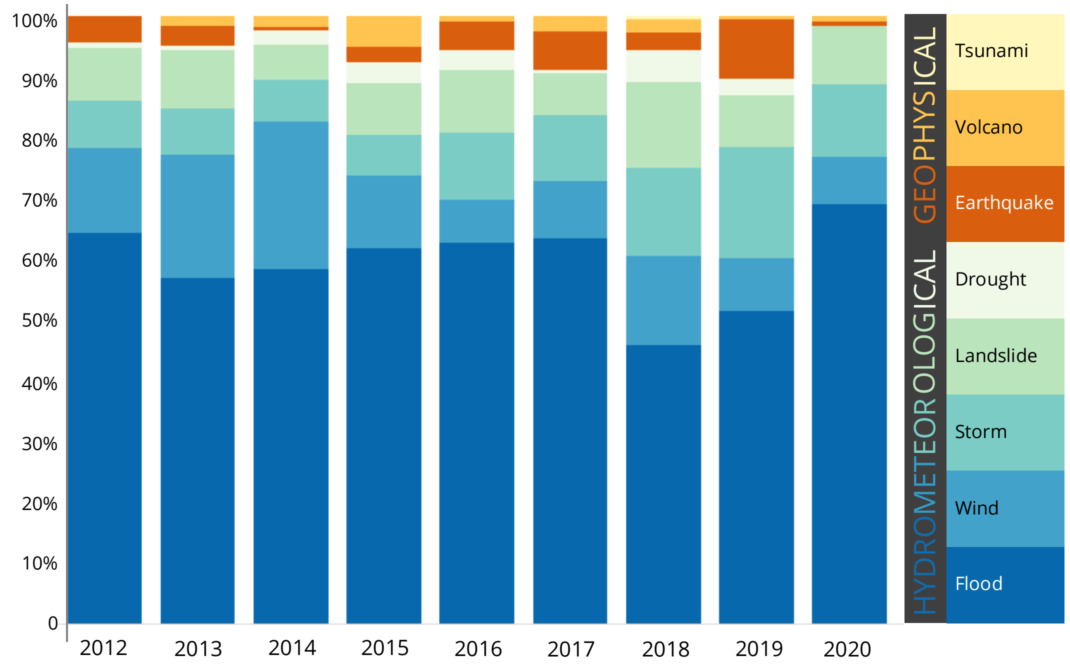

Figure 2.1

The breakdown of disaster events in the ASEAN region (by year and hazard) shows that the overwhelming majority of occurrences are hydrometeorological in nature, meaning that climate change can exacerbate them (source: ADINet, 2020).

Within the last two decades, the region has repeatedly experienced the destructive power and monumental scale of disasters resulting from hydrometeorological hazards. Significant events include the 2005 Thailand drought, 2007 Viet Nam flooding, 2008 Cyclone Nargis, 2009 Typhoon Ketsana, 2011 Bangkok flooding, 2012 Typhoon Bopha, 2013 Typhoon Haiyan, 2014 Typhoon Rammasun, 2018 Lao People's Democratic Republic (PDR) flooding, and 2020 Jakarta flooding, among others. With the changing climate, the region can expect more frequent and severe floods and TCs, as well as more intense, prolonged, and wider-ranging droughts.

The Intergovernmental Panel on Climate Change's (IPCC's) 2018 Special Report Global Warming of 1.5°C (SR 1.5°C) warns the world with a grave sense of emergency (IPCC, 2018a) that breaching the 1.5°C threshold of adapting to climate change as various systems collapse (United Nations Office for Disaster Risk Reduction (UNDRR), 2019b). This level of warming will exacerbate the frequency, severity, and geographic scale of hydrometeorological hazards, and also make many areas of the world uninhabitable, triggering mass migration. Social, economic, environmental, and political systems will overstretch and experience undue stress, resulting in a significant increase in disaster risk.

This article aims to describe the implications of climate change on the disaster riskscape of Southeast Asia. The study uses the mid-2020 global Index for Risk Management (INFORM) model and the 2020 ASEAN regional Risk and Vulnerability Assessment (RVA) index to evaluate the effects of climate change on each component of disaster risk. Both indices use similar disaster risk parameters, including MHE, V, and lack of CC. Because the indices use different ranges (1–10 for INFORM and 0–1 for RVA), normalised averaging was employed to enhance the precision of numerical comparison (Equation 2.1).

$$\text{Normalised Average} = \text{AVE}\left(\left(\text{INFORM} * 0.1 \right), \text{RVA} \right)$$

Equation 2.1

The INFORM index value is normalised to adopt the 0–1 range. Then, the average of the normalised INFORM and RVA results in a single index value.

INFORM is a dynamic composite indicator index, incorporating several components into each risk parameter (Figure 2.2). It identifies the level of risk of humanitarian emergencies overwhelming a country's capacity to respond and acts as a decision support mechanism for crisis management, preparedness, and response, thus supporting risk profiling and trend analysis.

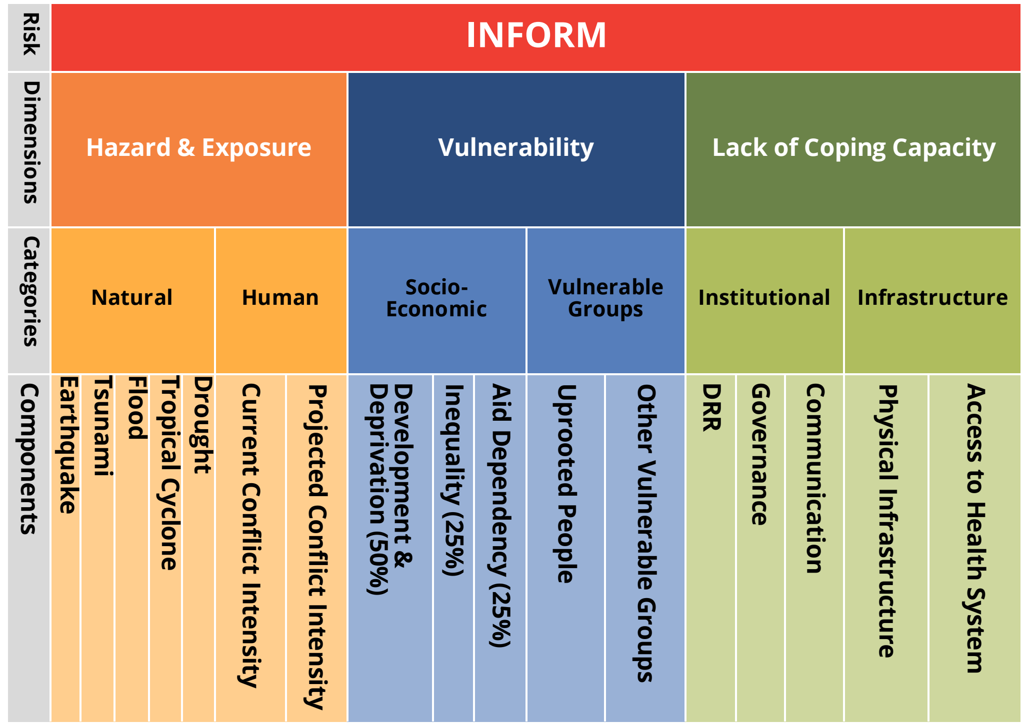

Figure 2.2

The Global INFORM model multilayer structure that builds up a score of risk by combining 54 different indicators in three dimensions: hazard and exposure, V, and lack of CC. These dimensions further divide into two risk categories each (source: Joint Research Center Scientific and Policy Reports. Index for Risk Management - INFORM: Concept and Methodology Version 2016).

The Pacific Disaster Center's (PDC's) existing Global RVA framework acts as the foundation for the ASEAN RVA. To capture the complexities of disaster risk in the ASEAN community, the PDC RVA methodology employs a composite index approach (Figure 2.3) in which it defines disaster risk as Multi-Hazard Risk (MHR) as a function of MHE, V, and CC. The methodology serves as a foundational assessment tool that ASEAN Member States can use to monitor progress, demonstrate change over time, and highlight areas in need of attention.

Multi-Hazard Risk (MHR)

MHR is a function of exposure, susceptibility to impact, and the relative inability to absorb, respond to, and recover from negative impacts that occur over the short term.

Vulnerability (V)

The characteristics and circumstances of a community, system, or asset that make it susceptible to the damaging effects of a hazard.

Multi-Hazard Exposure (MHE)

People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.

Coping Capacity (CC)

The ability of people, organisations, and systems, using available skills and resources, to face and manage adverse conditions, emergencies, or disasters.

Figure 2.3

The PDC RVA methodology for computing risk from MHE, V, and CC.

This article also documents changes over the past year using data from the ASEAN Risk Monitor and Disaster Management Review (ARMOR) 1st edition (Equation 2.2). By measuring rank change between countries, the data provide numerical evidence of how each ASEAN Member State has adjusted on its own and relative to the region.

$$\text{Index Difference} = 2^{nd}\text{ edition of ARMOR index} - 1^{st}\text{ edition of ARMOR index}$$

Equation 2.2

Comparing normalised average index values from the 1st and 2nd editions of ARMOR to quantify the level of change from the previous publication. The index difference reflects, to some extent, whether there is improvement or deterioration in each component of risk; thereby identifying the components in which each ASEAN Member State is doing well, and those which need more attention.

A positive index difference signifies that the risk relative to the component (MHE, V, or CC) increased or worsened, while a negative index difference indicates that the risk decreased or improved. Likewise, an upward change in the ranking shows that the ASEAN Member State's risk relative to the rest of the region worsened. The ranking uses the value of the indices such that 1 corresponds to the most at-risk country in the region, while 10 indicates the least at-risk country.

2.2 MHE Index

MHE comprises the people, property, systems, and other elements that are present in hazard zones and thereby subject to potential losses. INFORM measures physical exposure of the population to several types of hazards, and RVA examines both population and economic capital stock (building replacement cost) exposures. Moreover, INFORM considers both natural (earthquake, tsunami, flood, TC, and drought) and human-induced (conflict intensity and projected conflict intensity) hazards, while RVA only considers natural hazards (TC wind, tsunami, earthquake, flood, landslide susceptibility, wildfire, and volcano). For purposes of comparison, this article only focuses on exposure to natural hazards.

Rank	ASEAN Member State	INFORM (1 – 10)	RVA (0 – 1)	Normalised average index (0 – 1)
1	Philippines (the)	8.4	0.912	0.876
2	Indonesia	7.7	0.779	0.7745
3	Myanmar	7.8	0.686	0.733
4	Thailand	6.2	0.663	0.6415
5	Viet Nam	7.3	0.484	0.607
6	Malaysia	4.9	0.448	0.469
7	Cambodia	5.8	0.337	0.4585
8	Lao PDR	4.9	0.353	0.4215
9	Brunei Darussalam	2.6	0.073	0.1665
10	Singapore	0.9	0.221	0.1555

Table 2.2

Consistent with the findings in the 1st edition of ARMOR, the Philippines, Indonesia, Myanmar, Thailand, and Viet Nam remain the five ASEAN countries with the highest exposure to natural hazards.

The Philippines, Indonesia, and Myanmar ranked, respectively, as the top three ASEAN Member States with the highest MHE (Table 2.2). Globally, INFORM rates the Philippines as the country with the highest exposure to natural hazards (Figure 2.4), followed by Bangladesh, Japan, Myanmar, and Indonesia. On the other end of the spectrum, Singapore and Brunei Darussalam are the safest ASEAN Member States with regards to natural hazards, with INFORM rating Singapore as one of the 10 least-exposed globally.

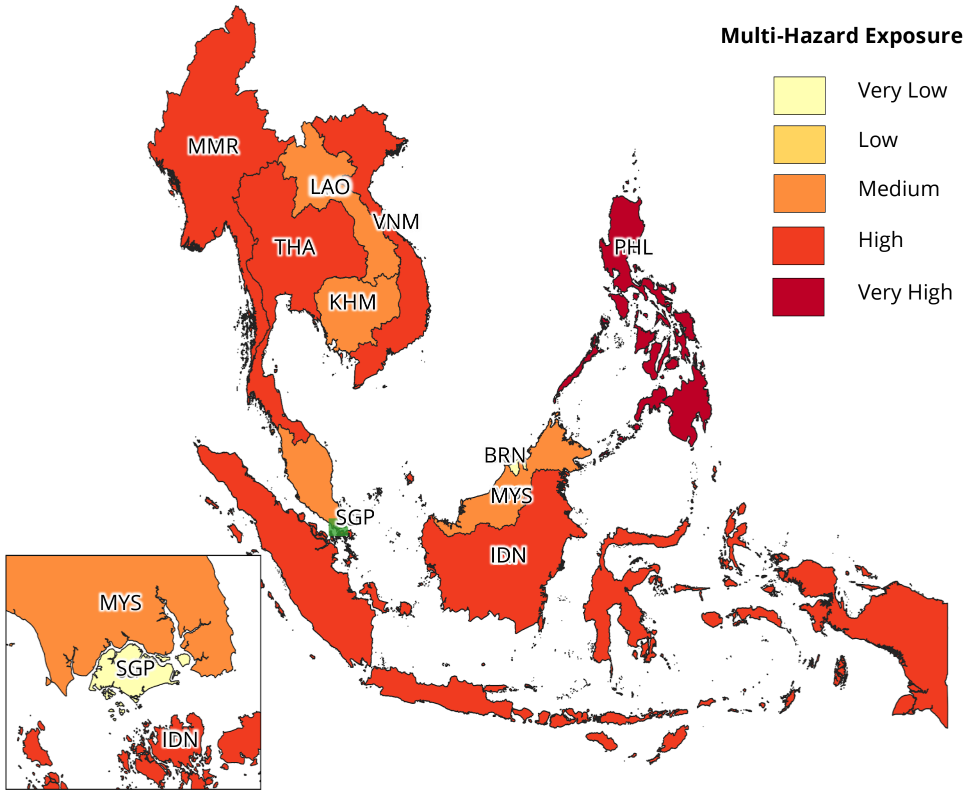

Figure 2.4

*A map of the MHE scores of the ASEAN Member States showing the Philippines as having very high *MHE (0.876) and Brunei Darussalam and Singapore as having very low* MHEs (0.1665 and 0.1555, respectively). *Based on equal intervals (0.2) of the normalised average index, which ranges from 0 to 1.*

In a comparison of the MHE indices and ranking of ASEAN Member States in the 1st and 2nd editions of ARMOR, Viet Nam exhibited the most significant improvement by lowering its index and improving its MHE ranking from the 3rd to the 5th most-exposed country (Table 2.3). The indices of Malaysia, Myanmar, and Thailand worsened, moving them up from their respective 2019 ranking positions. Brunei Darussalam, Indonesia, and the Philippines showed improvement in their respective indices, but their rankings remained unchanged. Similarly, Lao PDR and Singapore remained in the same respective rankings but experienced a worsening of their indices, with Singapore exhibiting the largest index increase in the region.

ASEAN Member State	1st Edition Normalised average index	1st Edition Rank	2nd Edition Normalised average index	2nd Edition Rank	Index difference	Rank change
Brunei Darussalam	0.245	9	0.1665	9	-0.0785	=
Cambodia	0.4385	6	0.4585	7	0.02	▼
Indonesia	0.854	2	0.7745	2	-0.0795	=
Lao PDR	0.351	8	0.4215	8	0.0705	=
Malaysia	0.3765	7	0.469	6	0.0925	▲
Myanmar	0.6075	4	0.733	3	0.1255	▲
Philippines (the)	0.902	1	0.876	1	-0.026	=
Singapore	0.014	10	0.1555	10	0.1415	=
Thailand	0.5565	5	0.6415	4	0.085	▲
Viet Nam	0.668	3	0.607	5	-0.061	▼

Table 2.3

The comparison between the 1st and 2nd edition of ARMOR shows that the most exposed ASEAN Member States, the Philippines and Indonesia, have improved their respective MHE indices. However, most ASEAN Member States' indices have worsened. * Green = improved; red = worsened; yellow = no change.*

The ASEAN region experiences very high levels of exposure to both hydrometeorological and geophysical hazards (Figure 2.5). RVA estimates 308 million people are exposed to TCs, while 357 million people are exposed to seismic activities. Examining hazard-exposure data for each hazard type provides a cross-section that can help identify the specific hazards contributing to exposure in each ASEAN Member State. Understanding exposure to particular hazards is valuable for determining appropriate mitigation actions, as differences in the types of hazards inherently dictate which mitigation options could be most effective in reducing losses and casualties.

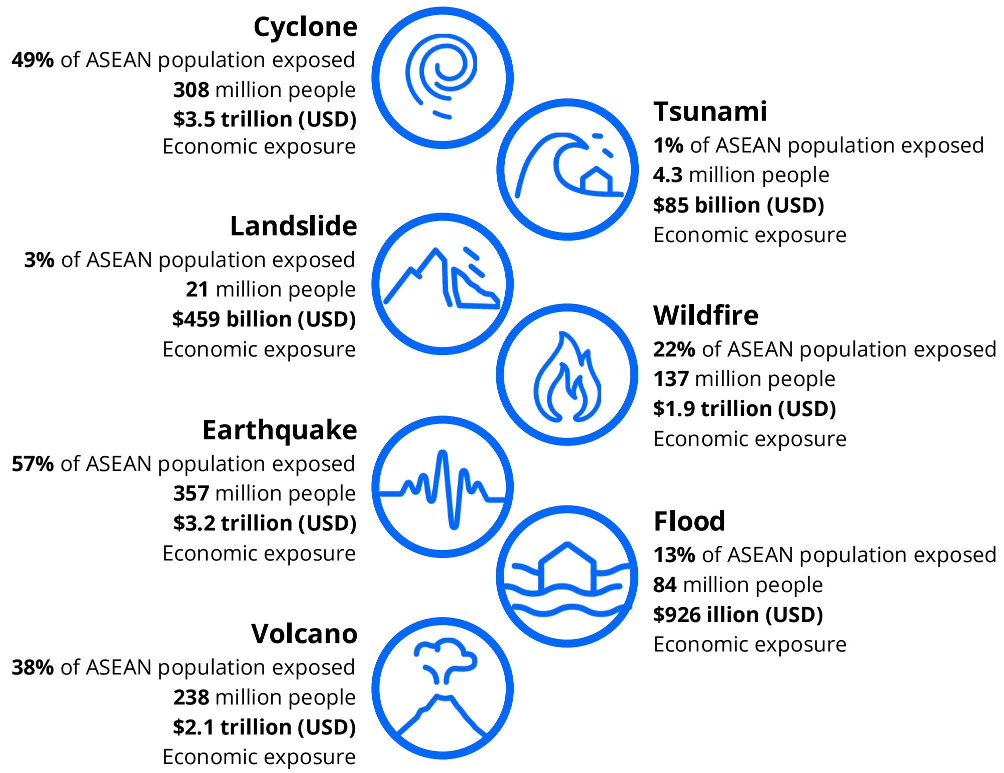

Figure 2.5

Summary of population and economic stock exposure showing that the ASEAN region experiences very high levels of exposure to seismic activity (57% of the total ASEAN population, USD 3.2 trillion), TCs (49% of the population, USD 3.5 trillion), and volcanic activity (38% of the population, USD 2.1 trillion).

Earthquakes pose the largest hazard risk primarily due to the extensive exposure of Indonesia, the most populous ASEAN Member State with 221 million people. The Philippines and Myanmar also have considerable population exposure to earthquakes at 85 million and 48 million people, respectively. Brunei Darussalam, Cambodia, Malaysia, and Singapore, on the other hand, have no population exposure to earthquakes, as they are the ASEAN Member States located farthest from tectonic plate boundaries. Climate change may indirectly increase population exposure to earthquakes as it can be a push factor for mass migration into cities. In the ASEAN region, a significant portion of the population is likely to migrate to seismically active megacities like Jakarta and Manila due to the impacts of climate change.

Population exposure to floods, the most common disaster event in the region, is highest in Viet Nam (26 million people), followed by Indonesia (20 million) and Thailand (13 million). Singapore, which has the lowest MHE, identified flood as its most threatening natural hazard, exposing 93% of the population (5 million people).

TCs remain the most extensive hazard in terms of the percentage of national population exposure. Excluding Indonesia, Brunei Darussalam, and Singapore—the only ASEAN Member States where TCs have no or negligible direct impact—the percentage of the national population with exposure to TCs in the region ranges from 69% in Malaysia to 100% in Thailand. The largest population exposures to TCs are in the Philippines (75 million), Viet Nam (74 million), and Thailand (67 million).

Collectively, the updated MHE of the ASEAN capital stock amounts to USD 12.17 trillion—almost four times the total economy of the region in 2019 (estimated at USD 3.1 trillion). This result is an increase compared to the findings from the 1st edition of ARMOR, which estimated the region's capital stock exposure to be three times its combined economy of 2018.

There are several reasons for this increase in exposure values. First, the RVA used an exposure model that had undergone significant refinement since the initial assessment, including enhancements of hazard zone, building, and population data, as well as processing methods. The result is a more precise capturing of the total population and economic exposure. This refinement has also updated the output for economic exposure. Previously, total economic exposure involved a comparison with a country's gross domestic product (GDP) for the year the model was evaluating. However, GDP is prone to fluctuations due to factors relating to the CC and V components of the RVA methodology. Therefore, countries that saw a drop in GDP would essentially receive a double penalty in their overall risk score. The RVA methodology now removes this potential double-counting by comparing economic exposure of the overall economic stock (building replacement cost) to produce a stable percentage value. This revised comparison removes the fluctuations associated with GDP and provides a more neutral evaluation of magnitude and relative importance of economic hazard exposure for ASEAN Member States. One by-product of this change is that some countries with relatively stable hazard exposure profiles will see a one-time jump in exposure scores, which may account for the increase in Singapore's index score.

The high exposure values for ASEAN Member States is problematic, given the continuing economic growth in the region. All countries within the region reported a positive trend in GDP per capita and purchasing power parity over the last five years. If disaster risk reduction does not improve at the same pace as the economic growth, the ASEAN region's MHE will continue to increase and threaten to undermine development.

Over the years, an increasing number of studies have found strong links between climate change and extreme weather events. According to the Global Climate Risk Index 2020, more evidence attributing specific extreme weather events to global warming has arisen recently and supports that as the global mean temperature rises, the frequency, intensity, and duration of extreme weather events also change. This intensification of extreme weather events is likely to increase MHE.

Based on IPCC's SR 1.5°C, climate models predict a significant difference between the climatic conditions of present-day temperature levels and those of global warming beyond 1.5°C of pre-industrial levels (IPCC, 2018b). The likely effects of such global warming include more extreme temperatures in inhabited regions, significantly heavier precipitation, and higher probabilities of drier-than-normal conditions which can lead to precipitation deficits and drought. Increasing climate risks are already evident at the current average global temperatures, supporting that an additional increase of 0.5°C from present-day temperatures will cause further negative consequences. At a global temperature increase of 1.5°C from pre-industrial levels, hotter extreme temperatures will be evident, heavy precipitation will be more intense and more frequent, and droughts will intensify in length and severity.

Temperature extremes on land are likely to increase even more than the global mean surface temperature (IPCC, 2018b). With a global average temperature increase of more than 1.5°C, droughts and precipitation deficits will pose even higher risks, as will heavier precipitation in certain regions. Additionally, precipitation associated with TCs will increase. Heavy precipitation is also likely to be higher at the global level if global warming reaches beyond 1.5°C. Relatedly, this level of global temperature rise will increase the proportion of land surface area at risk of flood hazards. These conclusions show that greater warming correlates with greater risk posed by the climate and extreme weather events.

2.3 V Index

V refers to the characteristics and circumstances of a community, system, or asset that make it susceptible to the damaging effects of a hazard. Both INFORM and RVA look into different indicators of economic, social, and political V, including the influence of recent disaster shocks on the most vulnerable groups. Additionally, RVA also takes into account environmental stress. By recognising the sensitivities of vulnerable areas, the V index can become an important instrument for decision-making by comparing and prioritising disaster prevention and mitigation projects and allocating aid during emergencies.

Rank	ASEAN Member State	INFORM (1 – 10)	RVA (0 – 1)	Normalised average index (0 – 1)
1	Myanmar	5.3	0.705	0.6175
2	Philippines (the)	5.2	0.539	0.5295
3	Lao PDR	4.4	0.598	0.519
4	Cambodia	4.3	0.591	0.5105
5	Indonesia	3.2	0.506	0.413
6	Thailand	3.2	0.351	0.3355
7	Viet Nam	2.2	0.418	0.319
8	Malaysia	3.1	0.324	0.317
9	Brunei Darussalam	0.9	0.23	0.16
10	Singapore	0.3	0.142	0.086

Table 2.4

Myanmar, the Philippines, Lao PDR, and Cambodia remained the four most vulnerable ASEAN Member States since the 1st edition of ARMOR. This year, Indonesia moved up into the top five.

The normalised average index ranks Myanmar, the Philippines, and Lao PDR as the top three most vulnerable ASEAN Member States (Table 2.4 and Figure 2.6). Both INFORM and RVA agree that Myanmar is the most susceptible to harm from hazards as it has limited resources to adequately prepare for, respond to, and recover from disasters. The Philippines, despite a relatively lower socioeconomic V compared to Lao PDR and Cambodia, scored higher overall due to the compounding effects of recent disaster events and its larger populations of highly vulnerable people.

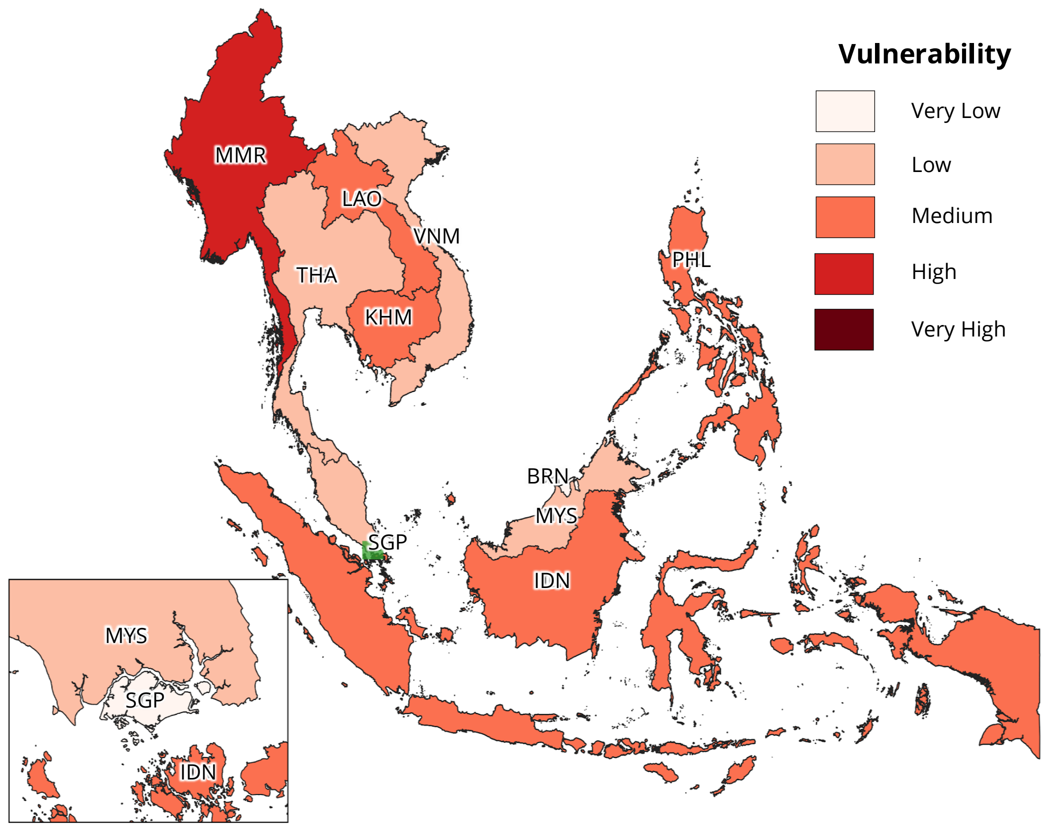

Figure 2.6

A map of the normalised average of INFORM and RVA V scores for the ASEAN Member States showing Myanmar as having high V (0.6175) and Brunei Darussalam and Singapore as having very low* Vs (0.16 and 0.086, respectively). *Based on equal intervals (0.2) of the normalised average index, which ranges from 0 to 1.*

All ASEAN Member States except Singapore increased their respective V index during the past year (Table 2.5). This deterioration highlights the need for an approach that targets the improvement of V in the region. Except for Myanmar and the Philippines, all other countries experienced a change in V ranking from 2019 to 2020. Cambodia, Malaysia, Singapore, and Thailand improved their V positions relative to the rest of the region.

ASEAN Member State	1st Edition		2nd Edition		Index difference	Rank change
	Normalised average index	Rank	Normalised average index	Rank		
Brunei Darussalam	0.1165	10	0.16	9	0.0435	▲
Cambodia	0.3815	3	0.5105	4	0.129	▼
Indonesia	0.308	6	0.413	5	0.105	▲
Lao PDR	0.3645	4	0.519	3	0.1545	▲
Malaysia	0.267	7	0.317	8	0.05	▼
Myanmar	0.417	1	0.6175	1	0.2005	=
Philippines (the)	0.409	2	0.5295	2	0.1205	=
Singapore	0.124	9	0.086	10	-0.038	▼
Thailand	0.3155	5	0.3355	6	0.02	▼
Viet Nam	0.251	8	0.319	7	0.068	▲

Table 2.5

*Alarmingly, the most vulnerable ASEAN Member States also recorded the highest increase in V over the past year. *Green = improved; red = worsened; yellow = no change.*

According to the Global Climate Risk Index 2020, four ASEAN Member States are in the top 10 countries in the world that suffered the most from extreme weather events for the period 1999–2018 (Table 2.6). Myanmar and the Philippines lead the region, although for different reasons. In the case of Myanmar, the exceptionally catastrophic Cyclone Nargis in 2008 caused an estimated 95% of total fatalities and damages in the country in the past two decades. On the other hand, recurrent disasters in the Philippines often occurring in quick succession placed it among the most affected countries in the long term.

Country	Climate Risk Index rank	Climate Risk Index score
Puerto Rico	1	6.67
Myanmar	**2**	**10.33**
Haiti	3	13.83
Philippines (the)	**4**	**17.67**
Pakistan	5	28.83
Viet Nam	**6**	**29.83**
Bangladesh	7	30.00
Thailand	**8**	**31.00**
Nepal	9	31.50
Dominica	10	32.33
Cambodia	**12**	**35.33**
Lao PDR	**76**	**76.33**
Indonesia	**77**	**76.83**
Malaysia	**114**	**103.33**
Brunei Darussalam	**175**	**169.17**
Singapore	**180**	**172.17**

Table 2.6

Climate Risk Index for 1999–2018 highlights that, globally, the ASEAN region suffered more than any other region in the past two decades and may suffer even more as extreme events become more frequent and more severe due to climate change.

While impacts from extreme weather events have always hit the most impoverished countries hardest, high-income countries are starting to experience the impacts of climate change more clearly than before. For example, several extreme weather events have recently occurred in Europe, North America, and Japan (Eckstein et al., 2019). In addition, global V is likely to increase as other impacts of climate change, such as food and water insecurity and sea level rise, become more apparent. In the ASEAN region, Singapore and Brunei Darussalam are most at-risk to food and water insecurity due to their small territories and limited natural resources. The Global Food Security Index 2020 ranks Singapore as the most food-secure country in 2019. However, it also ranks Singapore as one of the least resilient countries to climate-related threats to food systems as it is heavily dependent on food imports.

Global warming also heavily threatens resource provisions from ecosystem services. Possible risks to terrestrial ecosystems related to global warming of over 1.5°C include species loss and extinction. Keeping the temperature increase within 1.5°C limits the risks, therefore granting the opportunity to adapt and retain vital terrestrial ecosystem services. In addition to terrestrial ecosystems, marine ecosystems are also vulnerable to rising temperatures. Possible species extinction, ocean acidification, and decreases in ocean oxygen levels can directly impact marine ecosystem services to the human population. Similarly, keeping the increase in global average temperature well within 1.5°C reduces these risks. The loss of these ecosystem services would put the human population at greater risk in the event of disasters.

According to the IPCC (2018a), global mean sea level is likely to continue rising well beyond the year 2100 if temperature rise does not halt. With a global temperature rise of 1.5°C, projections from the IPCC SR 1.5°C indicate that global mean sea level will increase between 0.26 to 0.77 m relative to the 1986 – 2005 period by the year 2100. Such a rise would significantly threaten the ASEAN region since most of its Member States are maritime. The amount of sea level rise depends heavily on the direction of actions with regards to greenhouse gas (GHG) emissions. It was also outlined in the IPCC SR 1.5°C that the ability of humans to cope, however, depends on the rate at which the global mean sea level rises. A slower rate of sea level rise would result in more adaptation opportunities for populations in critical environmental systems such as small islands, low-lying coastal areas, and deltas. With the assumption of no additional adaptive measures, a 0.1 m reduction in forecasted global mean sea level rise would significantly reduce the number of exposed people (10 million fewer based on the 2010 population). However, instability and loss of ice sheets in Antarctica and Greenland alone could result in a multi-meter rise in sea levels. IPCC SR 1.5°C projections estimate that these instabilities or losses may occur at a global temperature rise of 1.5° C above pre-industrial levels. The risks associated with sea level rise include flooding, damage to infrastructure, and saltwater intrusion, the latter of which is already causing problems in Viet Nam and may affect water supply and cause sinkhole formation. These risks are probable at a global temperature rise of 1.5°C, but actions towards reducing GHG emissions can slow the rate of sea level rise. A 0.1 m reduction in projected global mean sea level rise could significantly reduce risk as well as provide opportunities for the human population to adapt correspondingly (IPCC, 2018a). Such opportunities include improving the management of coastal resources and ecosystems and reinforcing affected structures.

2.4 CC Index

CC describes the ability of people, organisations, and systems to use available skills and resources to manage adverse conditions, emergencies, or disasters. Both INFORM and RVA analyse institutional and infrastructural mechanisms that contribute to disaster risk reduction; RVA also takes into account environmental and economic capacities. A lack of CC hinders the ability of an entity to absorb negative impacts from a hazard event. Identifying countries with the least ability to absorb negative impacts is an important instrument for deciding which have the greatest need for investments to improve their internal capacity to respond to hazards.

Rank	ASEAN Member State	INFORM (1 – 10)	RVA (0 – 1)	Normalised average index (0 – 1)
1	Myanmar	6.3	0.874	0.752
2	Cambodia	6.2	0.755	0.6875
3	Lao PDR	5.8	0.722	0.651
4	Philippines (the)	4	0.663	0.5315
5	Indonesia	4.5	0.599	0.5245
6	Viet Nam	4.2	0.627	0.5235
7	Thailand	4	0.626	0.513
8	Malaysia	2.9	0.441	0.3655
9	Brunei Darussalam	3.5	0.307	0.3285
10	Singapore	1	0.152	0.126

Table 2.7

The index scores indicating lack of CC for the ASEAN Member States. Myanmar, Cambodia, and Lao PDR have the most limited capacities to cope, while Malaysia, Brunei Darussalam, and Singapore have the highest capacities.

Consistent with the 1st edition of ARMOR, Myanmar, Cambodia, and Lao PDR ranked as the three ASEAN Member States with the most limited capacities to cope with hazards (Table 2.7 and Figure 2.7). The quality of infrastructures remains a challenge in the ASEAN region and is a primary driver for the lack of CC.

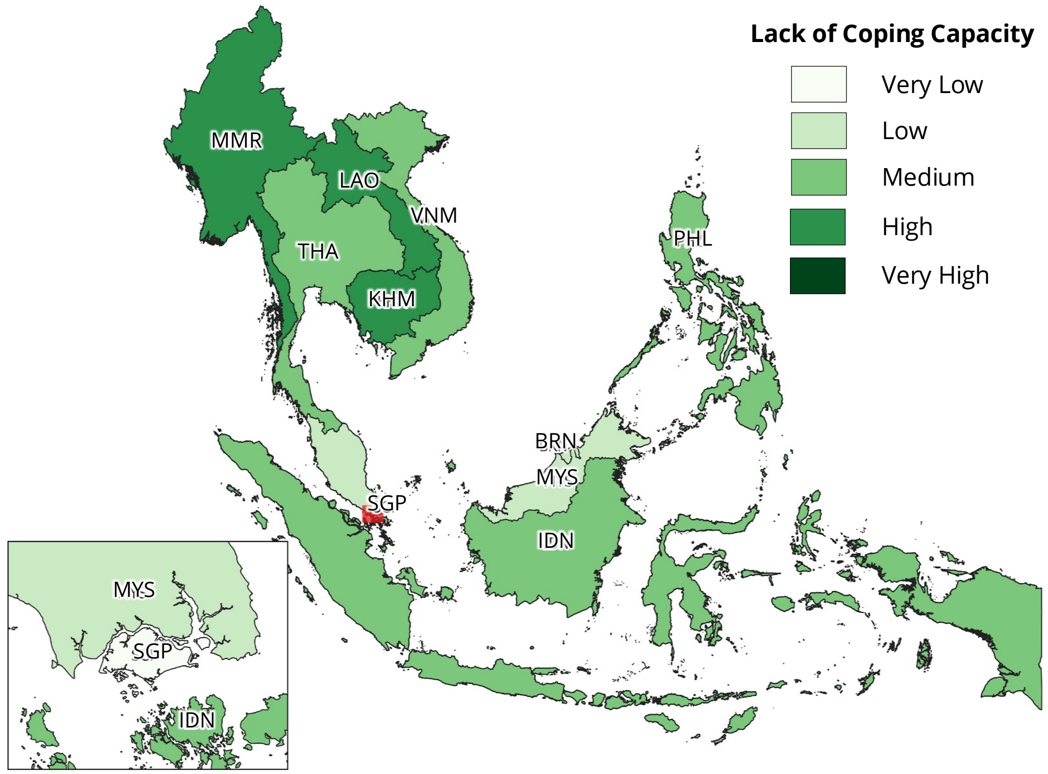

Figure 2.7

A map of normalised averages of INFORM and RVA lack of CC scores of the ASEAN Member States, showing Cambodia, Lao PDR, and Myanmar as having a high lack of CC (0.6875, 0.651, and 0.752, respectively) and Singapore as having a very low* lack of CC (0.126). *Based on equal intervals (0.2) of the normalised average index, which ranges from 0 to 1.*

The Worldwide Governance Indicators (WGI) database over the period 1996-2018 shows that Singapore, Brunei Darussalam, and Malaysia consistently rank in the upper percentile in most dimensions of governance (Figure 2.8). Robust governance indicators, combined with economic and infrastructural capacity, provided these ASEAN Member States with strong CC to natural hazards. Likewise, improvements in the governance indicators of Myanmar, Cambodia, and Lao PDR will contribute to the increase of their recovery rates after a disaster strikes.

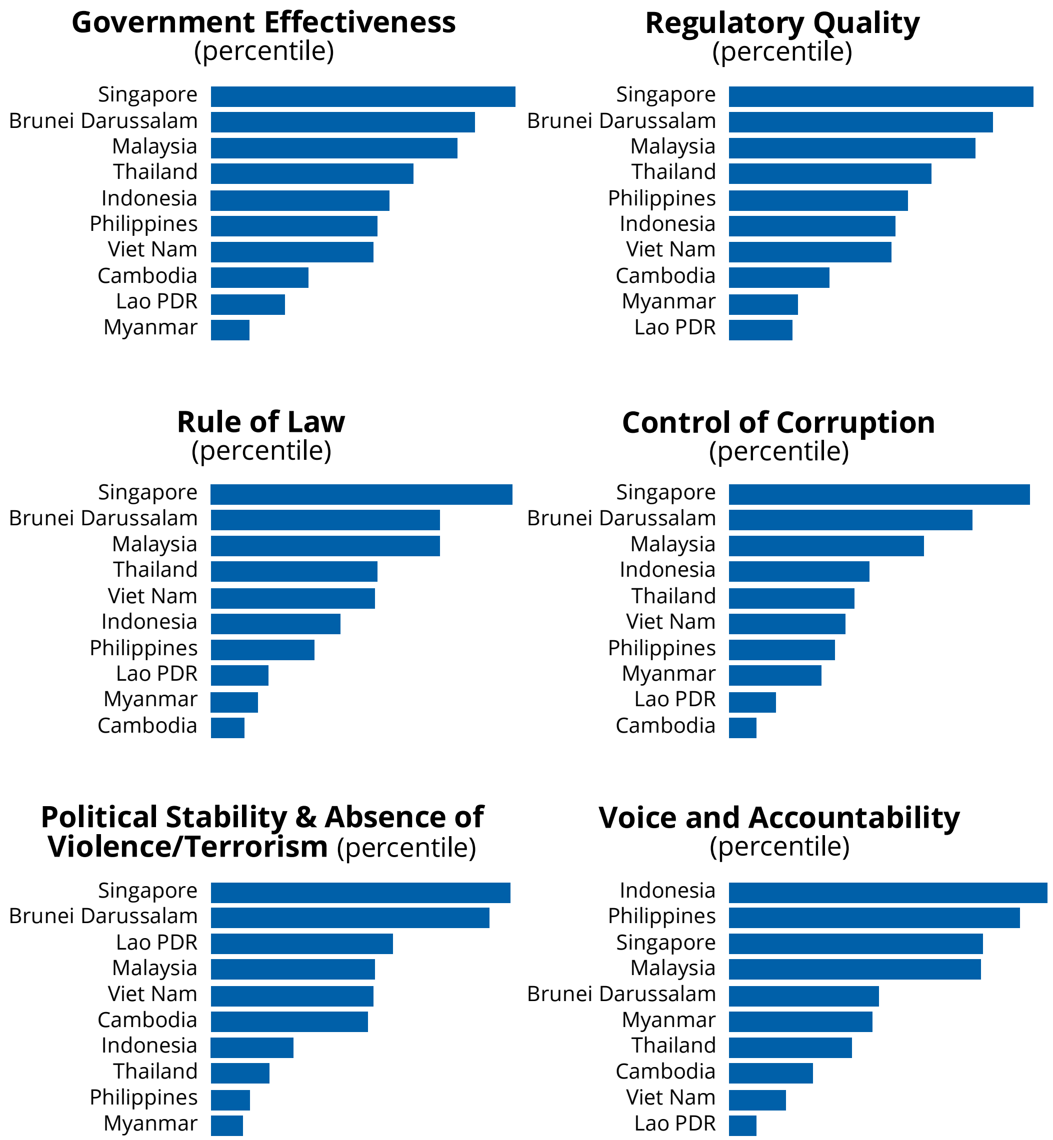

Figure 2.8

The WGI 2019 database shows Singapore, Brunei Darussalam, and Malaysia consistently ranking in the upper percentile for most indicators. This high ranking is evidence of the strong institutional CCs of these Member States (source: WGI DataBank, 2020).

Singapore and Brunei Darussalam have experienced slight improvement of their CCs since 2019 (Table 2.8). However, the rest of the ASEAN countries have a higher lack of CC compared with the findings in the 1st edition of ARMOR, with the biggest dip recorded in Myanmar, causing it to switch ranking positions with Cambodia. In terms of relative ranking, Thailand had the best movement in the region, improving its ranking by two steps downward.

ASEAN Member State	1st Edition		2nd Edition		Index difference	Rank change
	Normalised average index	Rank	Normalised average index	Rank		
Brunei Darussalam	0.3455	8	0.3285	9	-0.017	▼
Cambodia	0.5825	1	0.6875	2	0.105	▼
Indonesia	0.4375	4	0.5245	5	0.087	▼
Lao PDR	0.5405	3	0.651	3	0.1105	=
Malaysia	0.328	9	0.3655	8	0.0375	▲
Myanmar	0.555	2	0.752	1	0.197	▲
Philippines (the)	0.427	6	0.5315	4	0.1045	▲
Singapore	0.152	10	0.126	10	-0.026	=
Thailand	0.43	5	0.513	7	0.083	▲
Viet Nam	0.3945	7	0.5235	6	0.129	▼

Table 2.8

Singapore both improved its CC and maintained the strongest relative CC ranking in the region.

** Green = improved; red = worsened; yellow = no change.*

Although the impact of climate change on governance is not as visible as the impact of governance on climate change, links between extreme weather events and social, economic, political, and environmental pressures support the general conclusion that climate change is a threat multiplier that can lead to social upheaval and possibly violent conflict. Instability stemming from climate change is likely to be greatest in countries and regions where conflict and political or ethnic strife are already present or have recently been present (National Research Council, 2013). Moreover, climate change and lack of CC compound each other. Inadequate response to extreme weather events can provoke social discontent, which can have adverse impacts on the coherence of the affected state and further weaken its governance structures.

2.5 MHR Index

MHR provides an assessment of the likelihood that a Member State will experience disruption of normal functions due to MHE, V, and CC. Thus, it essentially gives an overview of risk conditions as a function of exposure, susceptibility to impact, and the relative inability to absorb, respond to, and recover from negative impacts that occur over the short term.

Rank	ASEAN Member State	INFORM (1 – 10)	RVA (0 – 1)	Normalised average index (0 – 1)
1	Myanmar	6.3	0.751	0.6905
2	Philippines (the)	5.5	0.688	0.619
3	Indonesia	4.7	0.618	0.544
4	Cambodia	4.8	0.532	0.506
5	Lao PDR	4.2	0.534	0.477
6	Thailand	4.1	0.526	0.468
7	Viet Nam	3.7	0.502	0.436
8	Malaysia	3.1	0.4	0.355
9	Brunei Darussalam	1.6	0.173	0.1665
10	Singapore	0.5	0.168	0.109

Table 2.9

Index scores indicating MHR for the ASEAN Member States. Consistent with the 1st edition of ARMOR, the top three (Myanmar, the Philippines, and Indonesia) and the bottom three (Singapore, Brunei Darussalam, and Malaysia) ASEAN Member States have maintained their respective ranking positions over the past year.

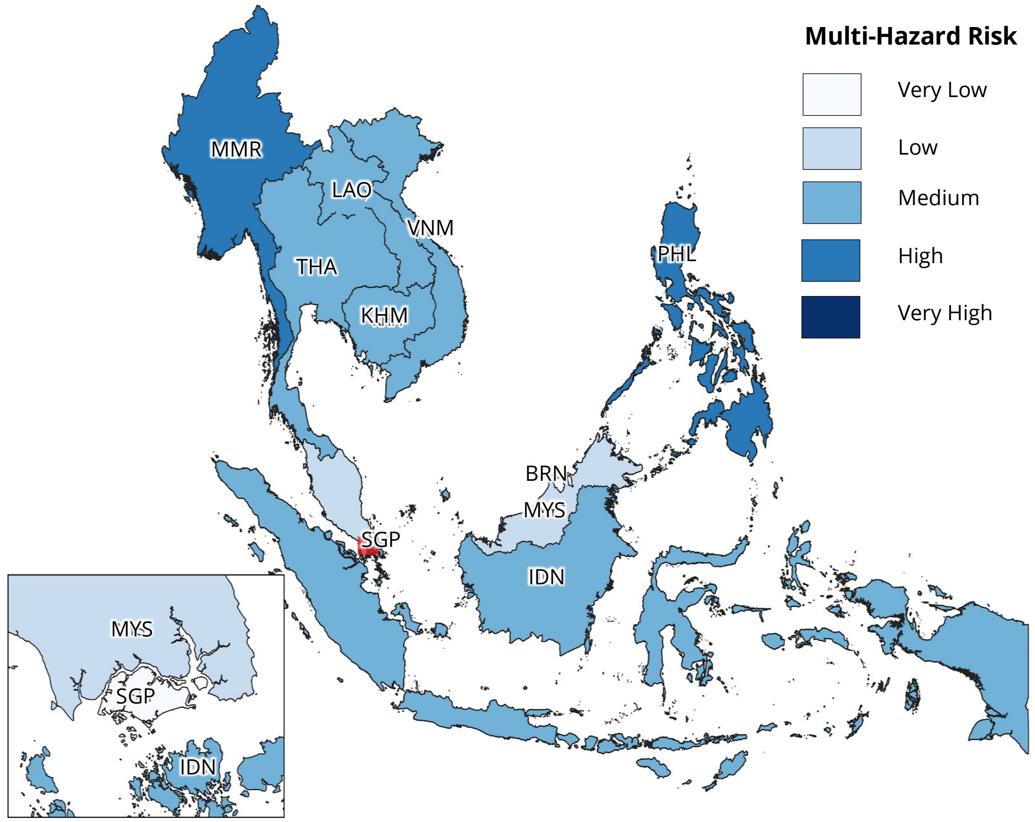

Figure 2.9

A map of the normalised average of INFORM and RVA MHR scores for the ASEAN Member States, showing Myanmar and the Philippines as having high MHRs (0.6905 and 0.619, respectively) and Brunei Darussalam and Singapore as having very low* MHRs (0.1655 and 0.109, respectively).*

Myanmar, the Philippines, and Indonesia are the ASEAN Member States most at risk to hazards (Table 2.9 and Figure 2.9). MHE, in which the Philippines and Indonesia lead, is the main driver of risk in the ASEAN region. However, high V and low CC in Myanmar propelled it to become the most at risk overall. As middle-income countries, the Philippines and Indonesia have a very high potential for reducing risk by investing in their respective CCs and minimising vulnerabilities. Singapore, Brunei Darussalam, and Malaysia have maintained their position as the least at-risk ASEAN Member States since 2019.

Overall, MHR in the region increased over the past year. Except for Brunei Darussalam, the MHR index values increased for all ASEAN Member States, with Myanmar experiencing the largest increase (Table 2.10).

ASEAN Member State	1st Edition		2nd Edition		Index difference	Rank change
	Normalised average index	Rank	Normalised average index	Rank		
Brunei Darussalam	0.227	9	0.1665	9	-0.0605	=
Cambodia	0.454	4	0.506	4	0.052	=
Indonesia	0.502	3	0.544	3	0.042	=
Lao PDR	0.393	6	0.477	5	0.084	▲
Malaysia	0.311	8	0.355	8	0.044	=
Myanmar	0.557	1	0.6905	1	0.1335	=
Philippines (the)	0.555	2	0.619	2	0.064	=
Singapore	0.064	10	0.109	10	0.045	=
Thailand	0.437	5	0.468	6	0.031	▼
Viet Nam	0.3675	7	0.436	7	0.0685	=

Table 2.10

*All ASEAN Member States (except Brunei Darussalam) recorded higher MHR Scores for 2020 compared to their scores in 2019 and retained their regional rankings except a switch between Thailand and Lao PDR. *Green = improved; red = worsened; yellow = no change.*

2.6 Conclusions and Recommendations

Anthropogenic activities in the last century have resulted in greater pressure on the environment and its climate. These activities generate GHG emissions, causing global warming and hastening the effects of climate change. Between 1880 and 2012, the global average of land and ocean temperatures increased by 0.85 (0.65–1.06)°C (IPCC, 2018a). These changes have significant impacts on the environment, particularly in the ASEAN region, where climate change can cause more frequent and severe floods and TCs, as well as more intense, longer, and wider-ranging droughts.

To summarise the IPCC's SR 1.5°C, anthropogenic emissions alone have caused approximately 1.0°C of global warming (defined from a 30-year average) above pre-industrial levels (IPCC, 2018a). It is with high confidence that IPCC predicts that global warming of 1.5°C will occur between 2030 and 2052. The average temperature during the decade 2006–2015 was 0.87°C higher than that of the period 1850 – 1900. This temperature is continuing to increase by 0.2°C per decade as the effect of both historical and present-day GHG emissions. The extent of warming is more apparent over land than ocean and is up to three times higher in the Arctic region. All of these effects are forecast to persist on a significant time scale. However, the SR 1.5°C also mentions that sustaining net zero anthropogenic global carbon dioxide (CO2) emissions could significantly reduce or halt global warming (IPCC, 2018a). Over longer time scales, sustaining negative total anthropogenic emissions can contribute to the prevention of further global warming.

The potential global temperature rise of 1.5°C could trigger massive destabilising climate events impacting global society as soon as 2040, particularly in the ASEAN region (IPCC, 2018b; Tatarski, 2018). Considering the changes in MHR scores of the ASEAN Member States (where only Brunei Darussalam had a decrease in its MHR score from the previous year), global warming of 1.5°C is likely to exacerbate many of the vulnerabilities of the ASEAN countries. The following list highlights the current vulnerabilities and natural hazards posing risks to the ASEAN Member States:

- Brunei Darussalam is highly vulnerable to the impacts of climate change, including increased risks from flooding, heat-related mortality, occupational health hazards, and water scarcity for agricultural production (Brunei Darussalam INDC, 2015).
- Potential impacts of climate change in Cambodia will be evident in hydrometeorological events such as floods, storms, TCs, and droughts. These events will likely impact the population's livelihood, as 90% of people in the country engage in agricultural activities, and 80% rely upon

subsistence crops (UNDRR, 2019a; U.S. Agency for International Development (USAID), 2019).

- Extreme weather events caused by climate change will directly impact the environment, livelihood, health, and even mortality of the population of Indonesia. By 2050, the cost of impacts of extreme weather events relating to climate change will likely amount to approximately USD 8.8 billion (Haryanto, Lestari, & Nurlambang, 2020).
- Flood and drought conditions in Lao PDR, which is highly susceptible to climate change and natural hazards, will seriously affect its agricultural production. Increased frequency and intensity of extreme weather events such as flooding, drought, and late-onset of the rainy seasons will all affect the agricultural sector (Food and Agriculture Organization, 2019).
- Extreme variations in rainfall in Malaysia, worsened by global warming, will be detrimental to the country's water resources. Climate change is likely to cause water shortages, affect water cleanliness, increase possibilities of heat-related illnesses, and cause massive population displacements (Norshidi, 2018).
- Myanmar has had extreme weather-related fatalities and losses in the past two decades (1988 – 2017); the impacts of rising sea levels, extreme heat, and severe weather events due to climate change will be catastrophic in the country (Nortajuddin, 2020).
- In the Philippines, the climate change risk profile by USAID (2017) projects temperatures of 1.8°C to 2.2°C above pre-industrial levels by 2050, wetter wet seasons and drier dry seasons, increasing incidence of extreme weather and hazard events, and a 0.48 to 0.65 m rise in sea levels by 2100. The impacts of these factors will primarily affect the country's agricultural economy, coastal ecosystems and services, water resources, energy production, infrastructure and services, and human health (USAID, 2017).
- As a low-lying island at only 15 m above sea level (with 30% only 5 m above sea level), Singapore's most immediate climatic threat is sea level rise. Climate change will also affect national water resources through increasing droughts and flash floods, and temperature change may negatively affect biodiversity. Public health is also at risk from the higher likelihood of vector-borne diseases and heat stress, and food security may fluctuate because of the country's dependence on imports from other areas experiencing the impacts of climate change (National Climate Change Secretariat, n.d.).
- Thailand will experience higher risk of impacts of more frequent and severe floods and droughts as a result of climate change. The V of its coastal communities will also increase due to the sea level rise likely to accompany a global temperature rise of 1.5°C (OpenDevelopment Thailand, 2018).
- Due to its diverse geography and high V with regards to climate change impacts, Viet Nam will experience increased risk relating to typhoons, landslides, flooding, and droughts in the coming years (Tatarski, 2018).

The Paris Agreement underscores the importance of limiting global warming to reduce the risks and impacts of climate change. Adaptive measures are also important for coping with the impacts that do occur. However, a report by the Asian Development Bank (ADB) noted an "emissions gap" in illustrating scenarios of CO2 emissions from fossil fuel combustion (ADB, 2019). The gap indicates that with the current policies of the Asia-Pacific region, CO2 emissions are likely to rise steadily from 15,000 metric tons in 2015 to more than 20,000 metric tons by the year 2040. The Paris Agreement introduced Nationally Determined Contributions that would result in less than 20,000 metric tons of regional emissions in the year 2040.

Climate change will also drastically alter the disaster riskscape of the region. More frequent, intense, and longer-lasting extreme weather events will become the new normal, and all ASEAN Member States, including those with strong CCs, will be increasingly vulnerable. While all Member States have already committed to mitigating and adapting to climate change, additional actions are necessary now more than ever.

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Food at Risk: The Repercussions of Climate Change and Drought in the Lower Mekong Region

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ARMOR

Abstract

The observable effects of climate change on agriculture and agricultural water management increasingly demonstrate that long-term climate risk will have direct impacts on agriculture and food security in Southeast Asia. The frequency of natural disasters has been increasing, and several studies have highlighted that drought is one of the most recurrent natural disasters. Over time, the increasing frequency of droughts has especially affected countries in the Lower Mekong region, causing them to face severely dry conditions. Prolonged dry periods result in loss of crops and directly impact food security and farmers' livelihoods. Due to their slow onset, the initial detection of drought disasters can be challenging; however, monitoring tools can reduce reaction time and mitigate the consequences.

This article observes the effects of the geographical shift of drought patterns in Southeast Asia, specifically focusing on the Lower Mekong countries and the impacts on food security. The study aims to understand the current drought trends in the region, the projected geographical shift, likely impacts on food security, and potential long-term interventions. The article also analyses some of the current and previous drought initiatives in the region to determine how they may be helpful towards improving the decision-making process. It will further demonstrate how Lower Mekong countries can maximise the impacts of their investments by implementing a comprehensive portfolio of sectoral investments and policies that jointly address the issues of inequality, poverty, and disaster risk.

Keywords: Drought, Lower Mekong, geographical shift, food security

3.1 Introduction

Dry periods are frequent in Southeast Asia, with the most severe events taking place in concurrence with the El Niño natural phenomenon. The increasing frequency of dry periods in recent years has resulted in severely dry conditions and extreme drought, particularly affecting the Lower Mekong countries. Although drought impacts many sectors of life, it especially affects agriculture and can thus lead to food insecurity (Syaukat, 2011). Prolonged drought can lead to water scarcity and decreased household access to clean drinking water and sanitation for large populations: over the past 30 years, droughts have affected over 66 million people in Southeast Asia (United Nations Economic and Social Commission for Asia and the Pacific (ESCAP, 2019b).

Agriculture absorbs about four-fifths of the economic impact of drought. However, the effects extend to both demand and production in industry and services. The scale of the impact of drought depends on the extent, intensity, and duration of prolonged deficient precipitation. The outcome also varies according to land use patterns, local conditions, and water usage (ESCAP, 2019b).

According to the Intergovernmental Panel on Climate Change (IPCC), the temperature across Southeast Asia has been increasing at a rate of 0.14°C to 0.20°C per decade since the 1960s, coupled with a rising number of hot days and warm nights and a decline in cooler weather (Stocker et al., 2013). If droughts intensify in lowland Southeast Asia, the synergies between heat, drought, logging, fragmentation, fire, and tree mortality will further worsen the conditions, resulting in deforestation, smoke aerosols, and reduced rainfall, which could significantly increase the vulnerability of fragmented forest landscapes.

For much of Southeast Asia, an increase in frequency and duration of drought as a result of declining rainfall trends or rising temperatures is a major concern. Drought may lead to wildfires and smoke exposure that increase morbidity and mortality, as has already occurred in the region (Johnston et al., 2012). Frequent droughts can negatively affect agricultural production, increase water demand for irrigation, and exacerbate the already existing water crisis and human-induced desertification. If it disrupts food security, drought can also increase malnutrition (Kumar et al., 2005) and susceptibility to infectious diseases. Floods, droughts, and changes in seasonal rainfall patterns negatively impact crop yields, food security, and livelihoods in vulnerable areas (Dawe, Moya, & Valencia, 2009; Douglas, 2009; Kelkar, Narula, Sharma, & Chandna, 2008), affecting especially small farmers, agricultural labourers, and small business owners with the least access to rural safety net mechanisms and financial services.

The Lower Mekong River Basin covers an area of approximately 606,000 km2 across Cambodia, Lao People's Democratic Republic (PDR), Thailand, and Viet Nam, and more than 60 million people in the region rely heavily on natural resources, particularly agriculture and fisheries, for their well-being and livelihood (Hijioka et al., 2014). The increased frequency in the occurrence of drought in the region has led to prolonged dry periods in recent years. The effects of the 2014/2016 El Niño event, one of the strongest since that of 1997/1998 (ESCAP & Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES), 2015), further compounded the already fragile agricultural ecosystem of the region. The El Niño Advisory Notes prepared by ESCAP and RIMES (2015) suggest that the effects were severe in specific locations including Cambodia, the central and southern parts of India, the eastern part of Indonesia, Papua New Guinea, the central and southern parts of the Philippines, the central and north-eastern parts of Thailand, and other Pacific Island countries.

This study seeks to understand the drought conditions in the Lower Mekong countries and their probable impacts on food security for the region. The article will briefly touch upon the current drought trends and the projected geographical shift of drought patterns, as well as their anticipated impacts in the long run.

3.2 Geographical Scope

The Lower Mekong region comprises five countries, namely Cambodia, Lao PDR, Myanmar, Thailand, and Viet Nam (Figures 3.1a to 3.1f).

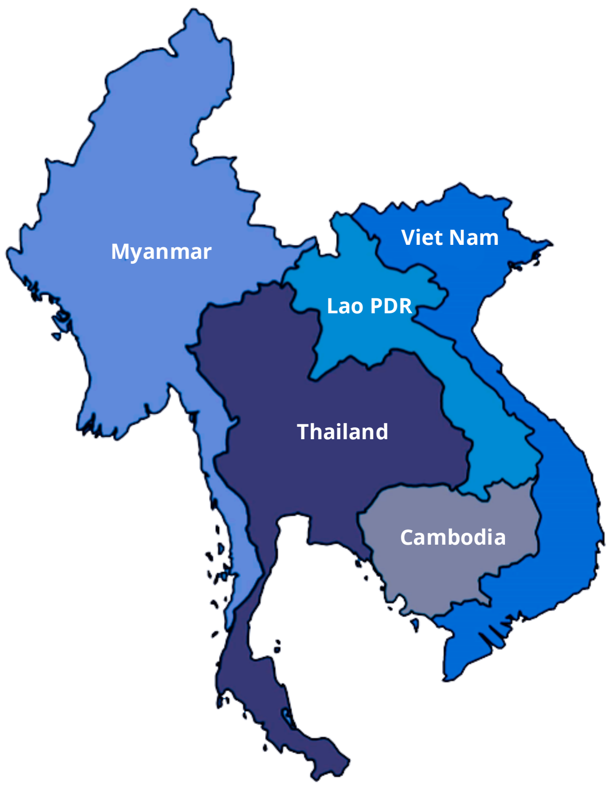


Figure 3.1a
Map of Lower Mekong countries (source: Nature Earth Data)

Figure 3.1b
Country profile of Cambodia

Cambodia

Total Area: 181,040 sq. km
Location: Inter-Tropical Convergence Zone
Climate: Tropical
Seasons: The dry season (November-April) and the wet season (May-October)
Borders: Thailand to the west, Lao PDR to the north and Viet Nam to the east. Shares boundary with Mekong River Basin, China and Myanmar
Tonle Sap River occupy approximately 2.2% of the total area of the country

Source: FAO AQUASTAT, 2011a

Figure 3.1c
Country profile of Lao PDR

Lao PDR

Total Area: 236,800 sq. km
Location: Inter-Tropical Convergence Zone
Climate: Tropical
Seasons: Rainy season (Mid-April to Mid-October)
Average annual Rainfall: 1,834 mm
Borders: China to the north, Viet Nam to the east, Cambodia to the south, Thailand to the west and Myanmar to the northwest
Arable Land: 1.360 million ha
Area under Permanent Crops: 108,000 ha

Source: FAO AQUASTAT, 2011b

Figure 3.1d
Country profile of Myanmar

Myanmar

Total Area: 676,590 sq. km
Location: Inter-Tropical Convergence Zone
Climate: Tropical Monsoon
Seasons: Southwest monsoon (May to October) and Northwest monsoon (December to March)
Average annual Rainfall: Dry zone <1,000 mm and Delta region 2,500 mm
Borders: Bangladesh to the west, India to the northwest, China to the northeast and Lao PDR and Thailand to the east
Total Cultivable Area: 18.3 million ha

Source: FAO AQUASTAT, 2011c

Figure 3.1e
Country profile of Thailand

Thailand

Total Area: 513,120 sq. kim
Location: Inter-Tropical Convergence Zone
Climate: Tropical
Seasons: Rainy season (May to October and October to February)
Average annual Rainfall: 1,622 mm
Borders: Myanmar to the north and northwest, Lao PDR to the northeast, Cambodia to the east and Malaysia to the south
Cultivable Area: 26.79 million ha
Area under Rice Crop: 15.3 million ha
Area under Permanent Crops: 3.695 million ha

Source: FAO AQUASTAT, 2011d

Figure 3.1f
Country profile of Viet Nam

Viet Nam

Total Area: 331,052 sq. km
Location: Inter-Tropical Convergence Zone
Climate: Northern Viet Nam: Sub-tropical climate
Southern Viet Nam: Tropical climate
Seasons: Northern Viet Nam: spring, summer, autumn, and winter seasons and Southern Viet Nam: dry and wet seasons
Average annual Rainfall: 1,820 mm
Borders: China to the north, the South China sea to the east and south, Gulf of Thailand to the southwest, Cambodia and Lao PDR to the west

Source: FAO AQUASTAT, 2011e

3.3 Methodology

The study uses existing tools, data platforms, and techniques available at the global, regional, and national levels to understand drought trends and determine whether these show the pattern that the study aims to analyse. Their implementation will also help validate to some extent their applicability in the context of drought monitoring and early detection. The different tools used in the study include the Climate Engine, the Agricultural Stress Index System (ASIS) developed by the Food and Agriculture Organization (FAO), the Global Agricultural and Disaster Assessment System (GADAS), the Regional Drought and Crop Yield Information System (RDCYIS) of Lower Mekong, and climate scenarios such as those in the Representative Concentration Pathway (RCP) database.

3.3.1 Climate Engine

Climate Engine uses Google Earth for on-demand processing of satellite and climate data via a web browser (Climate Engine, n.d.). Capabilities and characteristics of the platform include the following:

- Unprecedented access for visualising and interacting with Earth observation datasets
- Ability to overcome the computational limitations of big data for use in real-time monitoring and research contexts
- Ability to download or share results rather than processing entire data archives locally
- Full customisability for spatial and temporal analyses, and
- Ability to provide early warning indicators of climate impacts such as drought, wildfire, agricultural production, and ecological stress.

Climate Engine can also carry out anomaly mapping as well as time series and statistical analyses. It can instantly display maps in GeoTIFF format or through web URLs, and time series results in Excel or CSV format. The development of Climate Engine resulted from a partnership between the Desert Research Institute, the University of Idaho, and Google through a Google Faculty Research Award called the White House Climate Initiative (Figure 3.2).

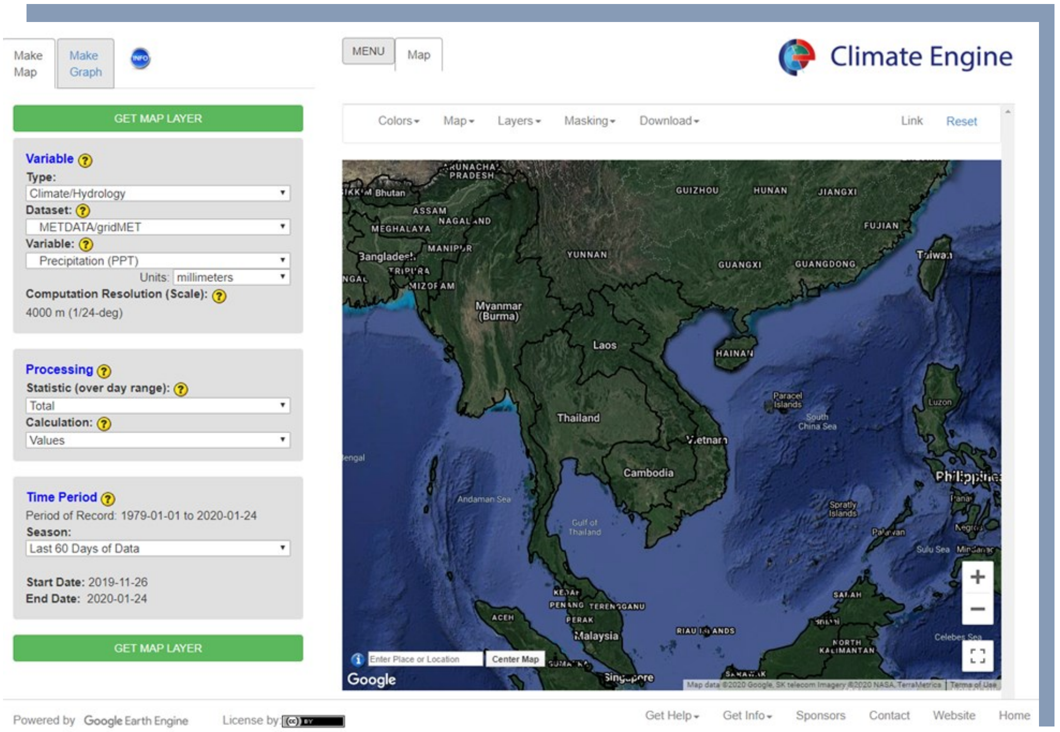


Figure 3.2

Climate Engine platform (source: Desert Research Institute and University of Idaho).

3.3.2 FAO ASIS

Figure 3.3

ASIS (source: FAO, 2015).

ASIS uses 10-day (dekadal) satellite data of vegetation and land surface temperatures from the Advanced Very High-Resolution Radiometer sensor on board the Meteorological Operational Satellite at 1 km resolution (FAO, 2015). It relies on the Vegetation Health Index derived from the Normalised Difference Vegetation Index (NDVI) and developed by Felix Kogan from the Center for Satellite Applications and Research of the National Environmental Satellite, Data, and Information Service. ASIS was successfully applied to several different environmental conditions in Asia, Africa, Europe, North America, and South America.

ASIS allows users to fine-tune its parameters based on national crop statistics and detailed land use maps. At the country level, ASIS can aid in developing a remote-sensing-based index for crop insurance. The Index assesses the severity (intensity, duration, and spatial extent) of agricultural drought and expresses the final results at the administrative level, granting the possibility to compare results with the agricultural statistics of the country (Figure 3.3).

3.3.3 GADAS

GADAS is an interactive global web analysis system capable of displaying, comparing, analysing, and sharing geospatial data. It is a powerful visualisation tool relying on an ArcGIS platform that enables analysts and other users to rapidly assess real-time crop conditions using a wide variety of data layers from several sources. GADAS integrates an array of highly detailed data streams, including daily precipitation data, vegetation indices, crop masks, land cover data, irrigation and water data, elevation and infrastructure data, political data, and more. The platform incorporates real-time data streams into GADAS for worldwide monitoring, tracking, and pre- and post-disaster agricultural assessments resulting from typhoons, hurricanes, floods, tsunamis, earthquakes, droughts, and volcanic eruptions (Figure 3.4).

Applications of GADAS include:

- Drought monitoring
- Natural disaster assessment and analysis
- Tracking current and historical disaster events
- Spatial modelling of potential disaster impacts
- Highlighting regional risk posed by natural disasters
- Environmental change detection studies and analysis
- Comparative climatic and satellite-derived vegetation analysis
- Global agricultural monitoring and commodity forecasting
- Delineation of major land use categories worldwide
- Regional planning and climate resilience studies, and
- Project-specific data archiving and mining.

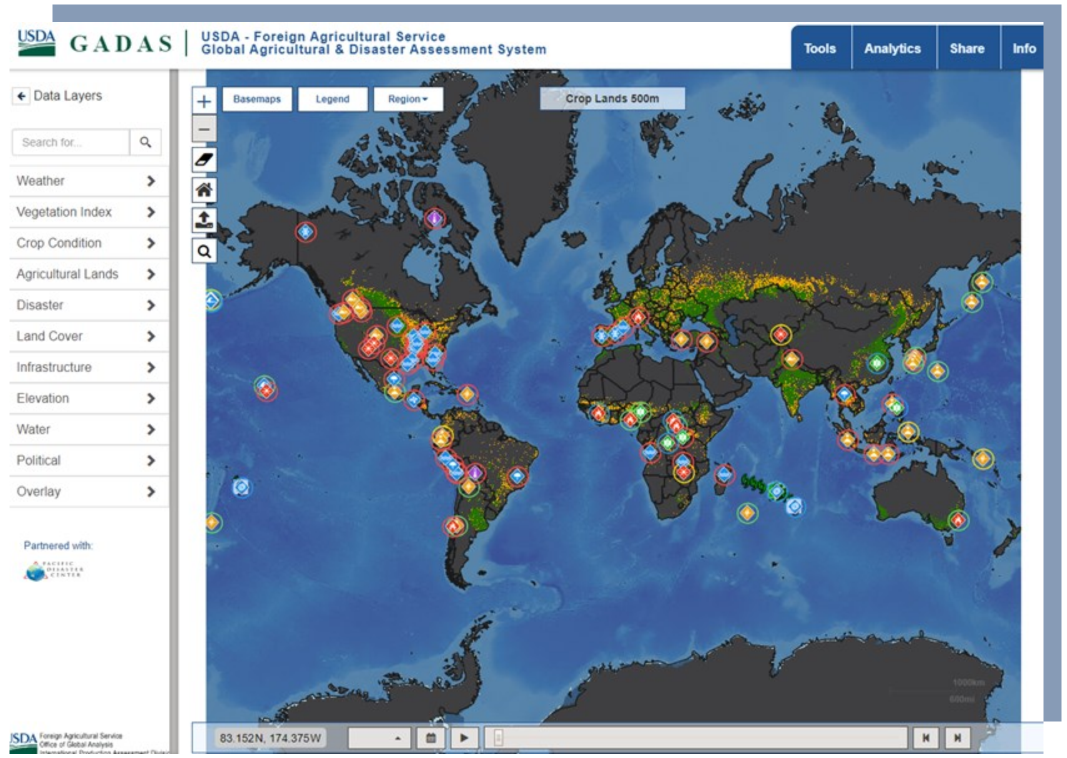


Figure 3.4
GADAS (source: United States Department of Agriculture, Foreign Agricultural Services).

3.3.4 RDCYIS of Lower Mekong

The purpose of RDCYIS is to address the need for drought preparedness, monitoring, and forecasting while assessing economic, social, and environmental impacts in the Lower Mekong countries. The system aims to provide insurers with documented and spatially explicit drought condition records to facilitate targeted decisions in the context of drought warnings, crop subsidies, and insurance programmes. RDCYIS deploys the Regional Hydrologic Extremes Assessment System (RHEAS), an integration of hydrological and crop simulation models developed by the National Aeronautics and Space Administration's Jet Propulsion Laboratory.

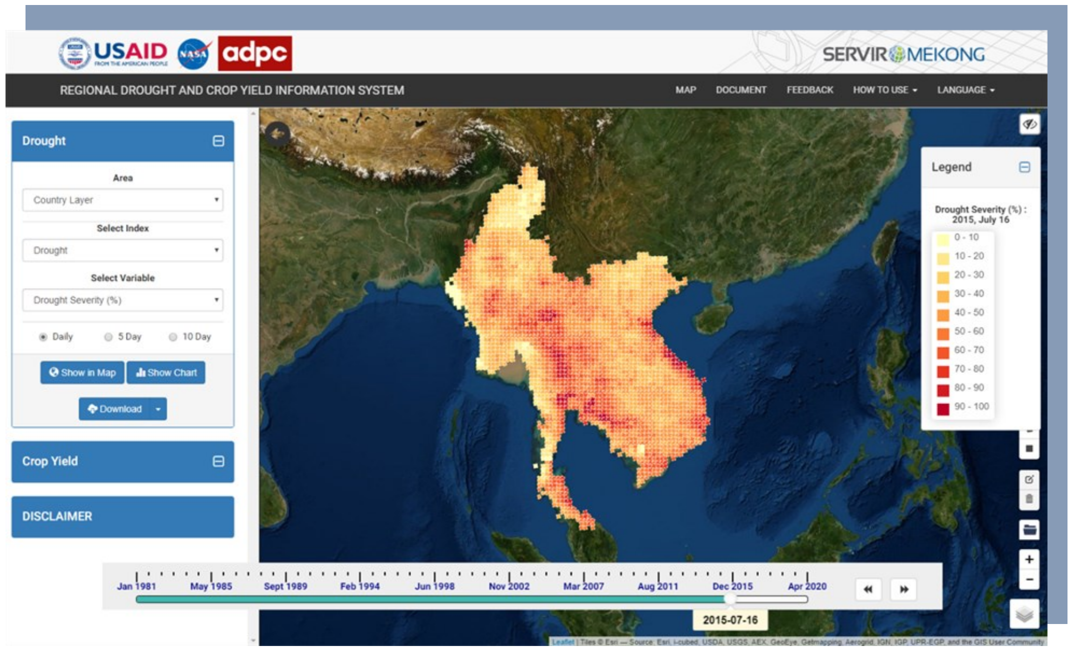


Figure 3.5
RDCYIS (source: Asian Disaster Preparedness Center, SERVIR-Mekong).

The Variable Infiltration Capacity model and the Decision Support System for Agro-Technology Transfer model, which automate the deployment of nowcast and forecast hydrologic simulations and ingest satellite observations through data assimilation, form the core of the RHEAS framework. The framework also allows the coupling of other environmental models and facilitates the delivery of data products to users via a geographic information system-enabled database. The ability of RDCYIS to simultaneously carry out nowcast and forecast within the framework enhances the currently existing resources and systems available for drought monitoring (Figure 3.5).

3.3.5 Climate Scenarios

A climate scenario is a plausible and simplified representation of a future climate projection based on an internally consistent set of climatological relationships and assumptions of radiative forcing (Santoso, Idinoba, & Imbach, 2008). RCPs are climate scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases, aerosols, and chemically active gases, as well as time series of land use and land cover (IPCC, n.d.). Each RCP provides only one representative pathway of many possible scenarios affected by specific radiative forcing characteristics. The term "pathway" emphasises that each RCP represents not only the long-term concentration levels but also the specific trajectory taken over time to reach that outcome.

Integrated Assessment Models from the IPCC Fifth Assessment Report produced four RCPs. Below is a brief summary of the details of each one:

- RCP2.6 is a pathway where radiative forcing peaks at approximately 3 W/m2 before the year 2100 and then declines (the corresponding Extended Concentration Pathway (ECP) assumes constant emissions after 2100).

- RCP4.5 and RCP6.0 are the two intermediate stabilisation pathways in which radiative forcing stabilises at approximately 4.5 W/m2 and 6.0 W/m2, respectively, after the year 2100 (the corresponding ECPs assume constant concentrations after 2150).
- RCP8.5 is a high pathway where radiative forcing reaches more than 8.5 W/m2 by the year 2100 and continues to rise for some amount of time (the corresponding ECP assumes constant emissions after 2100 and constant concentrations after 2250).

This study considers only RCPs 4.5 and 8.5 to understand the projected drought conditions based on return periods.

3.4 Results and Discussions

3.4.1 Drought Assessment

The different platforms used to observe the drought trends in the Lower Mekong region suggest that the area has been experiencing frequent drought conditions. The Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) pentad shows an irregular precipitation trend between May 2015 and December 2019 (Figure 3.6). Of particular interest is that the irregular patterns from May 2015 to mid-2016 coincide with one of the three most powerful El Niño events since 1950. NDVI measures the greenness of vegetation with an index value ranging from -1 to +1. High positive NDVI values correspond to dense and healthy vegetation, while low or negative values indicate poor vegetation conditions or sparse vegetative cover.

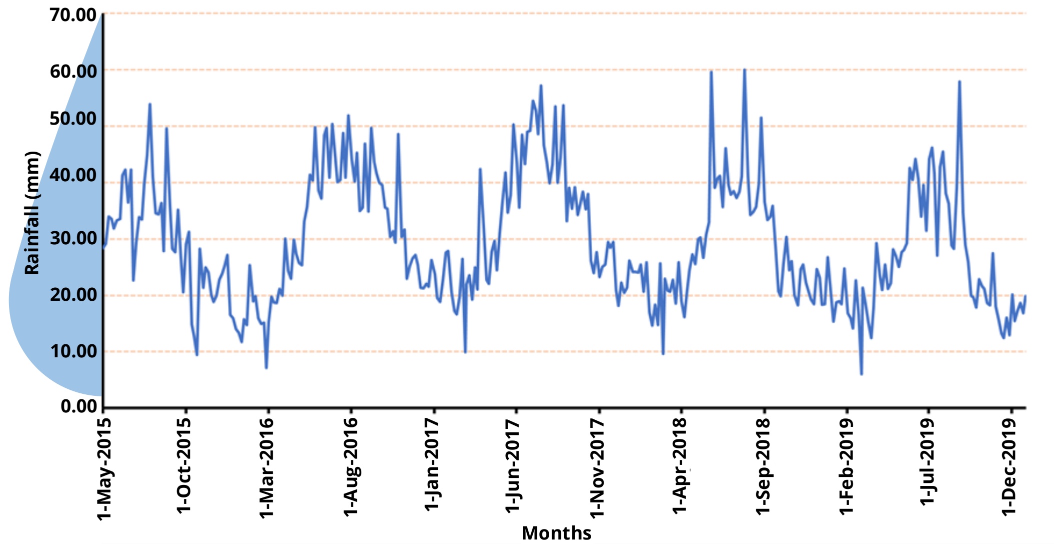


Figure 3.6

Precipitation trends from May 2015 to December 2019 from CHIRPS pentad (source: Climate Engine, n.d.).

During the year 2015, an NDVI anomaly showed that the Lower Mekong region, including Indonesia, was experiencing drought-type conditions based on the variations observed from the current dekad compared to the long-term average. A positive NDVI anomaly value signifies enhanced vegetation conditions compared to the average, while a negative value indicates comparatively poor vegetation conditions (Figures 3.7).

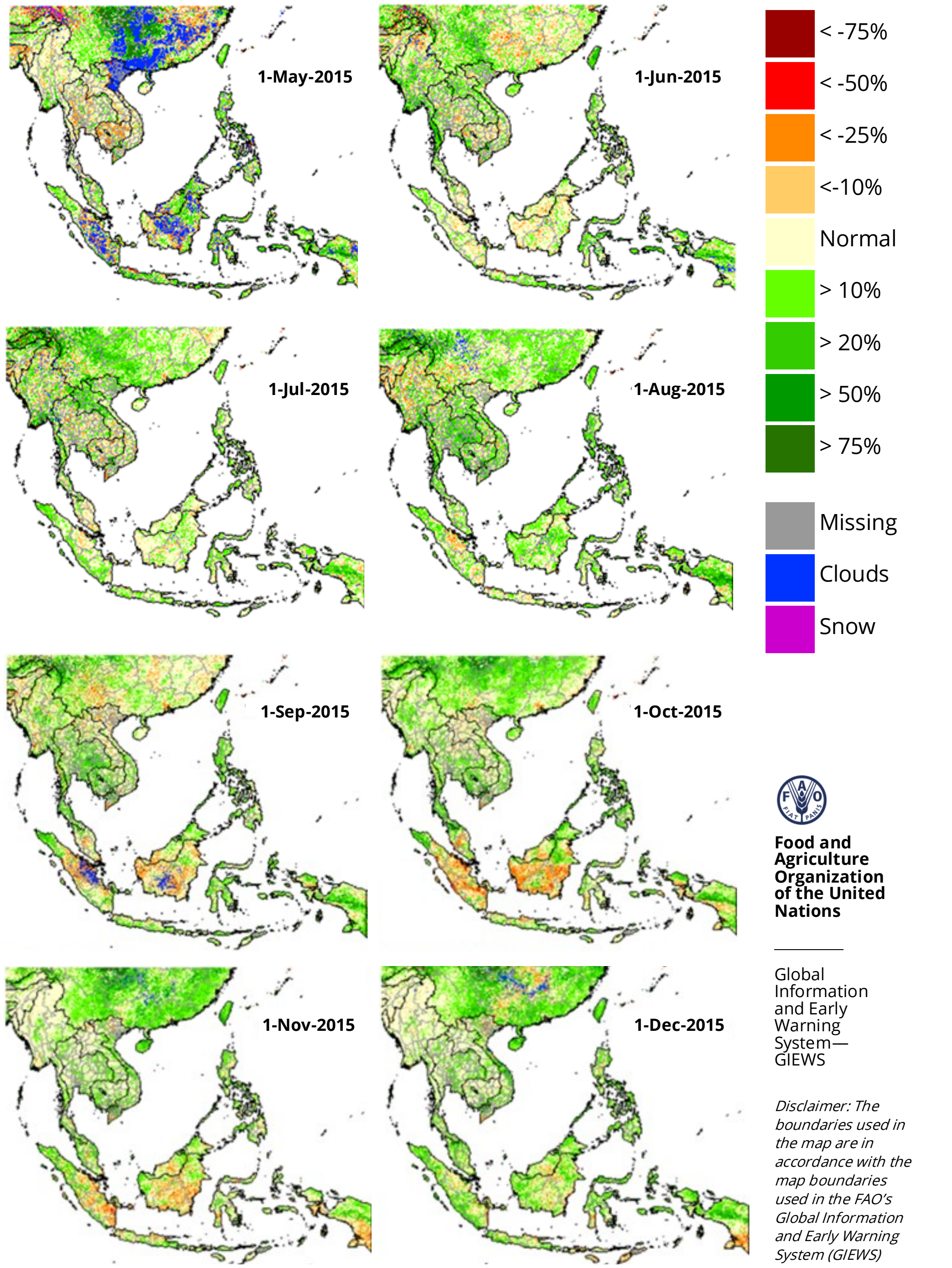


Figure 3.7

(a) Maps showing the NDVI anomaly from May to December 2015

From May to December 2015, the Lower Mekong region, including Indonesia, experienced below-average precipitation conditions. Myanmar's Dry Zone showed indications of drought conditions, while Cambodia, Lao PDR, Thailand, and Viet Nam showed signs of drought conditions in the south and central parts of the region. The NDVI observations also confirm that the Mekong Delta experienced drought during the El Niño period, and Indonesia experienced severe conditions between August and December 2015.

Myanmar's Dry Zone has experienced prolonged stressful conditions for years. Government agencies such as the Ministry of Agriculture, Livestock and Irrigation and the Department of Meteorology and Hydrology periodically monitor conditions on the ground. Satellite-derived data have shown that the Mandalay region in Myanmar's Dry Zone experienced severely stressful conditions during the 2014/2016 El Niño event, resulting in extended dry spells (Figure 3.8). 2014 and 2015 were the driest years on record in the region (Dutta, 2018).

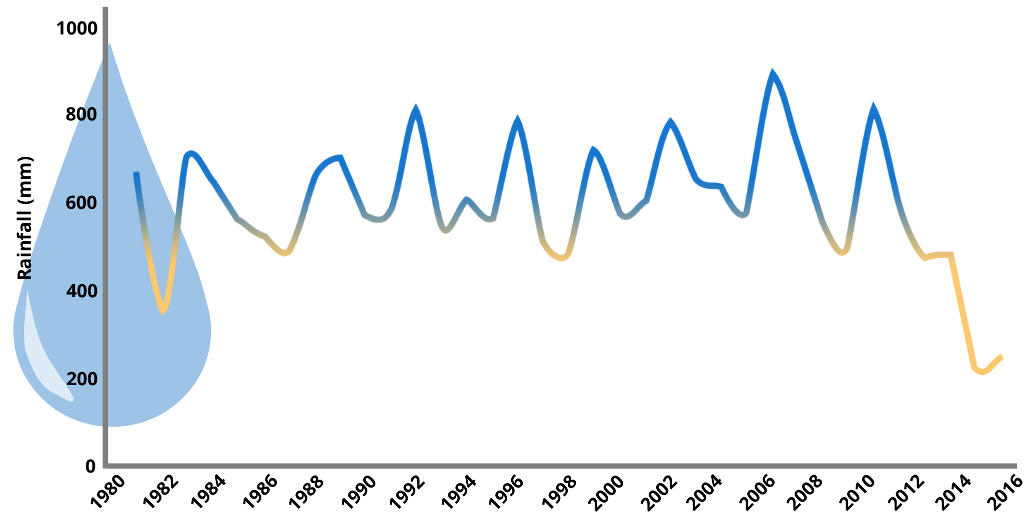


Figure 3.8

Rainfall pattern of Mandalay in the Dry Zone of Myanmar, 1981-2016.

The dry spells during 2014 and 2015 reduced Myanmar's agricultural yield, resulting in food insecurity. The water shortages and extremely high temperatures led to lower yields compared to previous years, and the effects continued even after the 2014/2016 El Niño event ended. Satellite data using NDVI measured the effect of rainfall on vegetation. NDVI quantifies vegetation by measuring the difference between near-infrared light (which vegetation strongly reflects) and red light (which vegetation absorbs). The NDVI and rainfall data show a strong R2, suggesting that rainfall directly relates to vegetation conditions (Figure 3.9).

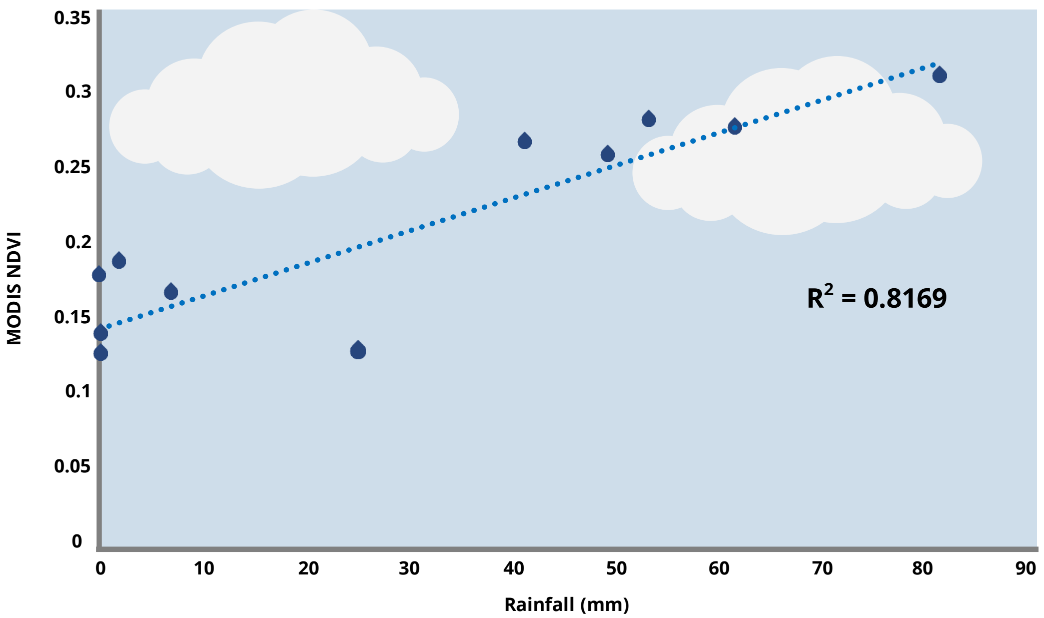


Figure 3.9
Rainfall and NDVI in the Mandalay Region, 2015.

Water shortages, drought, land degradation, loss of livestock, and reduced agricultural productivity in Cambodia affected about 2.5 million people during the 2014/2016 El Niño period. Drought impacted almost 250,000 ha of cropland and destroyed over 40,000 ha of rice crops in 2015 (ESCAP, 2019b). In Myanmar, an estimated 300 villages suffered from water shortages, and the country experienced extreme temperatures, dry soil, unusual rainfall patterns, high risk of fires, and acute water shortages (ESCAP, 2019b). The 2014/2016 El Niño event resulted in the worst drought that Viet Nam had experienced in 90 years, affecting 52 out of 63 provinces. Additionally, in some coastal areas, saltwater intrusion extended up to 90 km inland, making river water too salty for human and animal consumption, crop irrigation, and fish farming. During the peak of the drought (February–May 2016), about 2 million people lacked access to water for consumption and domestic use, 1.1 million experienced food insecurity, and more than 2 million faced damaged or lost livelihoods. The risks of water-related diseases and severe acute malnutrition in the region increased significantly. For 18 drought-affected provinces, the total recovery needs from October 2016 to 2020 equalled USD 1.2 billion (ESCAP, 2019b).

In Indonesia, 16 of the 34 provinces reported drought, while a total of 43 districts in eight provinces faced extreme drought. One of the most severely affected provinces was Nusa Tenggara Timur, where high levels of poverty and malnutrition exacerbated the impacts of the drought. In Nusa Tenggara Timur, 500,000 people needed immediate food assistance, and an additional 700,000 were at risk of food insecurity (ESCAP, 2019b). In February 2016, the Government of Thailand announced that 28 provinces throughout the country were likely to be at risk of water shortages (ESCAP, 2019b).

While the 2014/2016 El Niño caused widespread damage to agriculture and increased food insecurity in the Lower Mekong region, it also left a trail of after-effects resulting in more frequent droughts occurring in the region over time. Recent assessments of conditions in the region show evidence of an ongoing drought in the Lower Mekong region affecting parts of Cambodia, Thailand, and Viet Nam. NDVI anomaly data from FAO ASIS indicate that the region is experiencing below-average to severe conditions (Figure 3.10).

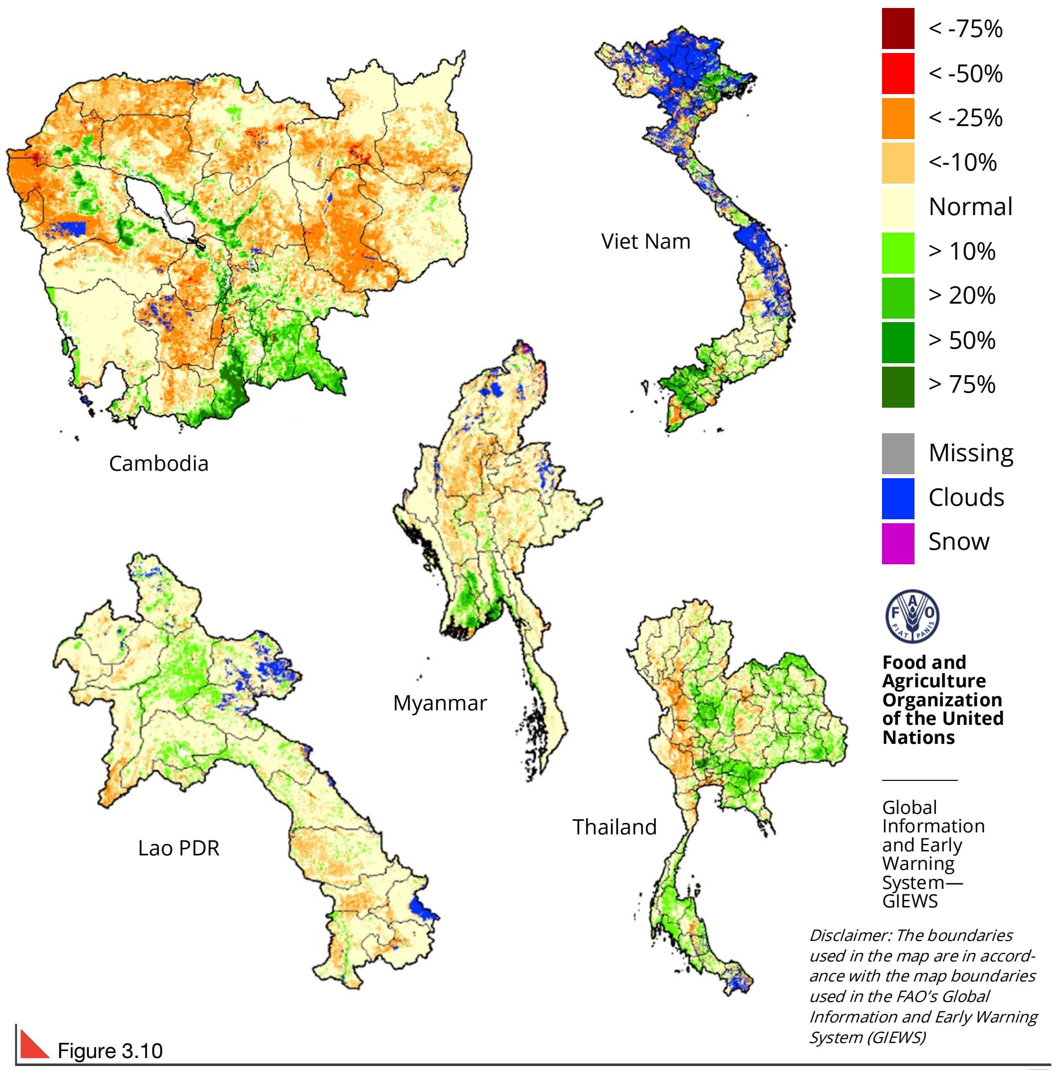


Figure 3.10

Country-wide NDVI anomaly from FAO ASIS (January 2020).

The Standardized Precipitation Index (SPI) deriving from CHIRPS data generated by GADAS further confirms severe to extreme drought conditions prevailing over Lower Mekong countries, including Indonesia. The SPI for January 2020 shows prevalent severe to extreme conditions towards the south of Cambodia, Thailand, and Viet Nam, as well as parts of Indonesia and Malaysia (Figure 3.11).

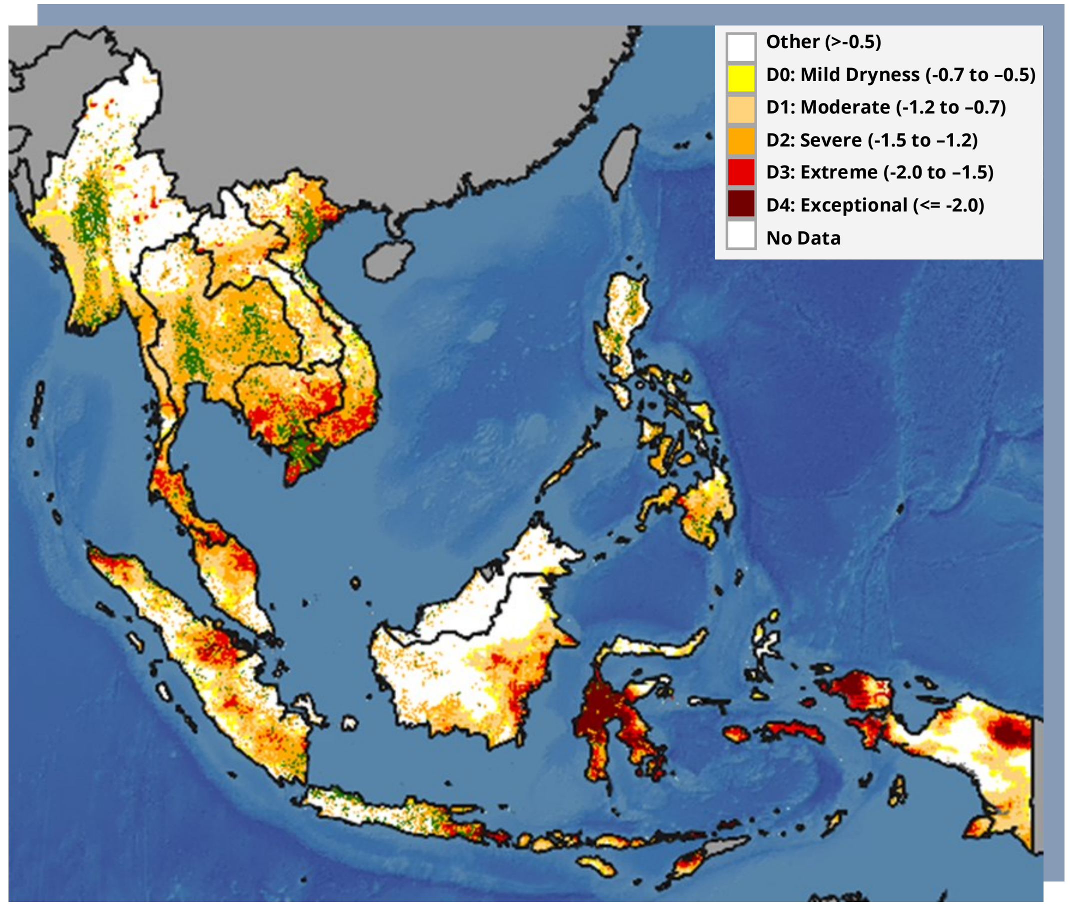


Figure 3.11

SPI showing current drought conditions in the Lower Mekong region (January 2020).

The precipitation map deriving from CHIRPS data for the Lower Mekong region (including Indonesia) for the same period as that of the SPI also suggests that the area has been experiencing inadequate rainfall (Figure 3.12).

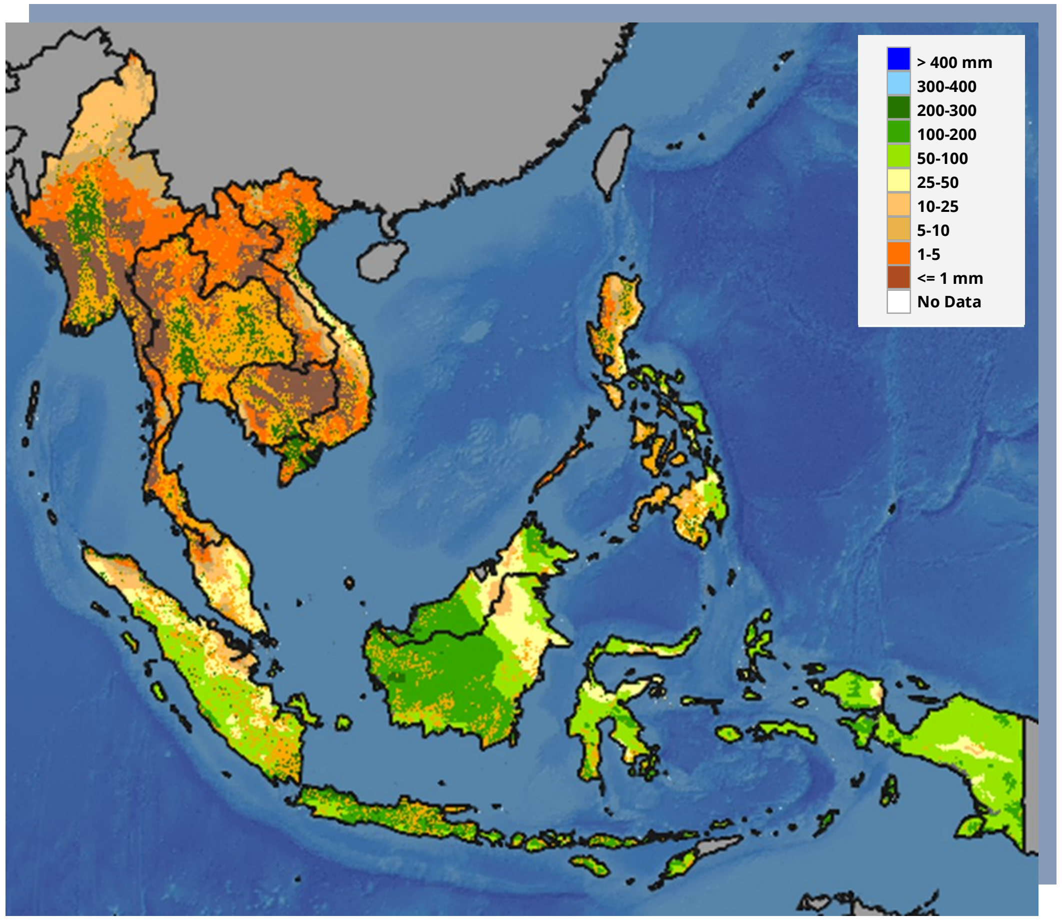
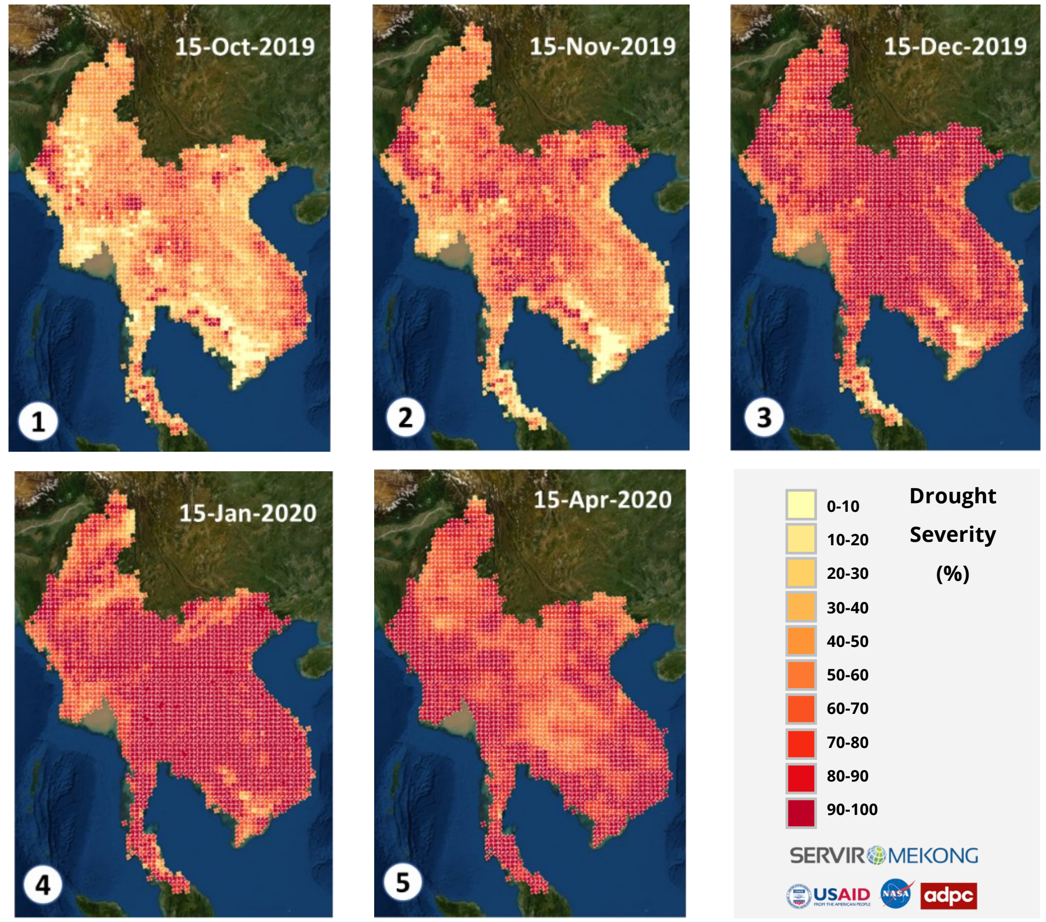


Figure 3.12

Precipitation map derived from GADAS using CHIRPS data for the Lower Mekong region (January 2020).

The GADAS analysis indicates that continuing severe to extreme conditions will significantly affect the agricultural sector, leading to a loss of crops and a decline in production, as well as directly impacting the farming community's source of income and livelihood. Increased ecological stress will therefore have additional consequences, including increasing the overall socio-economic vulnerability and causing degradation of agricultural land. Due to the timing and intensity of drought, there exists a likely possibility of crop failure leading to direct increases in the community's food insecurity, causing hunger. Crop failure will also increase poverty, as farmers will have no produce to sell, triggering a negative multiplier effect as their incomes drop.

The results from RDCYIS also suggest that there are ongoing drought conditions in the Lower Mekong region, with drought severity maps indicating severe conditions. While maps 1, 2, 3, and 4 in Figure 3.13 show the drought severity at intervals starting in October 2019 and ending in January 2020, map 5 shows the three-month drought severity forecast for April 2020. The forecast result indicates that the probability of severe conditions continuing until April or even beyond is greater than 90% (Figure 3.13).



Disclaimer: This product has been created with the highest degree of accuracy possible and depicts information at regional and national scales. Local conditions are subject to variations based on local climatic conditions. The product has been produced based on the latest available satellite and global modeled data and subject to update every two weeks.

Figure 3.13

Drought severity maps from RDCYIS.

3.4.2 Institutional Challenges that Prevent Countries from Effectively Using the Existing Drought Monitoring Tools

A paradigm shift in terms of effective monitoring of drought conditions in the Lower Mekong countries requires a stable and efficient drought monitoring system. However, at the national level, each country faces a unique set of challenges in developing an improved drought monitoring system that corresponds to its specific natural, social, economic, and political resources. As a result, each country may need to develop a different drought monitoring system according to its overall objectives and the information and technical resources that are available within it.

For the development of an effective monitoring system, all countries and organisations must take the same initial first step of completing a thorough investigation of all relevant information, resources, and tools available at the national, regional, and global levels. All countries in the Lower Mekong region have their own national meteorological services that provide climate information and predictions. However, the existing government structures in these countries often fragment the collection of agricultural and hydrological data among many agencies and ministries.

The World Meteorological Organization (WMO) highlighted several common challenges to the establishment of drought monitoring and early warning systems (EWSs) (WMO, 2006), including the following:

- The station density of meteorological and hydrological data networks is often inadequate for collecting all required climate and water supply parameters. Data quality is also problematic due to missing data or insufficient record length.
- Data sharing is often inadequate between government agencies and research institutions, and high data costs also limit their application.
- The information delivered through EWSs is often too technical and detailed for decision-makers to use effectively.
- Forecasts on the seasonal timescale are often unreliable and lack the specificity required for use in agriculture and other sectors.
- Drought indices such as the SPI or the Standardized Precipitation Evapotranspiration Index sometimes have a limited ability to detect the early onset and end of drought.
- Comprehensive systems should couple multiple climate, water, and soil parameters and socio-economic indicators that fully characterise a drought's magnitude, spatial extent, and potential impact. These types of data are often lacking or incomplete for many countries.
- The lack of standardised or widely available impact assessment methodologies, which are a critical part of drought monitoring and EWSs, hinders impact estimates and the creation of regionally appropriate mitigation and response programmes.
- The development of delivery systems for promptly disseminating drought information and data to users is often quite poor, limiting their usefulness for decision support. Additionally, the quality, collection, and dissemination of meteorological data are key factors for the reliability and use of the drought monitoring products.

While not necessarily a comprehensive list, these points illustrate several of the challenges that most of the Lower Mekong countries are facing in terms of the application of drought monitoring tools and services. Additionally, the lack of institutional capacity in most of these countries makes it difficult to successfully customise such systems at the national level. Building long-term internal capacity to fully understand the concepts and technology required to independently and sustainably operate and design technical tools and systems is crucial (ESCAP, 2019a). This capacity development requires constant multi-stakeholder engagement from the start of the process, in addition to the technical training.

3.4.3 Improving Drought Monitoring EWSs

Over time, drought monitoring and EWSs have advanced considerably. The occurrence of several severe drought events in the Lower Mekong region emphasised the issue of countries needing to set up effective drought monitoring and early warning mechanisms for improved decision-making. National and international agencies have come together to improve their ability to predict food insecurity in the region while also working closely with national governments to implement several EWSs to monitor drought signals that may indicate the likelihood and magnitude of food insecurity.

Many tools are currently available in the region, providing abundant information and data to monitor and forecast drought. In an ongoing process, the region has been able to enhance its ability to monitor and disseminate critical drought-related information by integrating new technologies such as automated weather stations, improved satellite observations, advanced computing technology, and improved communication techniques. However, the region still lacks a comprehensive system in which drought monitoring tools are part of a single EWS that can provide decision-makers with further improved and timely information. Moreover, an EWS using improved drought monitoring tools can only trigger timely and appropriate preventive measures if a country has adequate institutional capacity to communicate and implement recommendations or advisories. Well-informed decision-makers can assess food security indicators to detect significant changes in food availability and advise on the likely occurrence of food crises due to drought in advance of a severe event.

3.4.4 Strengthening Drought Early Warning Services

Every country in the Lower Mekong region should have appropriate drought monitoring and EWSs in place to alert key sectors to potential threats while also providing social protection to the low-income groups that are most vulnerable to the direct impacts of drought. Accurate meteorological observations can also reduce risk by providing weekly, 14-day, and monthly forecasts that allow decision-makers to provide necessary advisories to farmers. Forecasts enable farmers to enact early response to drought in the form of mitigation measures and changes to their cropping cycle or calendar. Furthermore, near-real-time and in-season monitoring can complement longer-range forecasting to offer additional warnings several days ahead.

The Global Framework for Climate Services provides an initiative for undertaking drought forecasting and early warning services. The United Nations leads the initiative; its members, as well as inter- and non-governmental, regional, national, and local stakeholders work in partnership with WMO to develop targeted climate services. Other important regional institutions, such as the Association of Southeast Asian Nations (ASEAN) Coordinating Centre for Humanitarian Assistance on disaster management, the ASEAN Specialised Meteorological Centre, and RIMES, can provide regionally relevant datasets that are customisable by national hydrometeorological services. ESCAP, the ASEAN Secretariat, and WMO can help build the capacity of national hydrometeorological services to produce high-quality forecasts and early warning services for national and local decision-makers. In addition to increasing the quality of forecasts, it is also essential to build national capacity, particularly for national disaster management agencies, in order to understand, apply, and react to forecast information.

The ESCAP Regional Cooperative Mechanism for Drought Monitoring and Early Warning (Regional Drought Mechanism) is an appropriate intergovernmental platform for fostering regional cooperation through its long-standing Regional Space Applications Programme for Sustainable Development in Asia and the Pacific (ESCAP, n.d.). Through this mechanism, spacefaring countries can assist low-capacity, high-risk countries in using space applications for drought monitoring and EWSs. Several other government agencies and partners also support the development of practical tools and components for the Regional Space Applications Programme for Sustainable Development. The Regional Drought Mechanism provides drought-prone countries with the services, tools, capacity-building, and information that they need for building tailored drought-management programmes. These programmes should include drought monitoring and early warning tools linked with seasonal and climate forecasts, as well as catchment water balance tools. With these resources, countries should then be able to build a cross-sectoral system that links policies and strategies with space, hydrometeorological, census, and ground-level data.

3.4.5 Projected Geographical Shift of Drought

Climatological projections of future climate scenarios suggest that Southeast Asia is likely to experience geographical shifts in drought severity, with drought conditions becoming more severe in the region (ESCAP, n.d.). Rainfall variation (anomaly) and higher temperatures in the future will be the likely causes of severely dry conditions that have a high probability of leading to extreme drought. A study titled, Projected drought severity changes in Southeast Asia under medium and extreme climate change, published by the Royal Netherlands Meteorological Institute (Hariadi & van de Schrier, 2017) conducted an in-depth analysis of seven domains: North- and Southeast Asia (Cambodia, Lao PDR, Thailand, and Viet Nam), Borneo, Java, Papua, the Philippines, Sulawesi, and the Sumatra domain (Malaysia peninsula and Sumatra). The analysis covered three periods: the historical period (1971–2005), the near future (2021–2050), and the far future (2071–2100). It used the Palmer Drought Severity Index to measure drought severity and intensity and applied RCP 4.5 and RCP 8.5 for both near-future and far-future periods.

3.4.5.1 Projected Drought Conditions over a 30-Year Return Period

Considering a 30-year return period, the study found that drought areas primarily concentrated over the north and south of Viet Nam in the historical period. However, near-future scenarios show that the drought area in the southern part of Viet Nam will spread to Cambodia and the southern part of Thailand, with the region likely to experience severe drought conditions (Figure 3.14).

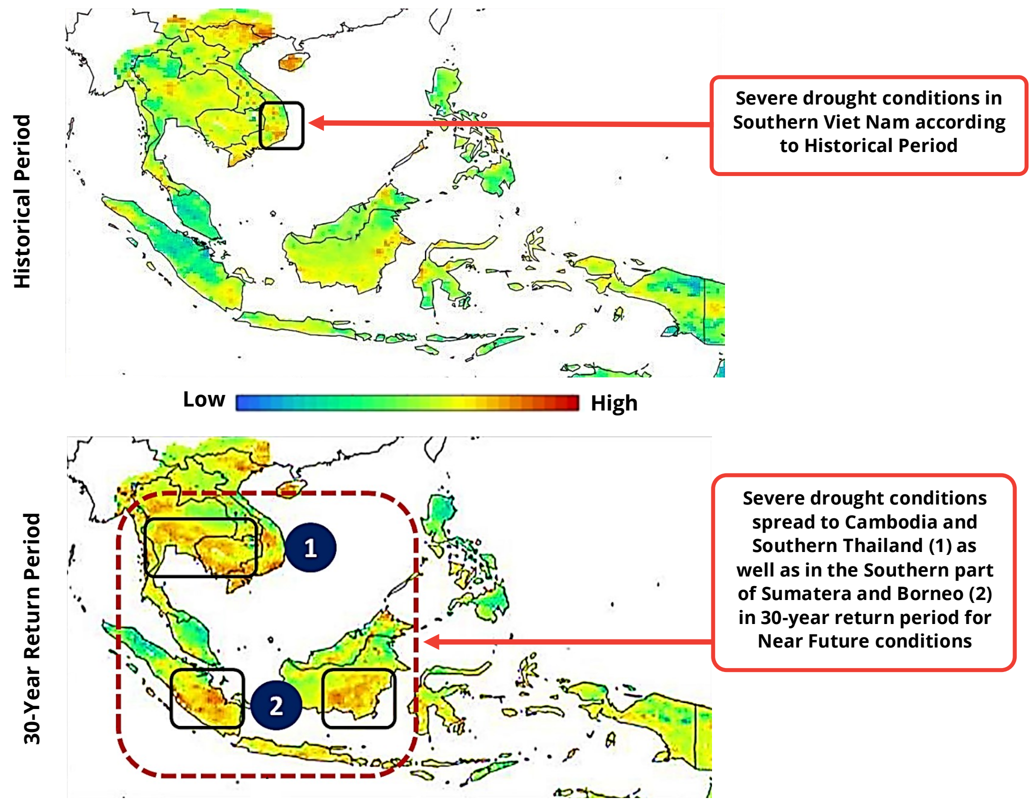


Figure 3.14
Projected drought conditions in a near-future scenario.

The far-future scenarios show that conditions are likely to become more severe, with moderate to extreme drought conditions likely to occur in every part of Cambodia and Thailand. The northern part of Viet Nam and some parts of Malaysia will likely experience extreme drought conditions, while Indonesia is likely to experience drought across the entire country (Figure 3.15).

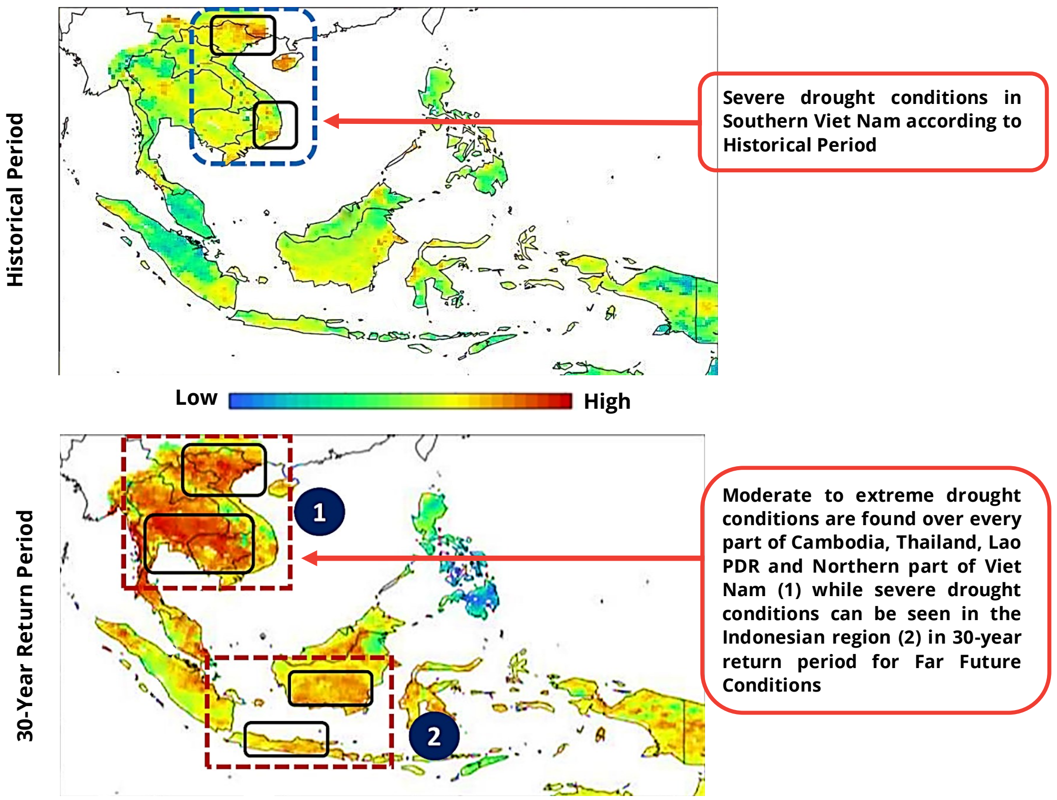


Figure 3.15
Projected drought conditions in a far-future scenario.

3.4.6 Drought and Food Security

Drought directly relates to poverty, inequality, food insecurity, and conflict. It can lead to environmental degradation and food scarcity, which may result in poverty and contribute to conflict over access to and unequal distribution of resources and land (ESCAP, 2019b). Drought also severely undermines food security due to decreasing agriculture production and increasing water scarcity.

The most direct result of drought on agriculture is a reduction in output, causing economic loss to farmers and, in turn, directly affecting the entire value chain, agricultural growth, and rural livelihoods. In the long term, loss of harvest and livestock, outbreaks of diseases, and the destruction of rural infrastructure and irrigation systems can have devastating effects on production capacity and the ability of affected communities to recover. If the drought is long-term, it can cause heat stress in crops, thereby damaging yields.

Assessments of the impacts of droughts are typically not adequate (FAO, 2018). This is in part because the indirect effects of recurrent and small-scale events (such as drought, flooding, reduced rainfall, etc.) can be challenging to identify and measure. In comparison, the direct, quantifiable effects (such as loss of life, loss of property, and destruction of infrastructure) of larger-scale climate-related disasters are more visible and easier to measure. However, both small- and large-scale phenomena can be equally destructive to vulnerable populations in the long term.

Because smallholders predominantly drive agriculture in the region, they disproportionately bear the burden of the loss and damage resulting from climate-related disasters. The risk of disruption from climate shocks for these farmers can lead to reduced consumption and increased liquidation of productive assets, resulting in a deterioration of the capacity to cope with future shocks (Porter et al., 2014). A combination of short-term events and long-term influences on poverty and food insecurity drives food crises. The outcome from a regional drought study for ASEAN Member States by ESCAP (2019) suggests that drought threatened food security and limited access to water for consumption and domestic use, affecting people's livelihoods. Therefore, tackling the impacts of drought in Southeast Asia has become a priority for ASEAN in addressing the growing needs of preventive solutions and measures to overcome the projected extreme conditions.

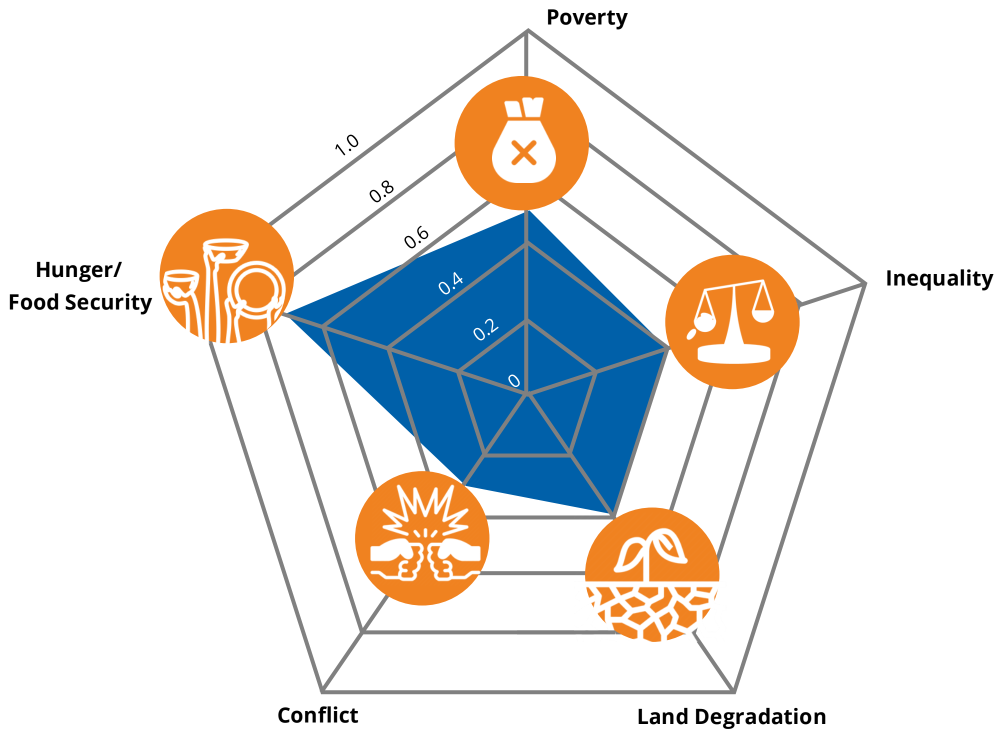


Figure 3.16
Standard scenario of drought impacts (source: ESCAP, 2019b).

It is clear that droughts compromise many aspects of food security by reducing both food supplies and the available incomes of poor communities. A study investigating subnational climate-conflict dynamics across Africa and Asia over the past 15 years observed that while drought is not the sole factor instigating a conflict, there is a powerful reciprocal relationship between armed conflict and local drought, wherein each phenomenon makes a group more vulnerable to the other (von Uexkull, Croicu, Fjelde, & Buhaug, 2016). The study also found that drought had a stronger association with conflict in countries or regions with a high dependency on agriculture, such as Southeast Asia. Another strong nexus the study found is between drought, poverty, inequality, hunger, land degradation, and conflict. Severe drought may hamper local food security, worsen the humanitarian situation, and instigate large-scale human migration and displacement. Droughts can lead to environmental degradation and food scarcity, which both exacerbate poverty and contribute to conflict over access to and unequal distribution of resources and land (Figure 3.16).

The scenario in Figure 3.16 shows that drought will have the most significant impact on poverty and hunger. A decrease in agricultural production and an increase in water scarcity due to prolonged drought will cause an increase in food insecurity. There will also be a decline in food supplies, and many poor and vulnerable communities will lose their sources of income. The cascading effects of prolonged drought will result in land degradation, which in turn will reduce agricultural productivity and lead to increased food insecurity and hunger. Crop failures will increase poverty, as farmers will have no means to sell their produce, resulting in a reduction in their source of income. However, while the poor struggle with negative consequences, the wealthier members of the community will still be able to cope with and absorb the shock. This disparity will result in increased inequality and poverty that may trigger conflict and migration.

3.4.7 Drought Risk Financing

Many risk financing tools suitable for intensive disasters such as floods and earthquakes may also be capable of supporting rural resilience against slow-onset disasters such as drought (ESCAP, 2019b). Fostering drought risk financing markets will require a paradigm shift from post-disaster financing to a model that plans financing in advance to achieve quick and efficient execution to save lives and protect livelihoods.

The model for social protection is also evolving. Rather than relying on post-event needs assessments, the goal is now to register recipients in advance. Instead of providing food aid, the focus is on making transfers to channel cash efficiently to those most in need. Such programmes find support in risk-financing tools that help manage global risk market capacity and developing country needs for budget stability. The African Risk Capacity (ARC) insurance agency, for example, has demonstrated that early warning combined with contingency planning and prior risk financing can reduce the overall impact of drought by four to five times. Since 2014 and over four risk pools, ARC has paid out an estimated USD 58 million to countries affected by drought. In 2015, three countries in the Sahel region (Mauritania, Niger, and Senegal) received a USD 26.3 million payout from ARC. The governments of the countries paid a combined premium of USD 8 million for drought insurance coverage, and the payout benefitted an estimated 1.3 million people and over half a million livestock. The funds, disbursed ahead of a United Nations appeal, were used to deliver quick and much-needed relief to affected populations.

In 2017, Malawi received a USD 8.1 million payout from ARC after having paid a premium of USD 4.7 million for drought coverage. The Government of Malawi used the funds to support over 800,000 Malawians by filling gaps in the scale-up on cash transfers and replenishing its strategic grain reserves. In 2018, ARC disbursed USD 2.4 million to the Government of Mauritania, which paid a premium of USD 1.4 million for drought coverage. The ARC payment was the first international funding that the Government of Mauritania received in response to a progressively severe drought, and the funds subsidised livestock feed for pastoralists in the most affected areas. As of 2019, the Government of Senegal received USD 23.1 million from ARC to assist in providing early action to support more than 975,000 people affected by drought during the agricultural season. ARC gave approximately USD 738,540 to the Government of the Republic of Côte d'Ivoire to provide rapid assistance to 32,496 people (6,500 households) in the central region of the country following severe rainfall deficits in the 2019 agricultural season.

Although agricultural insurance has provided a social protection mechanism for rural households, it is also expensive. Of Cambodia, Lao PDR, Myanmar, and Viet Nam, Viet Nam has moved furthest towards the introduction of agricultural insurance — but with mixed success. Initiatives to provide weather index insurance also proved disappointing when they deployed alone and at the individual farmer level. Linking these insurance mechanisms to other programmes within an integrated disaster risk framework makes them more effective. At the macro level, index insurance tools have had some success, and the financing benefits can flow quickly and efficiently to those in need.

Agricultural insurance first emerged in Viet Nam in 1982 with a small-scale pilot programme for rice farmers. Despite various plans and government policies since that time, the insurance market has struggled to grow due to several factors, including high costs, low awareness, and the need for subsidisation. Relatively small market shares led to inaccurate modelling and management of risks. As a result, less than 1% of crops in Viet Nam were under insurance as recently as 2010. Following decades of stagnant growth and substantial investments (including upgrading irrigation, strengthening flood protection, and improving pest and disease control measures), the Government of Viet Nam, in partnership with the country's two largest insurers and international reinsurers, implemented a three-year subsidised scheme in 2011 called the National Agricultural Insurance Pilot Programme (NAIPP) (Vulturius, Boyland, & Salamanca, 2017). The Government and its partners implemented the programme in 20 provinces, where it offers index-based insurance for rice and indemnity-based insurance for livestock and aquaculture against storm, flood, drought, cold temperatures, frost, tsunami, and saline intrusion (Organisation for Economic Co-operation and Development (OECD, 2015). The inclusion of saline intrusion as an insurable hazard is crucial, given the high risks faced by the Vietnamese Mekong Delta. However, the methods of measuring risks and assessing claims remain unclear. The Government subsidises between 60% and 100% of the insurance fees for participating farmers, depending on their degree of poverty. Nationwide, over 300,000 households participated in the programme, with 78% of them insuring rice crops, 20% insuring livestock, and 2% insuring aquaculture. The Government fully subsidised 77% of the participants (Ministry of Finance, 2014). Participation in the NAIPP has depended heavily on subsidies, and voluntary participation rates are very low, calling into question the long-term sustainability of such heavily subsidised programmes and the ability of insurances to provide continuous and uniform financial protection for farmers with limited incomes. However, promotion and awareness-raising campaigns seem to have improved the understanding of the benefits of insurance among farmers.

Another important aspect of drought risk financing is forecast-based financing, which is particularly relevant for slow-onset disasters such as drought. In forecast-based financing, the insurance company disburses funds prior to the event for increasing preparedness and resilience-building activities. However, basis risk is even more challenging to establish in forecast-based financing than in conventional index insurance. At the same time, even limited pre-disaster emergency financing could lead to significant resilience gains. Forecast-based financing heavily depends on remotely sensed datasets and will benefit at the regional level from the use of space-based data.

3.5 Conclusions and Recommendations

This study concludes that Southeast Asia, including the Lower Mekong region, is highly prone to slow-onset disasters such as drought. The frequency of drought in the region has increased considerably over the last 10 years, severely impacting the agricultural sector. The results from drought monitoring tools available at global, regional, and national levels suggest that such tools are beneficial for appropriate decision-making. However, the study also recognises that the countries do not widely use most of these tools to monitor or forecast drought conditions. This article, therefore, provides evidence towards the effectiveness and robustness of tools and services that provide ample amounts of information at very short notice, allowing the implementation of appropriate drought mitigation measures in the shortest possible time.

However, it is of note that several drought monitoring tools and services are currently available at the global, regional, and national levels. While such tools and services are providing near-real-time to real-time information on prevailing drought conditions, countries still do not widely or effectively implement them for decision-making purposes. This study aimed to efficiently use some of the available tools and services for the region such that the results can help understand the prevailing drought conditions in the Lower Mekong region. The results show that the outputs generated by these tools are useful for understanding the ground conditions and can therefore effectively help with drought monitoring, forecasting, and decision-making. The assessments also clearly demonstrate that customisation of these tools at the country level may further improve their accuracy and robustness.

The study further shows that drought severity in Southeast Asia, including the Lower Mekong region, is likely to see geographical shifts. Climatological conditions for future scenarios suggest that drought conditions are more likely to become severe or extreme in the region. Near-future and far-future scenarios show that drought conditions are likely to extend farther in the region and may result in more severe to extreme conditions. Increased drought will also increase food insecurity and affect community livelihoods, leading to poverty that may further aggravate or increase inequality and conflict. Considering the available tools and services and their benefits, countries should begin using them to gain near- to real-time information on prevailing drought conditions.

Tackling the impacts of drought in Southeast Asia and addressing the growing needs of preventive solutions and measures to overcome projected extreme conditions has become a priority for ASEAN. Therefore, every country in the Lower Mekong region should put drought monitoring and EWSs in place together with longer-range forecasting and near-real-time and in-season monitoring, offering additional warnings several days ahead. The study also found that significant opportunities exist for using risk financing and complementary forecast-based financing tools to support rural resilience against slow-onset disasters such as drought.

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Understanding Drought: When to Sound the Alarm?

By Harlan Hale & Elizabeth Downes

ARMOR

Abstract

Drought hazard events fall under contextual classifications based on a deviation from "normal" conditions, and the drought typology changes based on the intensity, duration, and scope of the event. Classified as a slow-onset disaster, a drought event can develop over weeks or months, often escaping the attention of the disaster management community until very late in its development. This article highlights the need to shift from a crisis management to a risk management approach in addressing drought.

The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) and the Association of Southeast Asian Nations (ASEAN) recommend building the capacity of National Meteorological and Hydrological Services (NMHSs) to produce high-quality forecasts and early warning services for national and local decision-makers (ESCAP, 2020). Efforts to increase the quality of forecasts should accompany efforts to increase the understanding of end-user requirements and foster partnerships between data providers and end users.

At the same time, it is also important to build national capacity to understand, apply, and react to forecast information. Governments and aid agencies should adopt a risk management approach by using leading indicators instead of trailing indicators to trigger response to drought. This article also recommends the potential timing and methods for triggering alarm before drought events in the ASEAN region.

Keywords: Drought, indicators, risk management

4.1 Introduction

Disaster management officials in the ASEAN region have considerable experience responding to a wide variety of hazards and disaster events, including typhoons, flooding, earthquakes, landslides, land and forest fires, and volcanic eruptions. Most of these events fall under the classification of rapid-onset disasters and typically have lead times in the range of hours or days. Each has a discernible initiating event that causes the public and the disaster response community to take notice and begin taking action in response. Drought, on the other hand, is classified as a slow-onset disaster and lacks a single, alarm-triggering event. A drought event develops over weeks or months, often escaping the attention of the disaster management community until very late in its development.

Rapid-onset disasters usually have visible impacts on infrastructure and may result in the immediate displacement of local populations. Drought does not damage infrastructure and only results in displacement after the exhaustion of available resources and assistance. In the ASEAN region, the impact of drought tends to be local and of shorter duration due to the mixed application of rainfed agriculture and irrigation practices. However, the negative impact of drought is likely to worsen over time as climate change exacerbates harsh weather conditions. A humanitarian response at the household and community levels in the affected regions is vital for preventing the potentially severe impacts of drought.

ASEAN and ESCAP jointly produced a study titled Ready for the Dry Years: Building resilience to drought in Southeast Asia (ESCAP, 2020). The study indicates that dry years are likely to occur more frequently in the upcoming years, and the area that drought affects will shift and expand.

The authors of the study recommend three areas in which the ASEAN Member States can work together to address approaching drought changes:

- Strengthening drought risk assessment and early warning services
- Fostering drought risk financing markets to support communities against slow-onset disasters, and
- Reducing conflict and losses by enhancing communities' and households' adaptive capacity to drought.

This article focuses on the first recommendation of improving drought assessment and early warning. It seeks to propose a way to identify and track slow-onset disasters such that the benefits of early warning systems (EWSs) can guide timely responses. The primary topic of discussion is the need for ASEAN Member States to approach drought from a risk management perspective (using leading indicators) rather than a crisis management perspective (using trailing indicators). Early intervention to address projected declines in socioeconomic security will reduce the costs of the response to drought while improving its effectiveness. It will also protect lives and livelihoods by reducing the extent of household asset depletion and resulting economic decline as affected households weather the event and begin recovery.

4.2 Definition of Drought

Unlike most hazard events, "drought" is a relative term that depends on a negative departure of rainfall patterns and available moisture from the norm of a specific geographic region and time of year. Three characteristics that further differentiate one drought from another are intensity, duration, and spatial extent (Wilhite, 2000). While there are numerous definitions, classifications, and typologies of drought, the National Drought Mitigation Center at the University of Nebraska (n.d.) offers the general definition of "a deficiency of precipitation over an extended period (usually a season or more), resulting in a water shortage". Furthermore, Wilhite and Glantz (1985) identify four main types of drought: meteorological, agricultural, hydrological, and socioeconomic.

Meteorological drought: this type of drought is usually defined as a decrease in rainfall from some measure of normal precipitation in a region. The number of days without precipitation in a specific area or the percentage decrease in the amount of rainfall during a particular season determine the severity of the drought.

Agricultural drought: this type of drought typically consists of insufficient, poorly timed, or poorly distributed rainfall that is not conducive to normal crop growth and yields. Agricultural drought conditions will vary depending on the types of crops and means of cultivation in each area, but they will generally result in yields that are below farmers' expectations in a typical season.

Hydrological drought: this type of drought is usually defined as a deficit in precipitation affecting both surface and subsurface water supply on a river basin or watershed level (streams, rivers, lakes, reservoirs, and groundwater). During a hydrological drought, a hydrologic system does not contain enough water to meet the various demands of the system, such as agriculture, domestic use, hydropower, and navigation.

Socioeconomic drought: this final type of drought concerns the balancing of supply and demand of goods, as well as elements of meteorological, agricultural, and hydrological drought. During socioeconomic drought, the demand for economic goods exceeds the supply due to weather-related shortfalls in the water supply. For example, the reduced water supply may lead to a reduction in food, fodder, hydroelectric power, or other economic goods. As the demand for these goods changes over time based on economic growth, population growth, and rural-to-urban migration, the water supply must also change to meet demand and avoid a socioeconomic drought.

Figure 4.1 shows how the types of drought transition over time in relation to one another, starting with an observable meteorological condition and leading to a set of widespread socioeconomic impacts.

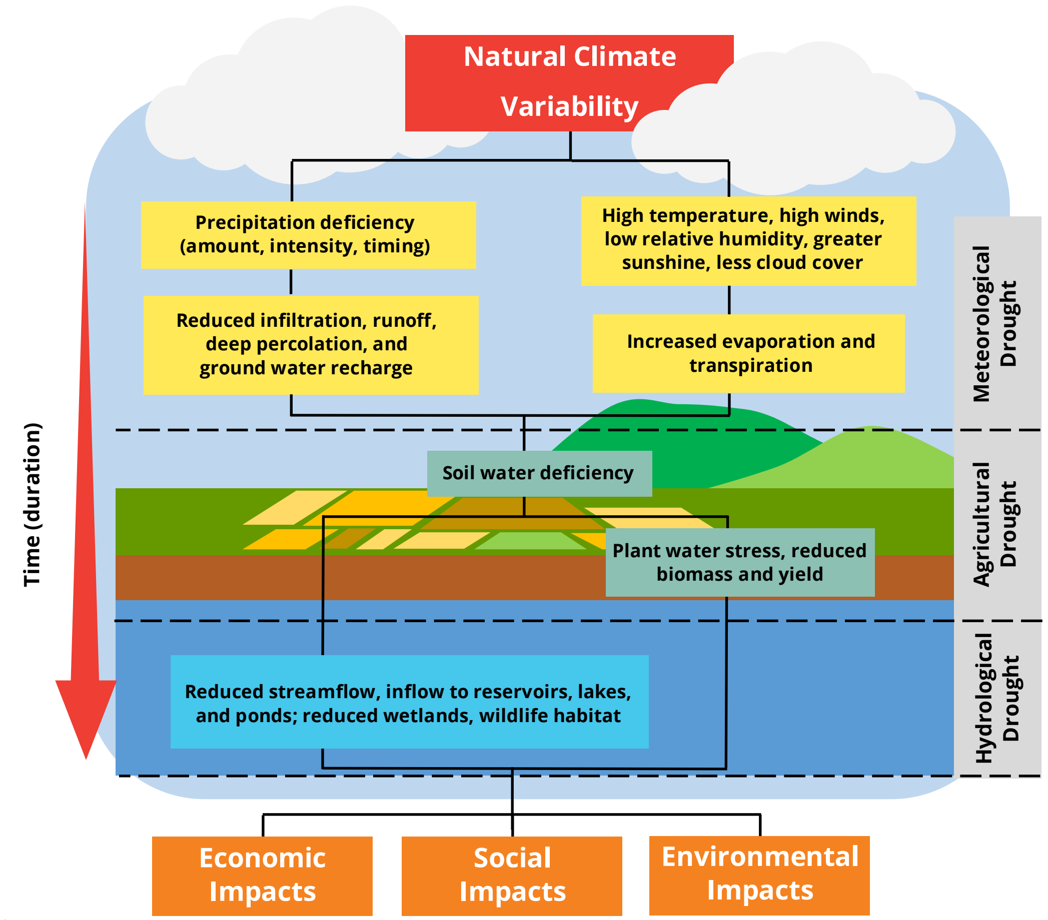

Figure 4.1

Impacts of different types of droughts (source: Wilhite, 2000, p. 10).

In 2019, the Indian Ocean Dipole (an alternation between warmer and colder temperatures of the western Indian Ocean compared to the eastern part) was one of the factors contributing to a reduction in rainfall across the northern ASEAN region during the annual monsoon season and an extension of the dry season across parts of Indonesia (TWC India, 2019). In Thailand, a 70% reduction in rainfall prompted the Government to declare several areas as experiencing drought (meteorological drought). Analysts also stated that unregulated water consumption for agriculture contributed to the drought, as the Mekong River was at historic low levels, causing competition for water resources among economic sectors such as agriculture and hydropower (hydrological and socioeconomic drought). In Indonesia, forest and peat fires burned longer due to the meteorological drought. The wells in communities across the Indonesian island of Java and other eastern islands began to run dry (hydrological drought), requiring water trucking to supply enough water to meet needs. The dense population of the capital city of Jakarta, which heavily depends on groundwater, also suffered water shortages as demand exceeded the available supply (socioeconomic drought). The late onset of rains across southern Indonesia delayed crop planting and may impact yields for smallholder farmers who depend on rainfed agriculture during the 2019–2020 season (agricultural drought). As in Figure 4.1, these connecting factors illustrate how meteorological drought transitions to agricultural, hydrological, and socioeconomic drought over time.

The prolonged 2019–2020 drought has impacted many communities throughout the ASEAN region. Drought severely affected over 100,000 people in Indonesia in June 2019, requiring the delivery of water through tanker trucks. In July 2019, 55 districts declared drought emergency; however, in December of the same year, excessive rainfall resulted in severe flooding and landslides. In March 2020, water shortages in Viet Nam were still impacting 95,600 households, with 38,000 ha of agricultural land damaged and five provinces in state of emergency. According to the Bank of Ayudhya (Bangkok Post & Bloomberg, 2020), the 2020 drought will likely cost Thailand TBH 46 billion (approximately USD 1.4 billion), or 0.27% of its gross domestic product.

4.3 Indicators of Drought

Given the slow-onset nature of drought, governments and aid agencies must identify appropriate indicators for triggering actions to address the impacts of a drought event. The three broad categories of indicators for measuring drought-related stress include leading indicators, concurrent indicators, and trailing indicators.

4.3.1 Trailing and Concurrent Indicators

Aid agencies and national disaster management organisations (NDMOs) have typically addressed drought through a crisis management approach, using a set of standard trailing indicators to determine whether emergency conditions occur. These indicators primarily relate to nutrition, health, and crude mortality rate, including measurements of nutritional conditions of children under 5 years of age (e.g. percentages of children suffering global acute malnutrition), increases in certain types of illnesses (e.g. oedema), and crude mortality rates (e.g. two deaths per 10,000 people per day). When the indicators surpassed predetermined thresholds, the international aid community generally agreed that the event constituted an emergency necessitating urgent, life-saving humanitarian assistance. Invariably, the assistance was insufficient and arrived too late to effectively aid the affected population. This inadequacy originates in the use of the trailing indicators of nutrition and health.

Trailing indicators show that a problem has already occurred. For example, a trailing indicator will show that households have exhausted their assets and resources, rather than showing that households are at risk of exhausting their resources soon. By the time the impact of drought manifests itself in the erosion of health and nutritional status, a high degree of household asset depletion has already occurred, making a recovery to pre-drought levels only possible with substantial injections of relief and recovery assistance.

Concurrent indicators provide a more effective alternative. Rather than measuring what has already occurred, they highlight a problem by measuring changes in behaviour in response to drought-induced livelihood stress. Specifically, concurrent indicators observe various coping strategies that households employ as they experience periods of stress. These behaviour changes are divided into positive coping strategies and negative coping strategies.

Positive coping consists of those activities or behaviours that a household implements to get through a period of short-term stress without compromising long-term food and income security. Some positive coping strategies include temporarily switching to cheaper, less nutritious foods; reducing the number of meals consumed for a predetermined time; the liquidation of surplus non-productive assets such as small livestock, jewellery, or other accumulated assets; and seasonal migration to different labour markets or participation in seasonal income-earning activities. It is relatively easy for households to reverse positive coping strategies and return to normal when the drought ends, the next harvest occurs, and food and income security improve. However, over time, positive coping strategies alone may not be sufficient to compensate for lost food and income. When they begin to fail, people start to employ negative coping strategies.

Negative coping strategies are activities and behaviours that produce short-term income or savings but compromise the long-term capacity of a household to recover. Some negative coping strategies include the sale or liquidation of productive assets, such as tools and draught animals; excessive and long-term exploitation of the natural resource base such that it cannot regenerate sufficiently, including excessive woodcutting, charcoal making, or hunting; foregoing expenditures for education and healthcare for household members; engaging in high-risk income-earning activities such as transactional sex, petty crime, or child labour; and permanent out-migration to urban and peri-urban slums. It is much more challenging for households to recover from negative coping behaviours, often resulting in lower income-earning potential in the long term. For example, reforestation of depleted wood reserves, earning and saving enough income to replace draught animals and other productive assets, and repaying debt may take several years or be nearly impossible.

Figure 4.2 illustrates the range and progression of coping strategies, from those that are easily reversible with minimal long-term impact on food and livelihood security to those that compromise a household's ability to recover in the future.

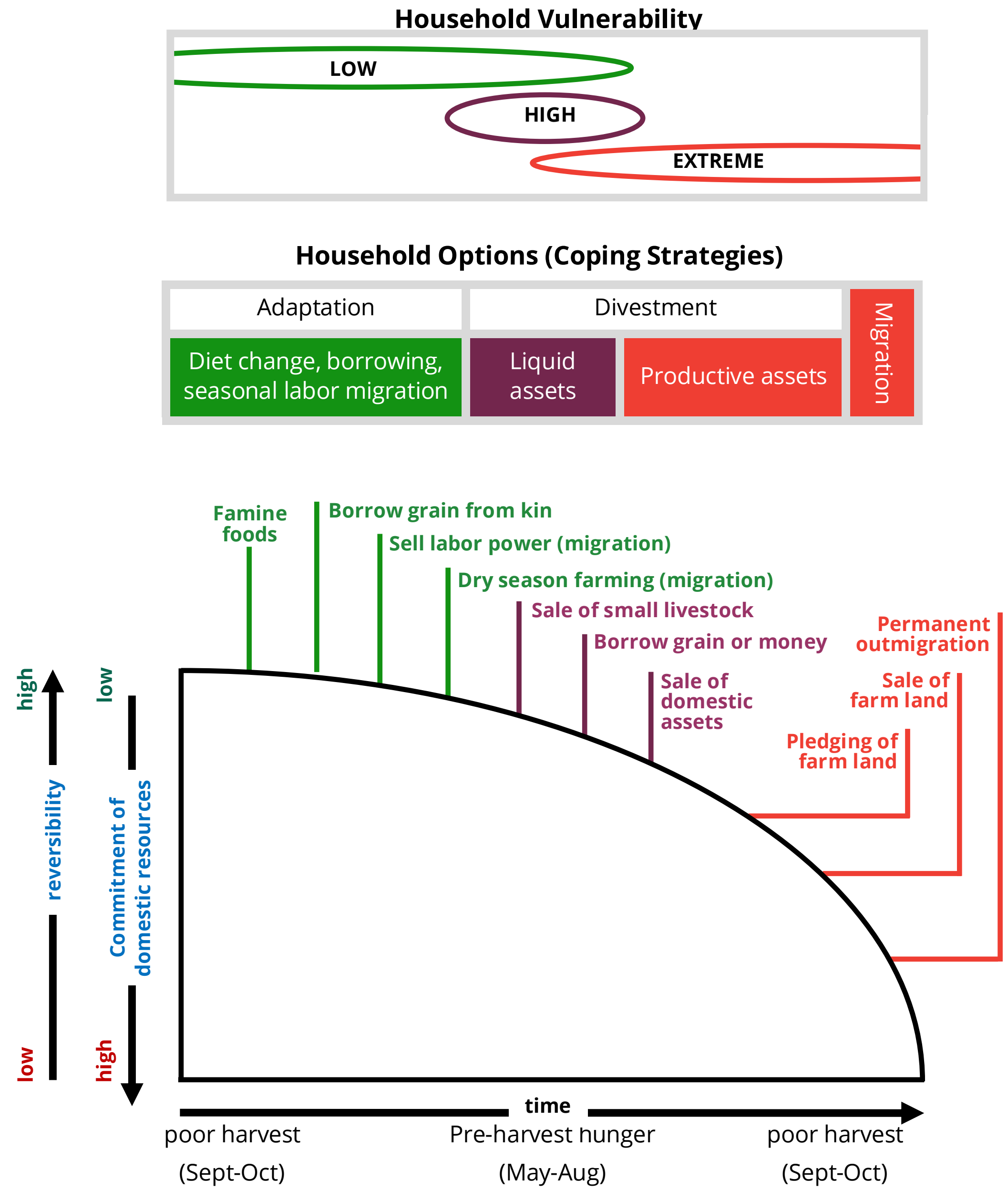

Figure 4.2

Coping strategies diagram (source: Maxwell and Frankenberger, 1992).

By observing concurrent indicators, including the type, duration of use, and dependence on coping strategies and other behaviour changes, aid agencies and governments can distinguish between positive coping strategies that help households handle a period of transitory drought stress and negative coping strategies that indicate severe food and income insecurity and stress. Changes in the use of coping strategies, such as switching from positive to negative, increasing numbers of households using them, or longer periods of implementation, signal that households are struggling to meet their basic food and income needs. Such signals also indicate that households may require additional assistance to prevent them from de-capitalising and compromising their ability to recover.

In the ASEAN region, the types of coping mechanisms will differ based on the local culture, economy, and whether rural or urban households experience the impacts of drought. For rural households, the sale of gold jewellery may be one positive coping strategy to liquidate savings. In the urban context, renting part of the property to tenants may be an option when households face stress on their income. Through community consultations and research, the development of context-specific "coping curves" can show the progression of behaviours and help monitor concurrent impacts of drought on affected households. When an abnormal dependence on coping strategies or a shift from positive to negative strategies is observed, aid agencies and governments should trigger assistance programmes to maintain their livelihood base and enable a quicker post-drought recovery.

In 2004, the United Nations Food and Agriculture Organization (FAO) developed the Integrated Food Security Phase Classification (IPC), an analytical approach for tracking current stress (IPC Global Partners, 2019). Today, the initiative includes 15 of the world's top humanitarian organisations, and the wider humanitarian community has accepted it as an official tool for comparing and measuring food insecurity, whether brought about by drought or by other disruptions to food availability or access. IPC combines concurrent and trailing indicators, considering both coping strategy usage and nutritional status, and accounts for the provision of humanitarian assistance (Figure 4.3).

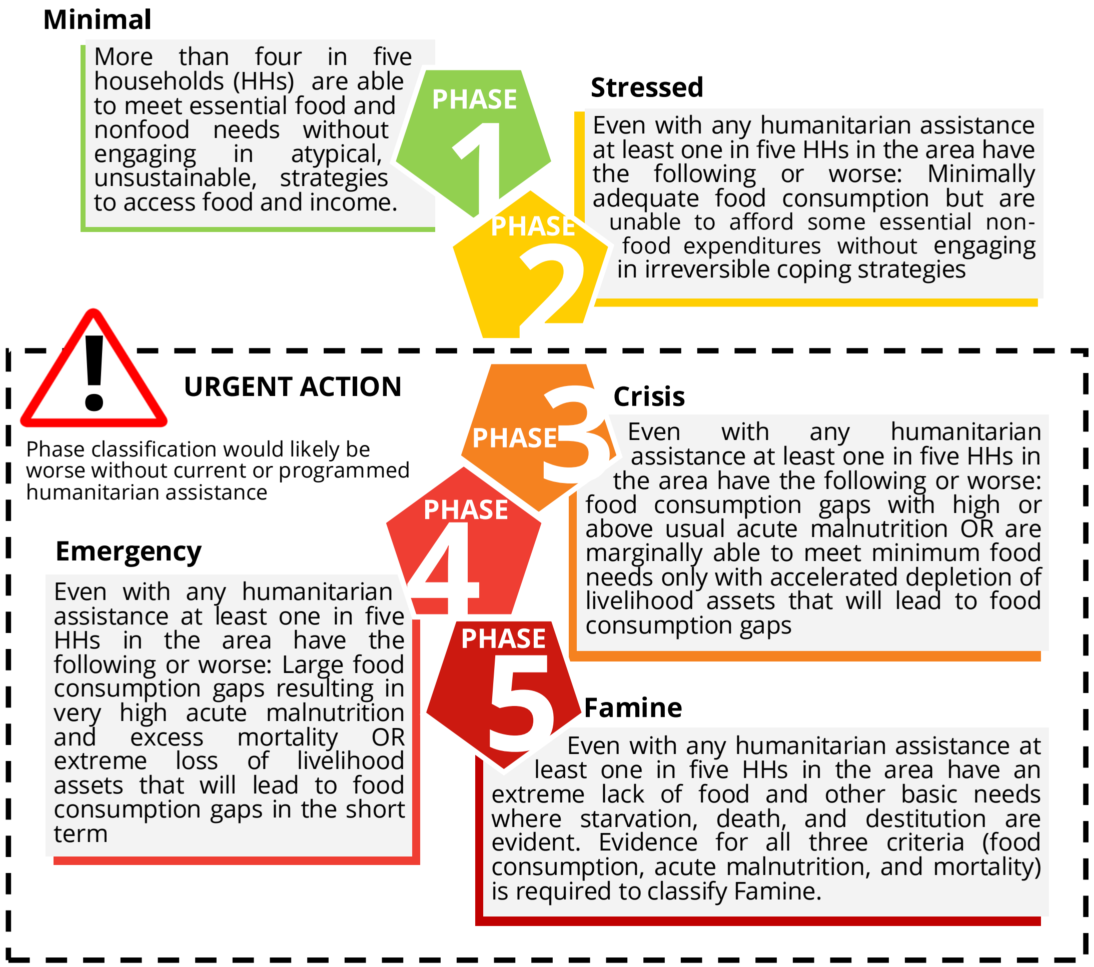

Figure 4.3
IPC phases (source: IPC Global Partners, 2019).

The original aim of IPC was to measure drought—and conflict-induced acute food insecurity. Over time, its use has expanded to also measuring chronic food insecurity. In the ASEAN region, IPC pilots have examined chronic food insecurity in Cambodia, Myanmar, and the Philippines.

4.3.2 Leading Indicators

While concurrent indicators are more useful than trailing indicators because they track the progression of drought-induced stress, leading indicators provide an even better option. Leading indicators expose problems before they have materialised. In the case of drought, leading indicators include forecasts and observations of rainfall during the growing season. Seasonal rainfall forecasts, as with all forecasting, are probabilistic, meaning that the given observations indicate a probability of a specific outcome. Forecasters use reliable data, observations, and analysis to produce probabilistic forecasts and then revise them throughout the season. Events such as the El Niño Southern Oscillation in the tropical Pacific Ocean and the Indian Ocean Dipole in the Indian Ocean are examples of cyclical phenomena that provide quality leading indicators for influencing seasonal rainfall forecasts.

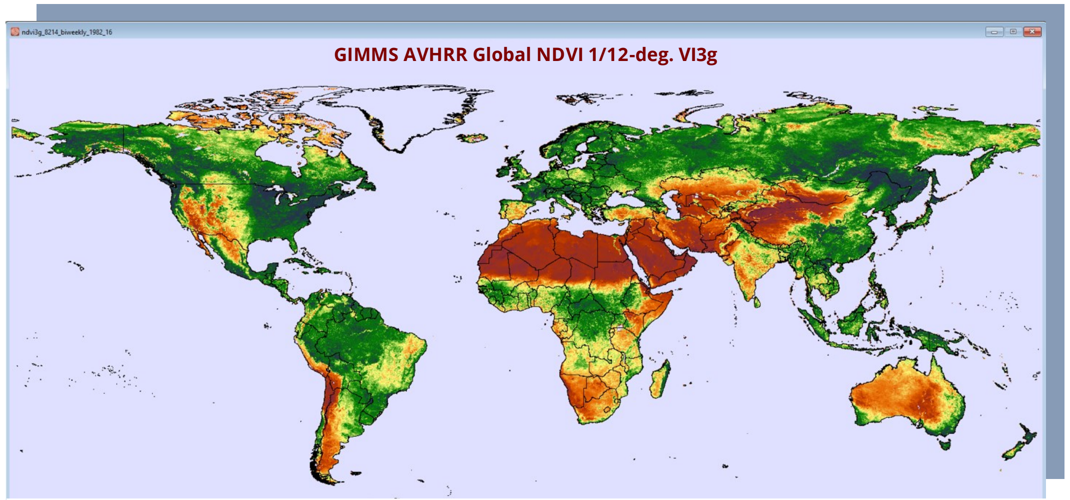

Figure 4.4
Global NDVI (source: Clark Labs, n.d.).

Agrometeorologists use the leading indicators of rainfall tracking by using on-site data collection and remote sensing during the growing season to forecast whether there is enough precipitation to yield a normal harvest. For example, the National Oceanic and Atmospheric Administration in the United States of America developed the Normalized Difference Vegetation Index (NDVI), which uses satellites to detect the vegetation colour of an area and compare it to the norm for that place and time of year (Figure 4.4). Additionally, FAO developed the Water Requirement Satisfaction Index for determining whether the quantity and timing of rainfall indicate that specific crops will yield a normal harvest.

The forecasting of seasonal rainfall and temperatures progressed in the ASEAN region when the World Meteorological Organization (WMO) and ASEAN established the ASEAN Climate Outlook Forum (ASEANCOF), one of 19 Regional Climate Outlook Forums, on 3–5 December 2013 in Singapore. Through this partnership, the NMHSs of ASEAN Member States gather (either physically or virtually) several times a year to produce a consensus forecast of rainfall and temperature, usually for an upcoming three-month period (Figure 4.5).

Disaster management, agriculture, and hydrology agencies should use these resulting forecasts as critical leading indicators. For drought, these probabilistic forecasts will enable government officials to focus on the regions where rainfall is likely to be below average and monitor daily and weekly rainfall against the forecast to determine the impact on the people, economy, and environment. However, many EWSs managed by NDMOs in the ASEAN region do not track drought. The ASEAN Risk Monitor and Disaster Management Review (ARMOR) 1st edition published a review of the EWSs in ASEAN, in which Bisri (2019) found that only three of the 10 Member State multi-hazard EWSs tracked drought. The drought events of 2019 continuing into 2020 are likely to encourage this to change as more ASEAN Member States experience the impacts of drought.

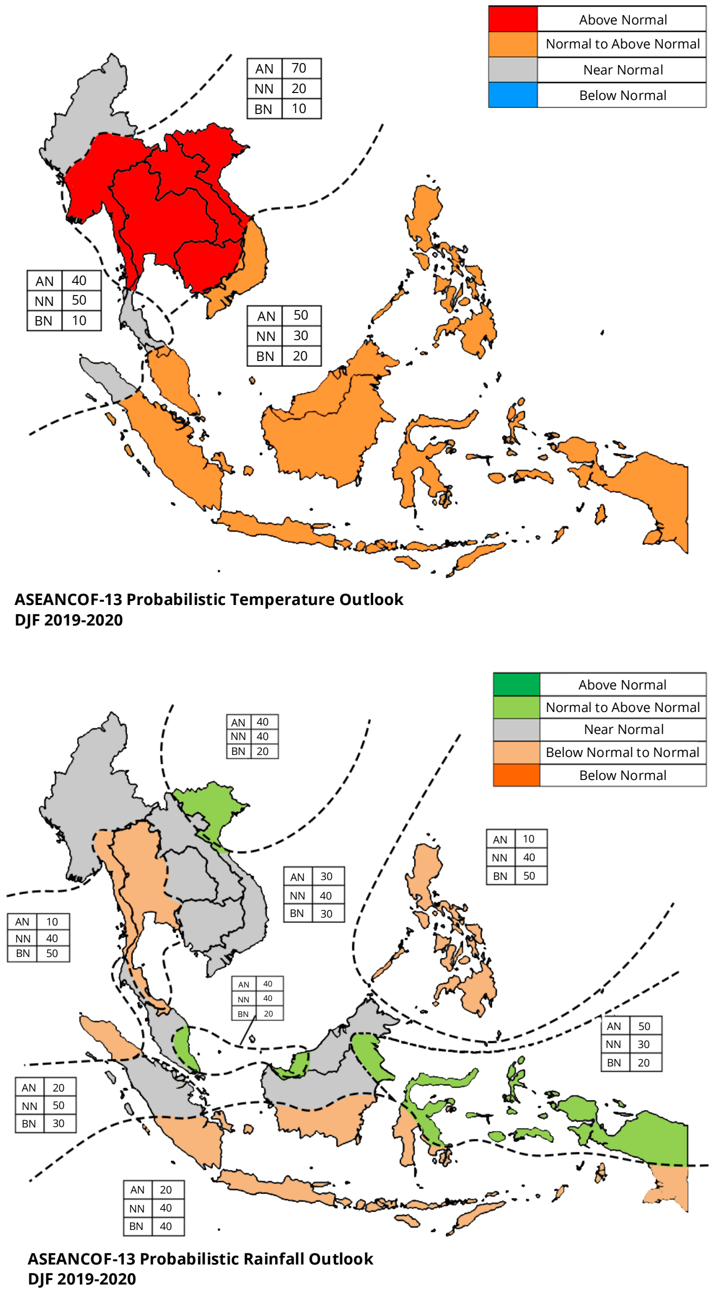

Figure 4.5

The ASEANCOF probabilistic outlook for December 2019–February 2020 (source: Thai Meteorological Department and ASEAN Specialised Meteorological Centre, 2019).

When rainfall observations indicate below-average levels of moisture for a specific time of the year, they should trigger officials to conduct pre-harvest crop assessments (another leading indicator) to obtain an indication of average percentage reduction in expected harvest. A lower harvest percentage should then trigger observational assessments looking for concurrent indicators such as households beginning to show signs of stress and employing initial positive coping strategies. If markets still have sufficient food supply, then the observations should trigger support programmes such as temporary cash grants or short-term public works to supplement purchasing power. If market supplies cannot meet demand, then support programmes should supply food aid. When leading indicators point to drought, governments and aid agencies should start anticipating and planning for a set of responses. For example, a forecast of likely El Niño conditions should trigger increased monitoring from the agriculture and meteorological services, as well as some discussion and planning on possible impacts by other agencies in sectors such as disaster management and social welfare.

4.4 Early Warning and Early Action

Much information has arisen since the 1980s concerning the impact of droughts and crop failures on food security and rural livelihoods. EWSs, such as the Famine Early Warning Systems Network supported by the U.S. Agency for International Development, FAO's Global Information and Early Warning System, and other specific systems, monitor climate and weather, agricultural production, terms of trade between cereals and livestock, and several other socioeconomic factors. National governments and regional institutions should be able to forecast with high accuracy the consequences of drought on the socioeconomic well-being of the affected populations in rural areas. The impact of drought in urban areas is not as well-understood or apparent but may manifest itself in several ways. Some potential urban impacts might include higher food prices from declining rural production, lower wage rates due to rural migration to urban areas, or declining availability of electricity and water services as reservoir volumes decrease.

Governments and aid agencies working with drought-affected communities can observe the consequences of drought on the behaviours of the affected population. However, without an understanding of drought indicators, their ability to prevent the progression from positive to negative coping strategies is limited. This inability to prevent asset depletion and negative consequences on health and nutrition largely stems from the use of a crisis management approach to drought.

In the paper National Drought Management Policy Guidelines: A Template for Action (WMO & Global Water Partnership (GWP), 2014), the authors highlight the need for integrated drought management policies and preparedness plans and present a 10-step process for the development of a national drought management policy. Essential to developing an effective policy is the adoption of risk management instead of crisis management as the primary approach to drought. To promote a risk management approach, WMO and GWP advocate the following:

- Encouraging the improvement and application of seasonal and shorter-term forecasts
- Developing integrated monitoring and drought EWSs and associated information delivery systems
- Developing preparedness plans at various government levels
- Adopting mitigation actions and programmes
- Creating a safety net of emergency response programmes that ensure timely and targeted relief, and
- Providing an organisational structure that enhances coordination within and between government levels and with stakeholders.

The use of leading indicators such as forecasts and monitoring is crucial in the risk management approach, as is the development of preparedness plans that include concrete actions and safety net programmes for drought response. Safety net programmes can immediately benefit target populations

when leading indicators indicate the likelihood of drought. These programmes should compensate for lost food production or income and complement the positive coping strategies employed by drought-affected households and communities. Tracking concurrent indicators to detect the use of negative coping strategies should then trigger an expansion in assistance to new recipients or an increase in financial and material support per recipient in safety net programmes, preventing asset depletion, high-risk behaviour, and deepening of poverty.

4.5 Conclusions and Recommendations

Defining drought and establishing indicators depends heavily on the context; however, droughts share the common characteristic of a moisture deficit which causes social, environmental, and economic impacts. Unlike rapid-onset disasters, the impacts of drought are largely non-structural and deepen over time. Thus, a risk management approach, as opposed to a crisis management approach, is necessary to mitigate and adapt to the impact of drought.

Using trailing indicators to trigger a response to drought has proven to be inadequate, requiring large amounts of humanitarian assistance to reduce impacts and even more in recovery and development assistance to return to pre-drought conditions. The use of concurrent indicators, which requires waiting until households are already experiencing stress and beginning to de-capitalise, may also result in unnecessary economic and social decline if the drought response is not already set up for quick implementation. Using leading indicators from climate and weather observations, data collection, and modelling is the best option to manage drought risk. Leading indicators allow for forecasting the impact on socioeconomic conditions and communicating this to decision-makers to trigger an appropriate drought response. This risk management approach must be part of a national drought policy and preparedness plan.

Early detection and sound forecasting can grant governments and the aid community the ability to prevent a drought from becoming a humanitarian disaster and to protect livelihoods. Such prevention and protection enables recovery and growth after the drought breaks and the precipitation levels return to normal. The ASEANCOF provides a first step to developing region-specific leading indicators. However, the variety of microclimates, livelihood systems, and competing uses for water throughout the ASEAN region necessitates a deeper national and subnational analysis. Rather than relegating this information to meteorological services, agencies and officials in other sectors, such as disaster management, agriculture, social welfare, and economic areas, should understand the forecasts and use the information to develop national (and perhaps regional) drought policies. These policies should include preparedness and mitigation plans, as well as timely, actionable, and targeted drought responses triggered by leading and concurrent indicators of drought stress.

NMHSs have an increasing capability to provide intermediate- and short-range forecasts for rainfall. Agriculture and disaster management agencies should be the primary end users of these forecasts and understand how they may impact food and livelihood security. NMHSs need to hold joint meetings and training sessions to encourage their clients to make the best use of their products. A forecast for below-average rainfall should trigger local monitoring of crop conditions to detect the extent of the impact on upcoming harvests. Disaster management and social welfare agencies should begin planning for assistance programmes in preparation for potential harvest reduction at the local level passing predetermined thresholds that would lead to food and livelihood insecurity. Monitoring the use of coping mechanisms should then trigger targeted safety net programmes for the affected households.

For individual drought events, using leading indicators can signal when to sound the alarm before drought. The warning should happen when the rains fail, not when the livelihood systems fail—and certainly before reaching the point where the health and welfare of the people are compromised. Early warning can and should lead to early response.

For the ASEAN region and Member States, the time to sound the alarm is now. The ASEAN Secretariat is developing a declaration on drought for adoption by the ASEAN Leaders at the 36th ASEAN Summit, indicating that drought is a critical issue for all ASEAN Member States. Multi-stakeholder (inter-ministerial and inter-state) national and regional drought management policies and plans are essential for driving investments in monitoring, early warning, safety net programmes, and intermediate—and long-term programmes to mitigate the impact of drought. ASEAN Member States must work together to ensure that water demand and supply are in equilibrium and that the latter meets national and regional needs equitably.

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One Year Down: The State of ASEAN's Flood and Drought Early Warning Systems

By Justin Chin, Ferosa Arsadita, Palida Puapun

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Abstract

As climate change intensifies, rising sea levels and powerful downpours threaten to worsen floods, while escalating temperature extremes cause more severe droughts. Adapting to climate change and reducing disaster risk requires the implementation of effective early warning systems (EWSs).

This paper builds on data from the ASEAN Risk Monitor and Disaster Management Review (ARMOR) 1st edition (Bisri, 2019) to evaluate how EWSs in the Association of Southeast Asian Nations (ASEAN) have developed during the past year. Using this information, it proposes a model for re-examining the flood and drought EWSs currently in place in ASEAN and determining how they might further evolve and improve in the context of ongoing climate emergencies. The model comprises five elements (risk knowledge, detection to forecasting, dissemination, preparedness and response, and governance) and four subcomponents (hardware, software, people, and processes). In this model, governance is the central element underpinning the other elements. The study aims to serve as a guide for ASEAN Member States during the design and upgrading of their EWSs.

This paper also highlights the current challenges facing EWSs, especially in light of the potential for worsening of floods and droughts with the progression of climate change. Finally, the article provides examples of bottom-up community involvement and national policies while recognising the potential to strengthen regional EWS coordination and opportunities for private sector engagement.

Keywords: Early warning system, flood, drought, governance

5.1 Introduction

The Intergovernmental Panel on Climate Change (IPCC) has concluded with medium confidence that local flooding will increase due to climate change and natural hazards (Stocker et al., 2013). Although there is limited to medium evidence on changes in the frequency and severity of floods, the IPCC's projection stems from the logic that likely (medium confidence) increases in heavy precipitation will lead to increases in local flooding. Additionally, heavy precipitation that accompanies tropical cyclones (TCs) is likely to increase, although the global frequency of TCs will either decrease or remain essentially unchanged. The IPCC also reported with high confidence that small islands, low-lying coastal areas, and deltas will experience higher exposure to flood risks from sea level rise (IPCC, 2018). This risk increase would particularly affect archipelagic Indonesia and the Philippines, the many low-lying coastal areas in all ASEAN Member States, and the Mekong Delta area. The IPCC also projects with medium confidence that as daily temperature extremes rise, droughts will intensify (IPCC, 2018).

The World Meteorological Organization (WMO, 2018a) defines an EWS as "an integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities, systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events". Regional and national EWSs for geophysical and meteorological hazards are critical components of disaster risk management in ASEAN and hence require periodic reassessment and improvement after the initial baseline analysis (Bisri, 2019).

Countries are increasingly transitioning from reactive disaster response and recovery to more proactive preparedness and prevention (ICLEI-Local Governments for Sustainability, 2020). Proactive measures such as EWSs help reduce the impact of disasters by addressing risk and vulnerabilities and enhancing the resilience and response capacities of communities. For example, the EWS in Bangladesh helped limit casualties from Cyclone Sidr in 2007 by a hundred times compared to the equally strong 1970 Bhola Cyclone, which caused 300,000 casualties despite a population that more than doubled during that period (United Nations Development Programme (UNDP), 2018).

At the regional level, Article 7 of the legally binding ASEAN Agreement on Disaster Management and Emergency Response (AADMER) establishes that the Member States shall "establish, maintain, and periodically review national disaster early warning arrangements" (ASEAN, 2005, p. 8). The arrangements that AADMER mandates include (1) regular disaster risk assessments, (2) early warning information systems, (3) a communication network for timely delivery of information, and (4) public awareness and preparedness. At the global level, the urge for disaster risk reduction led to the adoption of the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015 – 2030 with the aim of substantially reducing disaster risk and resulting losses. Strengthening the EWS approach would directly address target G of SFDRR to increase the availability of and access to multi-hazard EWSs. The potential changes in hazards and urgency of climate change also led to the landmark Paris Agreement in 2015, with one of the goals being climate change adaptation and the indirect implication of disaster risk reduction. Specifically, Article 7 of the Paris Agreement detailed the need to strengthen scientific knowledge on climate, including EWSs, in a manner that informs climate services and supports decision-making (United Nations (UN), 2015a, p. 10). Article 8 of the Paris Agreement (UN, 2015a, p. 12) calls for cooperation and facilitation to enhance understanding, action, and support in EWSs. Additionally, the 2030 Agenda for Sustainable Development lays out 17 Sustainable Development Goals that call for an end to poverty and other deprivations by 2030 while combating climate change (UN, 2015b). Since disasters can protract or even worsen poverty and inequalities, the Sustainable Development Goals inherently promote climate change adaptation and disaster risk reduction actions.

The above three global agendas represent the nexus between climate change adaptation, disaster risk reduction, and sustainable development. Together, they create a comprehensive framework to reduce climate risk and vulnerability while enhancing resilience. EWSs can also contribute as one of the crucial solutions for reaching these goals. This paper will re-examine the state of EWSs in each ASEAN Member State for floods and droughts in the context of the current climate emergencies.

5.2 Elements and Subcomponents of EWSs

As an outcome of the first Multi-Hazard Early Warning Conference in 2017, the WMO published an updated multi-hazard EWS checklist based on the long-standing EWS elements from the original 2006 checklist. The new list consists of four elements with multiple interactions between each element, making it vital to not view them separately as a linear chain or cycle. Based on the WMO (2018a) model and referencing Bisri (2019), this paper proposes a model for assessing EWSs in ASEAN composed of five elements: (1) risk knowledge, (2) detection, monitoring, analysis, and forecasting, (3) dissemination, (4) preparedness and response, and (5) governance. In this model, governance is the central element underpinning the original four, and each of the elements has four subcomponents (Figure 5.1).

The following sections highlight the most vital features of effective EWSs and aims to serve as a guide for ASEAN Member States during the design and upgrading of their EWSs.

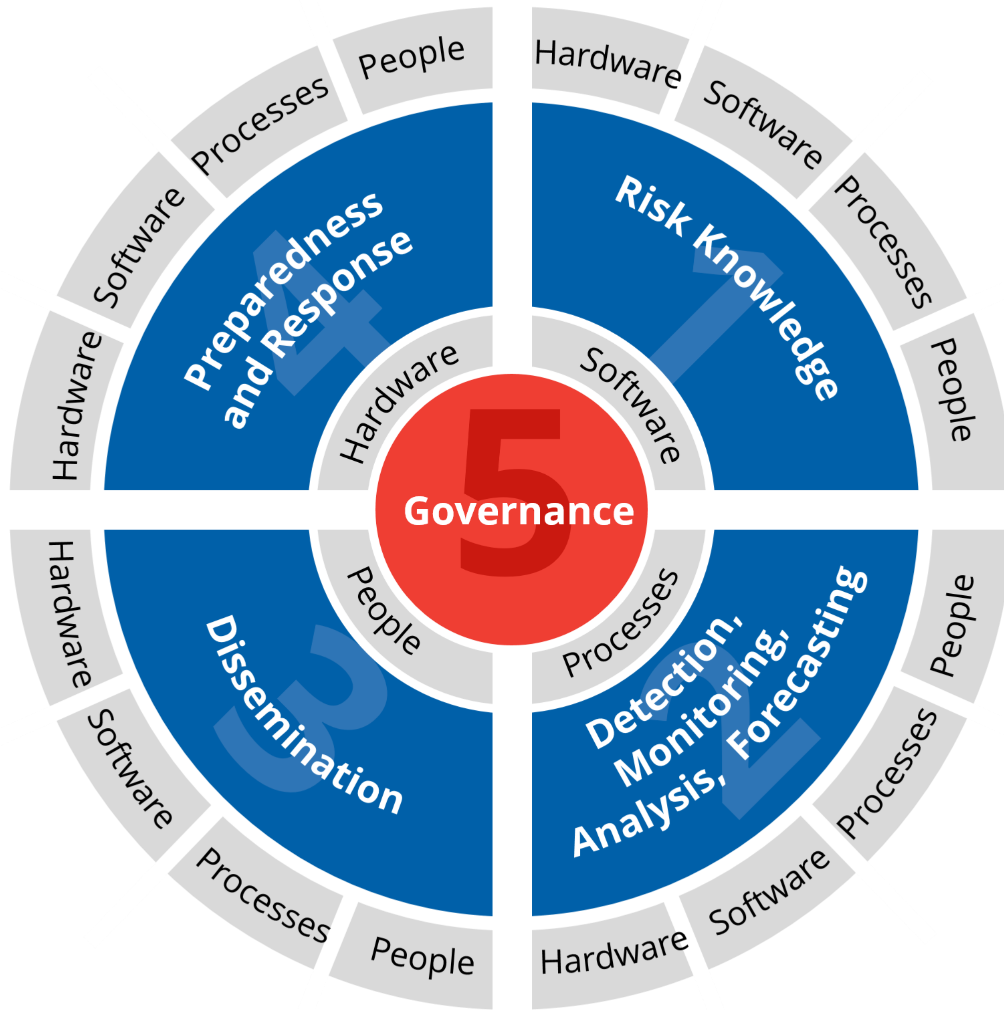

Figure 5.1
EWS model proposed.

5.2.1 EWS Elements

Element 1: Risk Knowledge

Risk knowledge comprises data collection and risk assessments. The data collection portion requires data standards, which specify a set of data to collect and the method for storing it, as well as a data repository. Modern technology allows for the collection and storage of large data sets, which are useful in the next element involving hazard modelling, analysis, and forecasting of impacts.

It is important to integrate weather and climate data with hydrological data to allow for better forecasting of floods and droughts. The forecasting should then be integrated with socioeconomic data, including information on physical and social vulnerabilities collected in risk assessments. This data integration improves the analysis and forecasting of human-related impacts as part of the next EWS element.

Over time, climate change is affecting and changing which locations experience hazards and risk, as well as causing return periods for flood and drought hazards to decrease (United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), 2019b). The growing frequency and severity of hazards due to climate change results in increased difficulty in applying historical data for risk analysis. Thus, emphasising extreme value statistics that describe extreme events will help set warning thresholds in the next element (UNDP, 2018).

Risk is the combination of societal vulnerabilities, exposure to a hazard, and the probability that a hazard occurs (UNDP, 2018). Risk assessments should include information on both physical and social vulnerabilities and exposures in addition to identifying and mapping hazards for all key actors identified in the "people" subcomponent. Geographic information systems are useful in mapping hazards, vulnerabilities, and exposures for visualisation and quantitative analysis. In carrying out risk assessments, it is imperative to consider a multi-hazard approach due to the frequent interactions between hazards and their simultaneous or cascading occurrences that may cause more severe or compounding effects. It is also important to consider climate change projections and development (economic or otherwise) when assessing vulnerabilities and exposures, especially when the projected cases involve a likely increase in frequency or severity of the hazard(s). In this regard, it may be useful to conduct risk assessments for different periods.

Element 2: Detection, Monitoring, Analysis, and Forecasting

Hazards require detection, monitoring, and forecasting, and their potential impacts require analysis. Accomplishing these tasks requires modern and accurate scientific knowledge, the recognition of scientific uncertainties, the application of technical skills, and the maintenance and upgrading of monitoring instruments and systems. Combining them with the knowledge derived from risk assessments allows for the definition of thresholds in the next element of "dissemination".

Drought monitoring necessitates a range of indicators due to the extended effects that drought has on the various components of the entire water cycle. The combination of indicators and data obtained using a bottom-up approach permits a higher spatial resolution with greater details at the local level to avoid solely relying on global models. For example, information from local observers such as farmers, market reports, and remote sensing can all contribute to higher resolution. Remote sensing can measure hydrological variables and the state of natural vegetation and agriculture, often at very high spatial resolution (under 1 km) and in near-real time. However, its use is presently uncommon in operational drought monitoring (UNDP, 2018).

Element 3: Dissemination of Information

Processes, systems, and their backups and contingencies are crucial in the dissemination of warnings. Some hazards—especially those that are rapid-onset—can fatally disrupt the dissemination of warning information. In the case of rapid-onset hazards, the short timeframe for reaction necessitates automated systems that link together hazard detection, warning dissemination, and response actions. Examples of automated response actions include activating red lights in tunnels or stopping elevators on the closest floor when hazards like earthquakes or floods are detected.

Warnings should use universal icons, ordinal alert levels with clear levels, and clear and simple response actions with which most people are already familiar. The December 2019 volcanic eruption of New Zealand's Whakaari/ White Island shows the importance of including response actions in warnings and governance as an underpinning EWS element. The volcano's warning system did not explain hazards in common terms or instruct people what to do in response to scientific warnings (The Straits Times, 2019), leading to tour companies and visitors entering the island when the volcano was already showing signs of activity.

The dissemination of information should also be timely and comprehensive, reaching all relevant sectors, including last-mile communities, and tailoring to the varying characteristics of different groups (individual risk, vulnerabilities, needs, environment, and local languages). Knowledge from risk assessments can feed into this area, and researching the target populations of the EWS in advance will help adequately prepare the system for handling the large geographical areas that floods and droughts often cover.

Element 4: Preparedness and Response
Preparedness and response cover five areas: capacity-building, response plans that activate upon receiving warnings, regular exercises to test the plans, public awareness and education campaigns, and lessons learned from exercises and past disasters.

Capacity-building is a long-term effort that requires planning and execution via shorter-term activities (Rose, Debling, Safaie, & Houdijk, 2020). Both functional and technical capacities need to be built as part of this element. Functional capacities include stakeholder engagement, monitoring and evaluation, policy development, planning and leadership, while technical capacities include those involved in the science and engineering of EWSs (Rose et al., 2020).

Public campaigns should conform to the characteristics of specific groups, paying attention to their unique risk and vulnerabilities as indicated by the risk assessments. There are four overarching approaches to public education: campaigns, participatory learning activities, informal education, and school-based education. A mixture of the different approaches and the repetition of messages achieves the best results (UNDP, 2018).

Element 5: Governance
The final element acts as the central part of the model, involving the legal, institutional, and coordination frameworks necessary for linking the other EWS elements together. Laws and regulations help establish the roles, responsibilities, and actions of key actors throughout the entire EWS. They also enable the responsive translation of early warnings into crucial decision-making that reduces the impacts of disasters. The results of capacity assessments, training, and after-action reviews of EWS-related drills and actual disaster events should lead to updates of the governance framework.

5.2.2 Element Subcomponents

Each of the five elements includes four subcomponents for assessing the EWS: (1) hardware or physical equipment, such as hazard monitoring instruments, (2) the software or programme containing a collection of instructions and procedures, (3) people, reinforcing WMO's (2018a) idea of people-centred EWSs, and (4) processes such as organisational systems, workflows, and standard operating procedures.

The key actors in an EWS for floods and droughts are:

- Disaster management authorities at the national, regional, and local levels
- National Meteorological and Hydrological Services (NMHSs) and other scientific and technical agencies
- Policymakers at the national and local levels

- Humanitarian and relief organisations (primarily for raising awareness and doing advocacy work within the fourth element of “preparedness and response”)
- The agricultural sector, especially in the ASEAN context
- The education sector
- Academia (which holds and advances scientific and technical knowledge, especially concerning the latest information on climate change)
- Media (to play the crucial role of dissemination of information and educating the public), and
- The private sector (particularly insurers, as well as companies that prioritise corporate social responsibility or those that are building their brand and reputation).

These key actors may operate at one or more of the following levels, specialising in and serving different purposes:

- Local level: includes communities and local governments. As they are the last-mile actors, participants at this level are vital for the design, implementation, and operation of EWSs.
- National level: establishes policies and frameworks that support the local level.
- Regional level: links neighbouring countries with one another and up to the international level. The regional level is particularly vital in the case of transboundary hazards.
- International level: provides coordination, standardisation, and knowledge exchange across all countries.

This paper will use the five elements and four subcomponents outlined above to reassess the state of EWSs in each ASEAN Member State. The assessment will first evaluate all hazards and then focus on floods and, finally, droughts.

5.3 General State of EWSs in ASEAN

Article 7 of AADMER shows that ASEAN Member States at the regional level have successfully incorporated the first four EWS elements. Making the elements part of the legally binding AADMER agreement on establishing and maintaining national EWSs also demonstrates the use of the fifth element of “governance”.

The August 2019 Disaster Monitoring and Analysis Workshop held with mid-level career officers of the respective National Disaster Management Organisations (NDMOs) through the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre) Executive (ACE) Programme Batch 6 provided additional insight into the implementation of the EWS elements.

5.3.1 Data Collection and Storage

Regarding the collection and storage of data for the first EWS element of “risk knowledge”, participants from all ASEAN Member States except Cambodia, Indonesia, and Lao People’s Democratic Republic (PDR) cited the use of file folder systems with both hard copies and soft copies. Hard copies are especially prevalent at the lower subnational levels, where they are used to feed data into the systems and databases at the national level. Four Member States (Indonesia, Singapore, Thailand, and Viet Nam) use cloud storage as an additional backup and for remote access. Several Member States (Cambodia, Lao PDR, Myanmar, the Philippines, and Viet Nam) also have national disaster databases for data storage and analysis (the Cambodia Disaster Damage & Loss Information System (CamDi), Lao-D, the Myanmar Disaster Loss and Damage Database (MDLD), the National Damage and Loss Registry, and the Damage Assessment and Needs Analysis, respectively).

The databases of Cambodia and Myanmar use the DesInventar methodology (CamDi, 2020; MDLD, n.d.). A representative from Brunei Darussalam reported the creation of a Microsoft Excel database but raised the concern that it lacked continuity in monitoring and still manually referenced hard-copy reports. This issue highlights the importance of the fifth element of “governance” in institutionalising processes and software, leading to the use of consistent practices and proper maintenance of technology.

5.3.2 Data Visualisation and Systems

Three of the ASEAN Member States have unique systems that span the first three EWS elements of data collection, disaster monitoring, and dissemination of information. Cambodia has an interactive online map system (called Platforms for Real-time Information Systems) that pools data from the Government, humanitarian actors, and last-mile communities (MangoMap, n.d.). This system collects hazard and exposure data, allows for visualisation of data, and can disseminate warnings through phone alerts (World Food Programme, 2020). Indonesia’s disaster database is an online dashboard that collects and displays data in spatial form, graphs, and tables (Data & Informasi Bencana Indonesia, n.d.). Malaysia’s National Disaster Information Management System conducts disaster monitoring and analysis and can disseminate real-time early warnings via social media, SMS, fax, and phone calls.

5.3.3 Information Flow and Reporting

Across the first three EWS elements, most ASEAN Member States have established processes for the flow of information from subnational levels (as far as the village level or last-mile communities) to the national level. Due to their smaller size, Brunei Darussalam and Singapore have not established these processes. Most Member States disseminate daily disaster reports, except the Philippines and Thailand, which do so twice daily.

5.3.4 NMHS People and Processes

Seven of the nine ASEAN Member States that provided information had NMHSs with a steadily increasing staffing trend during the past three to five years (WMO, 2019a), which indicates efforts towards strengthening NMHSs and improving the second EWS element of disaster monitoring. Malaysia specifically identified that its multi-hazard EWSs do not warn of potential cascading impacts, and its NMHS is not engaged in performance reviews of the multi-hazard EWSs (WMO, 2019a).

Table 5.1 summarises the current state of EWSs in ASEAN regarding three EWS elements (“dissemination of information”, “preparedness and response”, and “governance”) and the subcomponent of “people”.

The Joint Research Centre (JRC) of the European Commission developed the 2019 INFORM Global Risk Index, a composite risk index that scores countries on various risk components (JRC, 2019). Table 5.2 presents the scores for the components relevant to the first, third, and fifth EWS elements and the subcomponent of “hardware” for all ASEAN Member States. A lower score indicates that the Member State is strong in that component.

ASEAN Member State	EWS Element				Sub-component
	Dissemination of information	Preparedness and response	Governance		People
	Communication channels (other than television, radio, print media, web, social media)	Percentage of local governments with a plan to act on early warnings	Law(s)	Sources of funding for upgrading infrastructure	Other key actors providing climate services
Brunei Darussalam	Mobile application	N/A	None		None
Cambodia			Decree, unspecified	National	
Indonesia	Mobile application	70%	Law No. 31 Year 2009	International and national	None
Lao PDR			Minister's Resolutions and Mandates of Department of Meteorology and Hydrology	International	
Malaysia	Mobile application, siren	100%	Ministers of the Federal Government (No. 2) Order 2013	National	None
Myanmar		90%	The Department of Meteorology and Hydrology has a plan to create a law regulating Meteorology; National Disaster Management Standing Order	International	None
Philippines (the)	Mobile application, dedicated broadcast, word of mouth, fax		Presidential Decree No. 78: Establishing the Philippine Atmospheric Geophysical and Astronomical Services Administration; Republic Act No. 10121: Philippine Disaster Risk Reduction and Management Act of 2010	International and national	Non-governmental & academia
Singapore	Mobile application	N/A	National Environment Agency (NEA) Act, Cap 195	National	Other organisations, unspecified
Thailand	Mobile application, fax, email	100%	Disaster Prevention and Mitigation Act B.E. 2550 (2007); Ministry Regulations and the Reorganization of Ministry, Sub-Ministry, and Department Act (No. 17), B.E. 2559 (2016); National Disaster Risk Management Plan 2015	National	Other governmental and research institutes
Viet Nam			Several laws, unspecified	National	None

Table 5.1

Current state of EWSs in ASEAN regarding three EWS elements and one subcomponent (the grey boxes indicate that the Member State provided no information) (source: WMO, 2019a).

ASEAN Member State	Vulnerability	Lack of coping capacity: Communication	Governance	Physical infrastructure
Brunei Darussalam	0.7	1.9	3.4	3.9
Cambodia	3.8	5.3	7.2	6.1
Indonesia	3.2	2.9	5.7	4.9
Lao PDR	3.7	5.2	6.5	5.9
Malaysia	3.0	1.8	4.3	2.8
Myanmar	5.3	5.6	7.0	5.4
Philippines (the)	4.5	3.1	5.8	3.8
Singapore	0.4	1.3	1.1	0.9
Thailand	3.3	2.2	5.3	2.9
Viet Nam	2.4	2.4	5.8	3.4

Table 5.2

Scores for various components of the 2019 INFORM Global Risk Index for ASEAN Member States (source: JRC, 2019).

5.3.5 Regional Organisations

At the regional and subregional levels, the AHA Centre, the ASEAN Specialised Meteorological Centre (ASMC), and the non-ASEAN Mekong River Commission (MRC) and Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) exist for collaboration between countries on EWS and disaster monitoring, among other purposes (Bisri, 2019).

The AHA Centre is an ASEAN intergovernmental organisation that primarily works with NDMOs to facilitate cooperation and coordination for disaster management. In the regional EWS space, the AHA Centre monitors and analyses disasters (including floods and droughts) through the ASEAN Disaster Monitoring and Response System. It also disseminates updates based on information from NDMOs and other reliable sources and facilitates coordination of preparedness and response efforts.

The ASMC is a regional collaboration programme among the National Meteorological Services of ASEAN Member States. It supports the development of these services with scientific research and advances in meteorological science and technology. ASMC provides seasonal and sub-seasonal weather information and climate forecasts covering droughts and other events in the ASEAN region.

Subregionally, the MRC is a platform for regional cooperation in data and information sharing. It monitors and manages data regarding floods and droughts in Cambodia, Lao PDR, Thailand, and Viet Nam, which share parts of the Mekong River. RIMES is an intergovernmental agency that includes Cambodia, Lao PDR, Myanmar, the Philippines, Thailand, and Viet Nam. Apart from earthquake and tsunami warnings, RIMES provides weather information and seasonal climate outlooks to NMHSs. It also offers capacity-building for Member States' end-to-end multi-hazard EWSs, including a closed decision-support system for floods and droughts for Cambodia, Myanmar, and the Philippines (Bisri, 2019).

ASEAN Member State	Description of issue	Related EWS element * 1	2	3	4	5	Related sub-component
Cambodia	Inadequate mitigation analysis and vulnerability assessments	■					Processes, People
	Lack of technology awareness		■	■			Hardware, software, people
	Shortage of technical experts to undertake climate risk modelling, impact assessment, and development of adaptation measures	■	■		■		People
	Policy and institutional shortfalls					■	Unspecified
	Significant financial constraints and lack of financial mechanisms (see conclusions and recommendations)					■	Processes
Lao PDR	Lack of long-term historical data	■					Unspecified
	Lack of long-term, comprehensive studies on sectoral impacts, especially on agriculture, water resources, forests, and public health	■					Processes, people
	Need for more appropriate national climate scenarios and lack of long-term socioeconomic scenarios to assess impacts and vulnerability	■	■				Processes, people, software
	Need for improved research and systematic meteorological observation		■				Processes, people
	Need for improved awareness and capacity -building required at all levels				■		Unspecified
	Technological limitations inhibiting flow of information			■	■		Hardware, software
	Need for strengthened National Focal Point and insufficient networking of key stakeholders					■	People, processes
	Lack of priority given to climate change					■	People, processes

ASEAN Member States	Description of issue	Related EWS element* 1	2	3	4	5	Related sub-component
Lao PDR	Need for policies and mechanisms for securing finance to address climate change priorities (see conclusions and recommendations)					■	Processes
	Lack of systems to monitor and evaluate actions					■	Processes
	Shortage of technical experts	Unspecified					People
Thailand	Need for more climate change scenarios appropriate to Mekong subregion	■					Processes, people, software
	Need for development of techniques for preparing socio-economic scenarios consistent with climate change and analyse impacts on major sectors	■	■				Software, processes
	Need for technologies for disaster warning systems		■				Hardware, software
	No public health warning systems in critical areas			■			Hardware, software, processes
	Need for raising public awareness and stakeholder engagement				■		Unspecified
Viet Nam	Incomplete database of impact assessments	■	■				Software
	Need for climate models with better resolution to understand local impacts		■				Software
	Insufficient hydrological-meteorological observational infrastructure and lack of uniformity		■				Hardware, software, processes
	Insufficient telecommunication systems			■			Hardware, software
	Lack of technical experts and limited human resource capacity	Unspecified					People

Table 5.3

*List of issues faced by each MRC Member State and the EWS element(s) and subcomponent(s) that they relate to (source: MRC, 2019). *EWS elements: 1 = risk knowledge; 2 = detection, monitoring, analysis, and forecasting; 3 = dissemination; 4 = preparedness and response; 5 = governance.*

The MRC (2019) published the State of the Basin Report 2018, in which the four Member States identified several issues and gaps relating to climate change adaptation and their EWSs (Table 5.3).

5.3.6 EWS Challenges

System Complexity

As the EWS elements are interdependent and require coordination between several subcomponents, every element and subcomponent must function well. Otherwise, one failing element or component can lead to the failure of the entire EWS.

Data Harmonisation, Sharing, and Integration

Across the ASEAN Member States (and even within the individual Member States), varying institutional and regulatory arrangements mean that different actors collect and use different types of data and indicators. This variation results in a lack of harmonisation in data collection and implementation. For instance, the NMHS typically handles information and dissemination, while agricultural services perform data analysis and validation. In another example concerning droughts, the agriculture sector may require data on soil moisture to inform farmers, but the NMHS may only collect precipitation data to feed into the Standardized Precipitation Index (SPI). Data sharing between government agencies and academia can also experience similar limitations, emphasising the need for strong links between all key actors in EWSs, especially in the harmonisation and sharing of data (Bisri, 2019).

Data Quality

For the second EWS element regarding flood and drought modelling and forecasting, data quality limits the accuracy of the information when there is a lack of localised climate change scenarios (Table 5.3) and an inadequate density of meteorological and hydrological stations.

Communicating Scientific Uncertainty

For the second and third EWS elements, communicating scientific uncertainty to the general public can pose a challenge. This goal is to find a balance between raising false alarm bells when forecasts do not materialise and not convey a strong enough warning when some uncertainty exists for a significant threat.

False Information

In the current digital age, the spreading of false information can cause confusion and undue panic, especially among the less-informed population. With regards to the third EWS element, those who are responsible for disseminating information (especially the media) need to be aware of the problems that misinformation poses. Encouraging a culture of referring to official sources for information among the general public and last-mile communities can help combat the problem.

Legislation and Clear Roles and Responsibilities

Although the fifth EWS element of "governance" is crucial, only Malaysia, the Philippines, and Thailand have a national drought policy to legislate drought management (WMO, 2019a). Additionally, it is easy for NMHSs and NDMOs to have overlapping areas of responsibilities, which might obfuscate the respective roles. Governance is vital for clearly defining roles and responsibilities and holding the NMHSs and NDMOs accountable.

Developmental Constraints

As Table 5.3 shows, specifically with regards to Cambodia and Lao PDR, developing countries' need to focus on other priorities often leads to issues such as limited infrastructure, budget, and technical capacity for EWSs. Such cases may necessitate low-cost options, such as partnerships with the private sector and community involvement. The private sector can therefore become a key actor in EWS implementation, as identified in the "people" subcomponent and exemplified in the Philippines' flood EWS. An example of involving the community is a bottom-up approach to data collection for floods in Thailand. Alternatively, funding and support mechanisms can provide assistance. The Climate Risk and Early Warning Systems (CREWS) initiative is a project-based financing mechanism established through a collaboration between WMO, the World Bank, and the UNDRR. CREWS finances projects to develop climate-change-induced disaster risk EWSs and scale up multi-hazard EWSs for SFDRR objectives in Least Developed Countries such as Cambodia, Lao PDR, and Myanmar. Similar to four of the EWS elements, the objectives for CREWS are to (1) gather risk and climate information to guide EWSs, (2) improve service delivery of NMHS, (3) establish effective communications that reach communities at risk, and (4) create preparedness and response plans. By the end of 2018, CREWS had mobilised USD 32 million since its launch in 2015 (WMO, 2018b; WMO, 2019b). CREWS aims to mobilise more than USD 100 million by 2020. The Global Climate Action Summit 2019 recognised CREWS as a key financing mechanism for strengthening EWS approaches, pointing to its importance at the global level. Additionally, a new Risk-informed Early Action Partnership was launched with the aim of investing USD 500 million in EWS infrastructure and institutions by 2025 and targeting early action in the world's most vulnerable areas (WMO, 2019c).

5.4 Flood EWSs

5.4.1 Background

Bisri (2019) defines a flood in the ASEAN region as "a temporary inundation of water on the Earth's surface, mostly along a river system, due to long-lasting rainfall that caused overflow of water, or disruption of drainage or water management infrastructure". All ASEAN Member States are susceptible to floods. Traditionally, the six main types of floods include urban, pluvial and overland, coastal, groundwater, semi-permanent, and flash floods (Bisri, 2019). However, in the context of climate change, this paper focuses on three types that heavy precipitation and sea level rise may exacerbate, namely coastal, fluvial (river), and pluvial (surface) floods.

5.4.2 Types and Causes

Coastal floods consist of inundation by seawater along the coast due to extreme tidal conditions or storm surges from TCs. Due to a likely increase in heavy precipitation associated with TCs, as well as rising sea levels resulting from climate change, coastal floods may bring increasing damage to physical and social infrastructure (IPCC, 2018). Fluvial (or riverine) floods occur when a river exceeds its capacity, typically due to excessive rainfall over an extended period. Pluvial (or overland) floods result from excessive rainfall independent of an overflowing water body. In the ASEAN region, heavy rainfall tends to occur due to the Inter-Tropical Convergence Zone, wet monsoon seasons, and TCs. With the likely increases in heavy precipitation from climate change, fluvial and pluvial floods may occur more frequently.

5.4.3 Impacts

In the past 10 years across the ASEAN region, the average flood event affected more than 200,000 people, damaged 25,000 houses, and cost USD 110 million in damages. These figures exclude the extreme 2011 Thailand floods, which affected more than 11 million people, damaged 1.5 million houses, and cost more than USD 43 billion in damages (all figures compiled and averaged by the author from various sources).

As the agricultural sector dominates the ASEAN region, the potential impact of floods on crops can severely affect livelihoods and the economy. Coastal floods can also cause saltwater contamination, affecting freshwater ecosystems, freshwater supply, or access to drinking water. Other flood impacts include waterborne diseases and spillage of sewage.

8.4.4 Flood EWSs in ASEAN

Key actor(s)	Means of information dissemination
Brunei Darussalam	
Brunei Darussalam Meteorological Department (BDMD)	Weather forecast website
Cambodia	
Department of Meteorology; Ministry of Water Resources and Meteorology; National Committee for Disaster Management (NCDM)	Weather forecast website; EWS 1294: Mobile alert by voice recording
Indonesia	
Meteorological, Climatological, and Geophysical Agency (BMKG); National and Regional Disaster Management Agency (BNPB; BPBD)	Weather and climate forecasts website; Web-based EWS in each major-river agency
Lao PDR	
Department of Meteorology and Hydrology, Ministry of Natural Resources and Environment	National Early Warning Centre
Malaysia	
Malaysian Meteorological Department (MetMalaysia), Ministry of Energy, Science, Technology, Environment and Climate Change; Department of Irrigation and Drainage, Ministry of Water, Land and Natural Resources	Weather and climate forecasts website; InfoBanjir website for floods
Myanmar	
Department of Meteorology and Hydrology (DMH)	Weather and climate forecasts, hazards and warnings website
Philippines (the)	
The Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA)	Flood alerts and advisories; Weather and climate forecasts website
Singapore	
Meteorological Service Singapore (MSS), NEA; Public Utilities Board (PUB)	Weather and climate forecasts website, fortnightly weather outlook; Flash floods advisory; SMS alerts: heavy rain warning and high-water-level alert
Thailand	
Thai Meteorological Department (TMD); National Disaster Warning Center, Department of Disaster Prevention and Mitigation (DDPM), Ministry of Interior	Weather and seasonal climate forecasts website; Daily reports; Mobile application
Viet Nam	
National Centre for Hydro-Meteorological Forecasting (NCHMF), Viet Nam Meteorological Hydrological Administration, Ministry of Natural Resources and Environment	Weather and seasonal climate forecasts website

Table 5.4

Description of the key actors managing flood EWSs and the means of warning dissemination in ASEAN Member States (source: Bisri, 2019).

Subregionally, the MRC has a Regional Flood Management and Mitigation Centre (RFMMC) in Phnom Penh, Cambodia. RFMMC is responsible for more than 20 hydrological stations along the Mekong River that monitor and forecast water levels. The Centre also has a Flash Flood Guidance System that detects flash floods and issues warnings to the national and local authorities in the four Member States. In addition to RFMMC, mobile applications also play a role in the dissemination of information.

5.4.5 Discussion of EWS

Subregional EWS integration

The subregional arrangement of the MRC's flood EWS can work particularly well for the Mekong communities, as they all share effects originating from the same major river. Upstream data can translate into downstream early warnings and preparedness, while working together across upstream and downstream communities can help mitigate any adverse effects of upstream actions on the downstream communities. As the Mekong River forms parts of the different borders between Member States, especially between Lao PDR and Thailand, a subregional EWS helps ensure the sharing of resources and best practices while minimising duplicity and confusion. This interconnectedness fulfils part of the purpose of the regional level, as identified in the "people" subcomponent.

Bottom-Up Crowdsourcing

In Indonesia, the Zurich Insurance Group and the International Federation of Red Cross and Red Crescent Societies jointly created a flood resilience model based on pre-disaster actions that target poor communities. As part of this project, the organisations successfully implemented the mobile application Z-Alert for disseminating warnings on hazards such as floods, TCs, fires, and tsunamis, with a function for the public to create and verify warnings (UNDP, 2018). Z-Alert is also one of the data sources for another initiative in Indonesia: PetaBencana.id. This web platform crowdsources flood information from Twitter and combines it with information from the relevant government agencies, taking advantage of the big data available from the widespread and heavy use of geolocated tweets on Twitter in Jakarta (PetaBencana.id, 2019). PetaBencana.id represents a model for a bottom-up approach to flood mapping that relies on strong civic engagement. Although PetaBencana.id relates more to disaster reporting and response than early warning, the recent and severe 2020 Jakarta floods proved its value. Activity on the platform spiked during the floods, with residents using the information to guide preparedness and response decisions. Thousands of residents submitted reports concerning flood severity, failures in infrastructure, and response efforts. The local disaster management agency also used the platform to coordinate responses, and the United States' National Aeronautics and Space Administration used it to quickly calibrate satellite flood maps for analysis and planning efforts (PetaBencana.id, 2020).

In Thailand, TMD combines data from weather stations, satellites, and 1,000 volunteers for flood warnings. This is another example of combining a bottom-up approach which also proves to be more cost-effective.

Private Sector Engagement

In the Philippines, the private, non-profit Weather Philippines Foundation (WPF) installed and continues maintaining a modern network of almost 1,000 automated weather stations. The network has allowed WPF to provide localised weather services to the population, including five-day forecasts and automated current weather feeds updated every 10 minutes. WPF reaches the population through a broad public campaign on several platforms, including a mobile application, a website, a dedicated TV channel, and social media. The WPF campaign uses the hashtag #WeatherWiser to educate the public about its free weather services and how to use the information (UNDP, 2018). The campaign is an excellent example of how the private sector can play a role in EWSs.

5.4.6 Challenges

As stated in the second EWS element, maintenance and upgrading of monitoring instruments and systems is a necessity. For flood EWSs, the hardware, software, and systems are usually already in place, but damage can occur if the equipment and systems do not receive proper maintenance and upgrades due to neglect or budget constraints. This possibility also highlights the importance of the fifth element of "governance" in legalising and budgeting for regular maintenance and upgrading.

5.5 Drought EWSs

5.5.1 Background

Droughts are recurrent and slow-onset phenomena that result from a deficit in precipitation and depend on a region's long-term average climate (United Nations Office for Disaster Risk Reduction (UNDRR), 2019). Droughts can last for weeks to years and affect large areas and populations. Compared to floods, droughts are more complex due to their slow-onset nature and cascading impacts that can affect many aspects of human societies and the biosphere (UNDRR, 2019).

5.5.2 Types and Causes

Droughts can fall under the classifications of meteorological, agricultural, hydrological, or socioeconomic. They usually occur in a cascading sequence (Figure 5.2), beginning first with a meteorological drought, defined as a deficiency in precipitation over a specific area for a period (National Drought Mitigation Center (NDMC), n.d.). This may lead to agricultural drought, which links meteorological drought to agricultural impacts such as a decrease in soil moisture and crop failure. Over time, this can develop into hydrological drought, defined as a shortage in surface and underground sources of water (NDMC, n.d.). Socioeconomic drought links economic supply and demand with the other types of drought when water supplies fail to meet urban demands (Mishra & Singh, 2010).

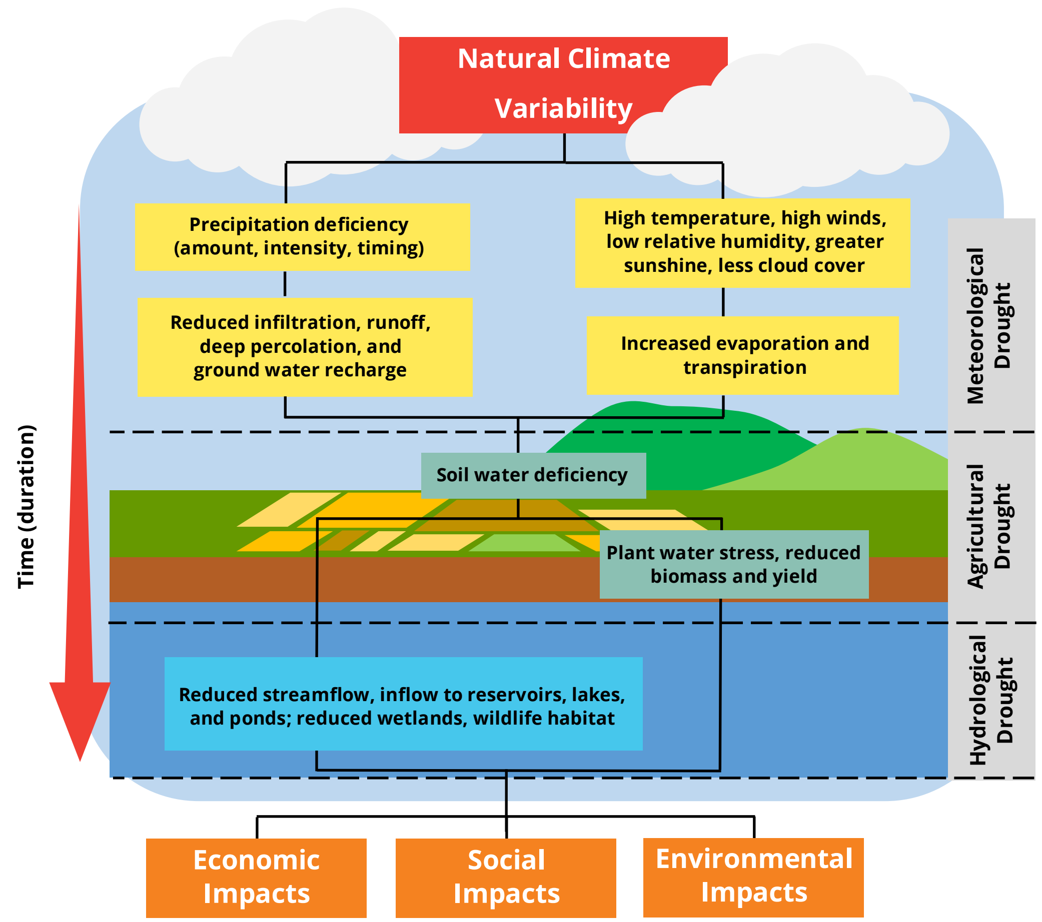

Figure 5.2

Cascading sequence of drought types and their impacts. All droughts begin as meteorological (source: Wilhite, 2000).

5.5.3 Drought Indices

In the second EWS element, drought indices function as indicators of the level of drought severity. The measure of severity then provides a decision-making basis for managing the risks and impacts as part of the fourth EWS element. Therefore, effective and accurate monitoring of hydro-meteorological data is a key input for identifying drought risk. In 2009, WMO recommended the SPI as the primary meteorological drought index for use in monitoring (Hayes, Svoboda, Wall, & Widhalm, 2011). In the ASEAN context, common indices include the following:

- SPI, the most common index, computes long-term historical precipitation to produce a probability of precipitation.
- The Standardized Precipitation Evapotranspiration Index (SPEI), a combination of various drought indices based on climatic data, uses the Thornthwaite equation to estimate potential evapotranspiration, including a temperature component.
- The Normalized Difference Vegetation Index (NDVI) uses multi-spectral remote sensing data and measures the green of leaf cells to indicate vegetation conditions. NDVI is suitable for monitoring large areas.
- The Moisture Availability Index (MAI) assesses soil moisture during the crop period, which is the ratio of dependable precipitation (75% probability of precipitation) to potential evapotranspiration.
- The Percentage of Normal Rainfall Index (PNRI) is a local drought index used in the Philippines. PNRI is a percentage of the ratio between the actual rainfall and 30-year average rainfall. While simple to calculate, it cannot be applied uniformly across a diverse area with different averages because a high rainfall area and a low rainfall area can have the same percentage of average rainfall.
- The Effective Drought Index (EDI) uses a single input of daily precipitation to compute the daily, mean, deviation, and standardised value of deviation of effective precipitation. These values can help identify the beginning, end, and duration of drought.

deviation of effective precipitation. These values can help identify the beginning, end, and duration of drought.

- The Keetch-Byram Drought Index (KBDI) typically helps in monitoring forest fires, which are a symptom of droughts. KBDI estimates the upper soil layer moisture using daily precipitation data, daily maximum air temperature, and other local climatic factors.
- The Combined Drought Index is a combination of SPI, soil moisture, and remotely sensed vegetation data (fraction of absorbed photosynthetically active radiation) that the MRC employs.

Ideally, a drought EWS has two parts to its second element: monitoring and forecasting. A drought monitoring system receives, tracks, and assesses information concerning climatic, hydrologic, water supply, and long-term historical records. Following the onset of a drought, a drought index can help indicate its severity. A drought forecasting system can then analyse and forecast the trends and impacts of the drought. An accurate drought forecast can reduce drought risk and impacts through early preparedness and response by key actors.

5.5.4 Impacts and Risk in ASEAN

Agricultural droughts reduce food production and increase water scarcity, in turn affecting food prices and security and access to water for other purposes such as drinking and cooling water for energy generation (APEC Climate Center, 2017). Thus, most countries consider agricultural droughts to be the most significant.

Droughts heavily impact the agriculture sector and economies in ASEAN, in part because agriculture contributes up to 26% of the gross domestic product in the region, and ASEAN produces nearly 30% of the world's total rice supply (ESCAP, 2019a). Over the past 30 years in ASEAN, droughts affected more than 66 million people, and the agriculture sector experienced the most severe economic impact at four-fifths of the total losses (ESCAP, 2019a). Drought events in the third quarter of 2018 alone affected more than 4.8 million people in Indonesia (AHA Centre, 2018).

Excluding Brunei Darussalam and Singapore, ASEAN Member States experience at least a moderate level of drought risk. Brunei Darussalam faces the risk of forest fires fanned by high temperatures and winds, especially in its areas of peatland. During the severe 2014/2016 El Niño event, the majority of Member States experienced drought, with Cambodia, Indonesia, the Philippines, and Thailand experiencing severe effects. Maintaining this understanding of risk and impacts is in line with the first EWS element.

5.5.5 Drought EWSs in ASEAN

As Table 5.5 shows, SPI is the most common index that ASEAN Member States use for the second EWS element involving monitoring meteorological drought, in line with WMO's recommendation (Hayes et al., 2011). SPI is easy to use and analyse because it only involves precipitation data. However, it does not account for different temperatures, which are important for the overall water balance and water use of a region.

The extensive use of satellite imagery with NDVI, KBDI, and EDI indices advances drought forecasting in some Member States and adds a layer of sophistication in managing the complexities of drought. Such remote sensing technology provides continuous data that can help determine the onset, duration, and severity of droughts, demonstrating the effectiveness of using a range of drought indicators in the second EWS element (Berhan, Hill, Tadesse, & Atnafu, 2011; Thiruvengadachari & Gopalkrishna, 1993).

Subregionally, the MRC has a Drought Monitoring and Forecasting System for the Lower Mekong Basin based on Regional Hydrologic Extremes Assessment System data from the Asian Disaster Preparedness Center. The Combined Drought Index produces forecasts and alerts, which are distributed to the Governments of the four Member States and published on the MRC's website with open access. RIMES is also adapting a drought EWS to identify climate and water supply trends and detect the probability and potential severity of droughts (RIMES, 2019).

5.5.6 Challenges

Droughts are inherently complex disasters influenced by atmospheric, hydrological, and geological conditions as well as land use changes. Thus, it may be difficult to differentiate droughts from water scarcity (Bisri, 2019). It is necessary to counteract this challenge through the use of a combination of different inputs and models for the second EWS element of drought monitoring and forecasting. Consequently, the complexity of drought also highlights the significance of having technical experts, especially those with experience and knowledge in climate risk and scenarios, to build and maintain expertise in every ASEAN Member State.

ASEAN Member State	Index used	Key actor(s)	Factors of the drought EWS
🔵 Brunei Darussalam	SPI	• Brunei Darussalam Meteorological Department	Seasonal climate information
🔵🟢 Cambodia	SPI	• Department of Meteorology; • Ministry of Water Resources and Meteorology; • Ministry of Agriculture, Forestry and Fisheries; • National Committee for Disaster Management	Drought risk map; DroughtWatch: drought indices monitoring and mapping
🔵🟢🔴 Indonesia	SPI; SPEI; NDVI	• Meteorological, Climatological, and Geophysical Agency; • Department of Hydrology; • Ministry of Public Works	Weather and climate forecasts; Periodical drought risk map
🔵🟢 Lao PDR	SPI	• Department of Meteorology and Hydrology; • Ministry of Natural Resources and Environment	National Early Warning Centre
🔵🟢 Malaysia	SPI	• Malaysian Meteorological Department; • Ministry of Energy, Science, Technology, Environment and Climate Change; • Department of Agriculture; • Ministry of Agriculture and Agro-based Industry	Weather and climate forecasts; Monthly drought monitoring report
🔵🟢 Myanmar	SPI	• Department of Meteorology and Hydrology	Seasonal drought reports; Drought Monitoring System
🔵🟢 Philippines (the)	SPI; PNRI; NDVI; LST*	• The Philippine Atmospheric, Geophysical and Astronomical Services Administration; • Department of Agriculture	Seasonal climate forecasts; El Niño Southern Oscillation alert system
Singapore	N/A	• Meteorological Service Singapore; • NEA	Seasonal climate outlook
🔵🟢🔴 Thailand	SPI; MAI; EDI; NDVI	• TMD; • National Disaster Warning Centre; • Department of Disaster Prevention and Mitigation; • Ministry of Interior; • Royal Irrigation Department; • Geo-Informatics and Space Technology Development Agency	Drought risk map; Seasonal drought reports and climate forecast; Daily reports
🔵🟢 Viet Nam	SPI; NDVI; KBDI	• National Centre for Hydro-Meteorological Forecasting; • Viet Nam Meteorological Hydrological Administration; • Ministry of Natural Resources and Environment; • Ministry of Agriculture and Rural Development	Monthly drought risk map; Weather and seasonal climate forecasts website

*LST is Land Surface Temperature, a drought indicator used in the Philippines

Types of Drought: 🔵 Meteorological 🟢 Agricultural 🔴 Socio-economic

Table 5.5

Description of types of droughts experienced and several aspects of drought EWSs in ASEAN. The table combines data from remote sensing and ground databases to provide information about the prevalence, severity, and persistence of agricultural drought (source: Bisri, 2019; ESCAP, n.d.).

5.6 Conclusions and Recommendations

This study found that some ASEAN Member States demonstrate bottom-up community involvement, reiterating the importance of using a range of drought indicators, including remote sensing, to manage the complexities of droughts. Despite some examples of national policies and frameworks that guide the local level in ASEAN, several Member States may be lacking in EWS-related laws. More legislative action can help establish clearer roles, responsibilities, and actions in this area.

The MRC represents an example of subregional EWS integration for floods and droughts in the Mekong region. However, when analysing the "people" subcomponent of the EWS model, a gap is evident at the regional level for EWS capacity-building, knowledge gathering, and coordination. One method of addressing this gap, similar to ESCAP's recommendation, may be to reinforce the operational links between the four identified regional organisations working in parts of the EWS space for floods and droughts. These organisations should continue to coordinate and support Member States' efforts to further their EWSs, be responsible for EWS best practices and capacity-building, and work to remedy the challenge of data harmonisation, sharing, and integration. Additionally, private sector engagement should contribute through both financial resources as well as preparedness and response. For instance, ensuring that businesses have robust continuity plans in place can minimise disruption to the economy during disasters. For countries facing financial constraints in implementing and upgrading EWSs, funding and support mechanisms such as CREWS and the Risk-informed Early Action Partnership can provide assistance. Finally, countries also need to consider creating a funding mechanism at the national level to ensure the sustainability of their EWS.

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When Early Actions Save Lives: Anticipating Instead of Reacting with Forecast-based Financing

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ARMOR

Abstract

Forecast-based Financing (FbF) is an Early Warning Early Action (EWEA) approach that releases humanitarian funding for agreed-upon early actions before weather-related hazard events. Forecast data help determine which actions to fund in anticipation of the hazard events to most effectively reduce negative impacts. The four components of FbF are (1) the trigger, which establishes where and when the implementation of early actions begins, (2) the predefined early actions, which aim to minimise the negative impacts of the hazard event, (3) the automatic release of funds from the dedicated financing mechanism of the International Federation of Red Cross and Red Crescent Societies (IFRC) following the activation of a trigger, and (4) the delivery, consisting of the implementation of the pre-identified early actions.

The Philippine Red Cross (PRC) developed an Early Action Protocol (EAP) for tropical cyclones (TCs) that enables the implementation of early actions focusing on the most at-risk municipalities. The EAP adapts to the local contexts of these municipalities by encouraging the strengthening of vulnerable houses, early harvesting of mature crops, and evacuation of livestock.

In Viet Nam, the Viet Nam Institute of Meteorology, Hydrology and Climate Change (IMHEN) and the Viet Nam Red Cross Society (VNRC) established a trigger for heatwaves. The trigger conditions help VNRC identify the urban areas that are most vulnerable to heatwave impacts by overlaying data for vulnerability, exposure, and hazards.

FbF is an excellent example of how humanitarian partners can help affected communities respond to short-term climate change effects as weather-related hazard events become more frequent and intense. FbF is adaptable to the local context and identifies early actions tailored to the impact that specific local communities experience. This customisation means that a single hazard event, such as a typhoon, can trigger different early actions depending on the contextualised vulnerability and exposure analysis of the at-risk areas.

Keywords: Forecast-based financing, early warning early actions, community-based strategies

6.1 Introduction

The International Red Cross and Red Crescent (RCRC) Movement is pioneering FbF with the goal of anticipating disasters, mitigating their effects, and reducing human losses and suffering. FbF is an EWEA approach that releases humanitarian funding for pre-agreed early actions based on forecast and risk data to reduce the impact of hazard events. FbF has four main components:

- **Trigger:** the threshold or series of conditions that determine where and when the implementation of early actions should begin based on forecast and risk analysis. The trigger is linked to Impact-based Forecasting (IbF), which analyses the likely impact or damage from a hazard event.
- **Early actions:** actions that take place between an initial forecast and the onset of a hazard event. Early actions are tailored to the local context to effectively reduce existing vulnerabilities and exposure.
- **Financing mechanism**: IFRC established Forecast-based Action (FbA) of the Disaster Relief Emergency Fund (DREF) as a designated fund for FbF implementation. The RCRC National Societies (National Societies) and FbA agree in advance on the allocation of financial resources that will automatically be released following the trigger.
- **Delivery**: the implementation of pre-identified early actions. Investments in institutional and community capacity to act are crucial to ensure the reduction of the impacts of a hazard event.

Apart from the National Societies, FbF actors include other humanitarian partners such as the United Nations (UN) system, local and national government ministries, research institutes, and the private sector. The EAP outlines the roles and responsibilities of all actors during an FbF activation and summarises the four FbF components. The EAP is similar to a standard operating procedure in that it provides instructions to implement anticipatory actions effectively and without delay. Each EAP for a specific hazard can receive up to CHF 250,000 (or USD 257,000) per activation.

6.1.1 The Trigger: IbF

The trigger defines when and where the funds will be released and the early actions will take place based on an analysis of who and what is most likely to be affected. The trigger is linked to the IbF concept, which focuses on "what the weather will do" rather than the traditional analysis of "how the weather will be". This analysis overlays the historical impact of a hazard, the exposure and vulnerability of communities in its path, and a forecast to predict which areas and communities will likely experience the most significant effects.

The 510 initiative of the Netherlands Red Cross (NLRC) developed an IbF model using datasets from 27 past typhoons (510 Global, n.d.). PRC uses the 510 model to help predict when and where housing will reach critical impact levels, contributing to the development of triggers.

The Indonesian Red Cross Society (PMI) is also exploring an integrated way of developing triggers. The PMI approach to IbF focuses on using a Government-led information management platform called InaSAFE FbA (InaSAFE FBA, n.d.). This platform integrates the forecast information from the Indonesian Agency for Meteorology, Climatology and Geophysics with risk data from OpenStreetMap and other government departments to identify the people and areas most likely to experience the consequences of floods. Support for the trigger development comes from a research investment by the Global Facility for Disaster Reduction and Recovery led jointly by Kartoza, an open-source geographic information system service provider, and the RCRC Climate Centre (Climate Centre). In time, IbF will allow the PMI to identify when and where it should activate its EAP.

The Mongolian Red Cross Society followed a similar trigger-development process. The organisation used a Government-generated IbF model with a risk map as an output. The model helps identify high-risk areas on a seasonal basis to enable anticipatory action before the effects of *dzud* (Mongolia's phenomenon of severe winter conditions) occur.

6.1.2 Early Actions

Once the conditions of the trigger are observed, early actions need to take place in preparation for the hazard event. The FbF actors pre-identify and tailor the early actions to the local context to effectively reduce existing vulnerabilities. Early actions require contextualisation because the impact of a natural event varies greatly depending on the geographic location, and the same hazard can trigger different early actions across a region based on the local contexts.

PRC identified a set of early actions that can help reduce the impact of typhoons based on the local context. In Catanduanes, one early action is premature harvesting or trimming of mature abaca trees to protect them from damage. Camarines Norte prepares for the same typhoon by providing shelter-strengthening kits to vulnerable houses to withstand the high winds. Chapter 6 provides additional details on FbF for typhoons in the Philippines.

When implementing early actions, the FbF approach acknowledges the challenges of forecasting typhoons and other natural hazards. It employs a "no regrets" policy in which, even if the hazard event does not occur or is not as severe as predictions stated, the early actions still take place to reduce the vulnerability of beneficiaries, and reimbursement of funds for these actions is not necessary.

6.1.3 Funding Mechanism: FbA by the DREF

The IFRC has extended the scope of its long-standing global financing instrument, the DREF, to include FbA. IFRC launched this dedicated fund in May 2018. FbA by the DREF provides multilateral funding to National Societies that have already developed their EAPs.

Following Validation Committee approval, each EAP can receive up to CHF 250,000 or USD 257,000 towards the implementation of the early actions within its agreement to ensure adequate readiness (including pre-positioning). The funds are automatically released as soon as the trigger is reached to allow the implementation of early actions in the most at-risk areas, according to IbF. FbA by the DREF is an innovative financing mechanism within IFRC's broader disaster risk financing (DRF) framework, further reinforcing the transition from reaction to anticipation by guaranteeing speed and predictability of the funds.

The anticipatory funding mechanism of FbA by the DREF strengthens links, data sharing, and decision-making between the different phases of intervention in the disaster management cycle. Assessments of exposure, vulnerability, and affected areas are already available as part of the IbF of FbF, allowing earlier emergency preparedness and response activities. FbA by the DREF thereby streamlines the integration of an anticipatory approach into traditional emergency response such that National Societies can implement preparatory measures and more rapid emergency response.

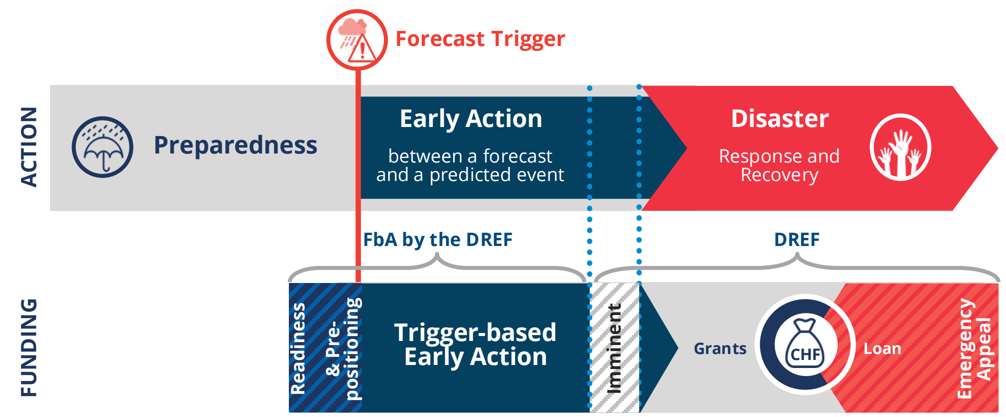

Figure 6.1

FbA by the DREF and DREF process (source: IFRC).

6.1.4 The Delivery

FbF relies not only on a trigger and an ex-ante financing mechanism but also on the capacity of National Societies to implement the early actions between a forecast and the onset of the hazard event. It is essential to have well-trained and equipped RCRC staff, requiring continuous capacity-building and organisational development. Similarly, local actors and disaster risk management authorities need to be capable of acting on a forecast and have trained staff available to implement early actions.

In addition to the personnel, RCRC also needs to adapt and strengthen its internal processes for procurement, logistics, and finance to ensure the delivery of goods and availability of services without delay. From a procurement and logistics perspective, FbF's need for short lead times when implementing early actions poses a challenge. At the same time, it is an opportunity to streamline internal processes and facilitate the delivery of goods and services, not only for FbF but also for traditional emergency response. In that sense, FbF contributes to making traditional response processes more risk-informed and anticipatory.

Similarly, FbF encourages new ways of transferring funds, both internally between IFRC and National Societies offices, as well as externally to beneficiaries. In Bangladesh, for example, the FbF project explored innovative ways of using mobile money and financial service providers to deliver unconditional cash grants within one day. This exploration included discussions with the Ministry of Finance, which regulates the quickly evolving financial landscape, and with mobile network operators that emerged as new and competing financial service providers.

Furthermore, FbF requires faster and more efficient identification of beneficiaries. As the impacted area changes with every hazard event, the beneficiaries also change, calling for the implementation of new or adapted systems to identify the most affected communities and households within hours or days after receiving a forecast. In addition to adapting traditional methods of beneficiary identification, RCRC is also exploring new approaches and seeking new partners to achieve this target. Discussions with the United Nations International Children's Fund (UNICEF) and other entities at the regional and national levels aim to evaluate how shock-responsive social protection (SRSP) systems can provide pre-identified and verified beneficiary names. This investigation is in line with global efforts to scale up FbF and to make traditional disaster risk reduction (DRR) and response approaches more anticipatory.

6.2 FbF In the Broader Anticipation Framework

FbF fits into the broader narrative of anticipatory approaches, which recognises that while climate change and the resulting consistent increase in extreme weather events affect everyone, they do not affect everyone equally. The poorest and most vulnerable populations disproportionately experience negative impacts, and climate change continues exacerbating their existing vulnerabilities. FbF is an innovative example of how the RCRC Movement helps affected communities to deal with the shorter-term climate change impacts as the severity and frequency of extreme weather events increases further.

FbF creates an enabling environment for communities to act in anticipation of an oncoming hazard event. It focuses on the local levels that suffer the consequences first, helping communities to understand a scientific forecast and translate it into actionable measures before, during, and after a hazard event. FbF empowers people, communities, and institutions to use science to make decisions and take action. National Societies are currently developing FbF in over 20 countries.

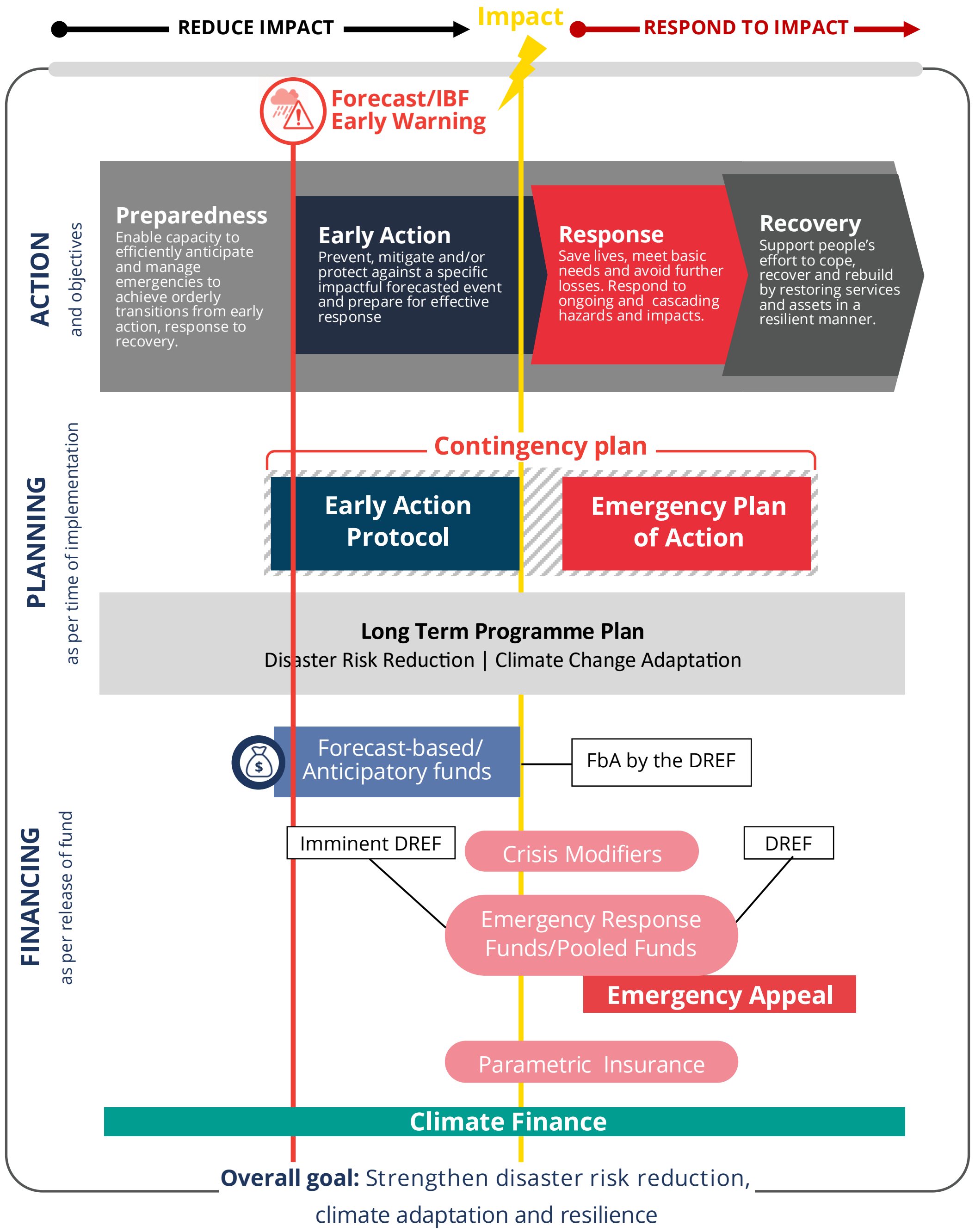

Figure 6.2
IFRC's DRF framework (source: IFRC).

FbF is also a part of IFRC's effort to strengthen its DRF systems to manage disasters of varying levels of severity and frequency by applying different types of financial instruments, such as contingent financing and insurance (Figure 6.2). Contingent financing, DREF, and FbA by the DREF enable pre-agreed arrangements for National Societies to receive funds after reaching trigger conditions. This rapid and predictable type of financing is applicable for small to medium hazard events. Insurances and regional risk pools, which IFRC is currently exploring through the Southeast Asia Disaster Risk Insurance Facility, offer more substantial, scalable, rapid, and predictable financing. The costs of premiums can be higher but are appropriate for larger events. Both of these ex-ante instruments can offer predictability that conventional IFRC emergency appeals do not.

DRF strengthens risk management by arranging financing in advance of crises through the use of supporting data and pre-planning. The design of FbF aims to make finance release rapid and predictable for governments to respond to a disaster, making it a critical DRF tool for funding anticipatory humanitarian action. States and organisations from global frameworks, such as the Global Platform for Disaster Risk Reduction, the United Nations Climate Change Conference, and several UN resolutions, have widely endorsed FbF as an innovative tool for better management of climate change and disaster. External research also shows that "developing an FbF mechanism that, based on early warnings, provides the institutional and funding arrangements that allow humanitarian actors to carry out pre-disaster activities to reduce potential losses and damages, effectively bridges the humanitarian and the development sectors" (Lopez et al., 2020). In addition to contributing to the humanitarian-development nexus, FbF has global relevance as it "can be scaled up in disaster-prone areas worldwide to improve effectiveness at reducing the risk of disasters" (de Perez et al., 2015). As the number of FbF projects grows globally, "the value of FbF systems will be greater than simply the losses avoided when the fund is released. If such a system is in place, actors in that region will be aware that many disaster effects are likely to be prevented due to FbA" (de Perez et al., 2015).

6.3 FbF for Typhoons in the Philippines

PRC developed its first EAP for TCs, the most frequent and impactful hazards affecting the Philippines, with the technical support of the German Red Cross (GRC), the Climate Centre, and the 510 initiative of NLRC. The EAP identifies the pre-agreed early actions that aim to mitigate the negative impacts of typhoons on livelihoods and housing. It also outlines how PRC will implement the anticipatory action for extreme typhoon events with a return period of at least five years. IFRC approved the typhoon EAP in November 2019 for activation in a total of 19 provinces. It selected provinces in which the respective PRC chapters (branches) had received training on the concept of FbF, and where the provincial DRR management (DRRM) partners had discussed and identified the early actions.

The trigger that activates the EAP links to a typhoon's forecasted impact, in accordance with the IbF concept. Based on a scientific analysis of historical typhoon events, the trigger threshold for implementing early actions is reached when the predicted impact of a typhoon 72 hours before the onset is total damage to 10% of the houses in at least three municipalities. At the lead time of 72 hours before the typhoon landfall, the accuracy of the forecast is at 70%. The accuracy and lead time allow PRC to act on the other factors while also acknowledging the forecast's average margin of error of 300 km.

The 510 initiative of NLRC developed a statistical model using datasets from 27 past typhoons (TC characteristics and corresponding house damages) to help PRC predict the time, location, and level of impact of typhoons (Figure 6.3) (510 Global, 2019a).

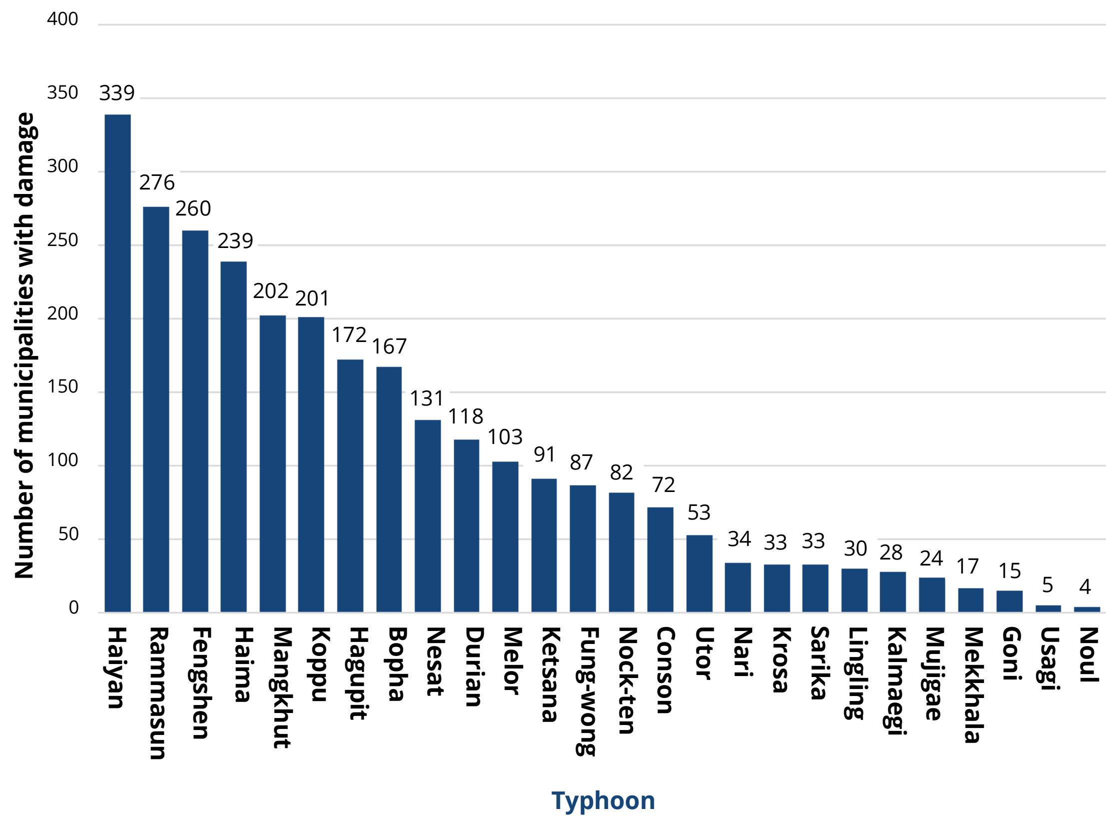

Figure 6.3
The 510 statistical model's TC damage data (source: 510 Global, n.d.).

As typhoons differ from case to case, the 510 team decided to predict absolute levels of damage in terms of the percentage of totally damaged houses per municipality. The predictions provided by 510 divide all municipalities into five classes of damage, with class 1 representing the lowest level of damage and class 5 the highest. When assessing the accuracy of these predicted damage classes against true damage classes (Figure 6.4), the model proves accurate enough to be applicable.

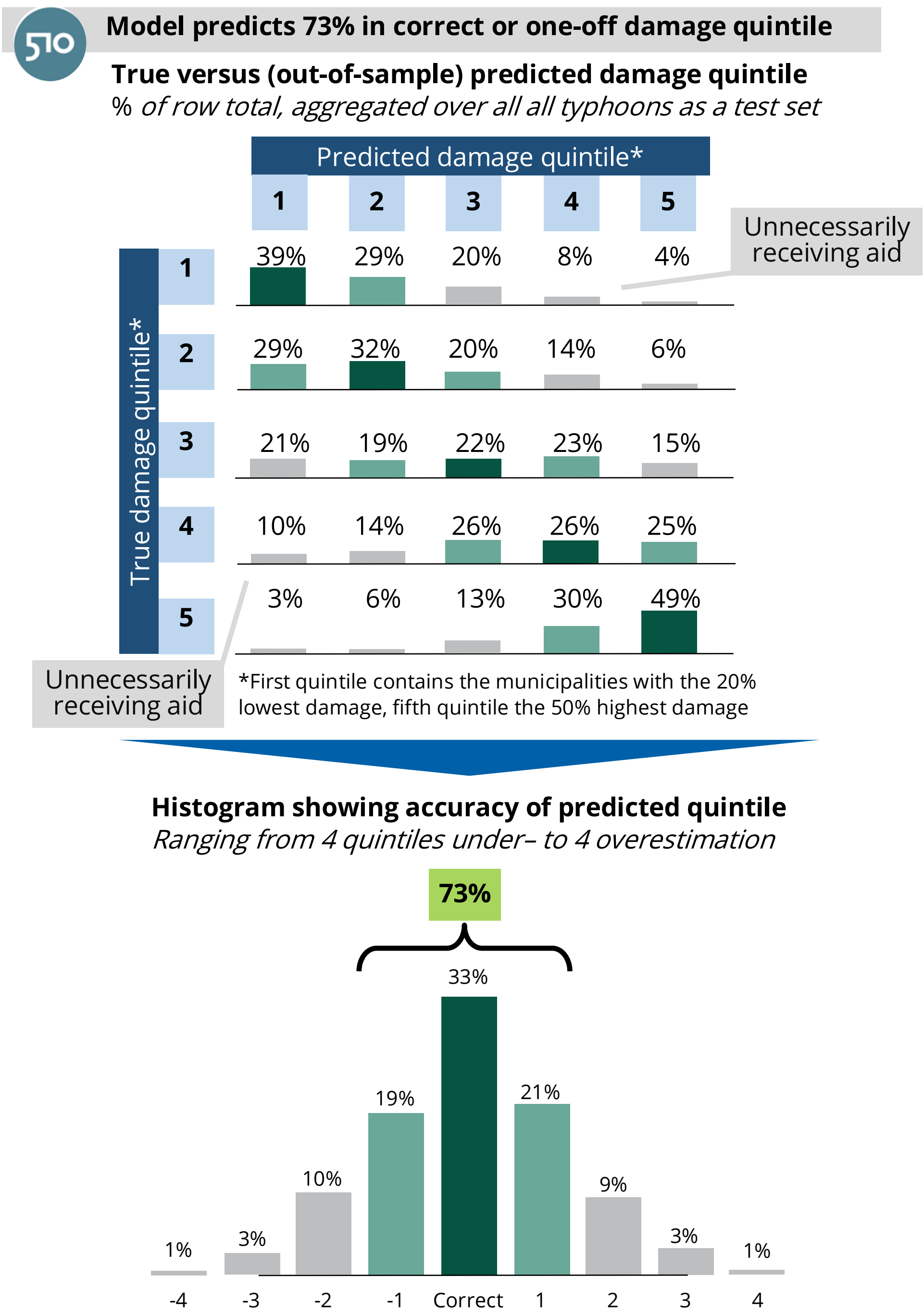

Figure 6.4

Accuracy prediction of the 510 statistical model (source: 510 Global, n.d.).

Regarding the early actions that aim to reduce the impact of typhoons on livelihoods and housing, PRC's EAP proposes the implementation of three contextualised early actions in the most at-risk municipalities:

1. **Strengthening of vulnerable houses in coastal areas with shelter-strengthening kits (SSKs):** the kits help vulnerable households to reinforce the roofs and walls, improving the shelter's ability to withstand strong winds and mitigating damage.
2. **Early harvesting of mature crops such as rice and abaca to help farmers maintain their agricultural livelihood:** abaca trees, for example, will not produce high-quality abaca fibre if they are damaged, leading to an income loss of up to 40% (based on focus group discussions from PRC and GRC with beneficiaries in Catanduanes). Uprooting abaca trees also results in losses as it can take up to two years for them to regrow.
3. **Evacuation of livestock and assets**: evacuation is a flexible early action that can target areas exposed to not only the severe winds but also the risk of flooding or landslide. This early action will also contribute to reducing the loss of lives, as many livestock owners are reluctant to evacuate without their animals and will remain in at-risk areas to avoid it.

A series of simulation exercises in 2019 thoroughly tested these three early actions (Abangan, 2019) and performed successfully during Typhoon Kammuri (locally known as Typhoon Tisoy) at the end of November 2019 (see section 6.1). The tests showed that PRC has the capacity to complete preparatory work three days ahead of the typhoon landfall and to implement the early actions two days before impact.

6.3.1 Test Activation During Typhoon Kammuri

When Typhoon Kammuri formed and entered the Philippine Area of Responsibility at the end of November 2019, PRC monitored the Philippine Atmospheric, Geophysical and Astronomical Services Administration's forecast of the typhoon track. PRC asked the 510 team to run the 510 statistical model to determine if the hazard event would reach the trigger level. The team ran the model from forecast day -5 (Thursday, 28 November 2019) to day -1 (Monday, 2 December 2019) using wind and track forecasts from the University College of London (Figure 6.5) (510 Global, 2019b). The impact-based forecasts confirmed that at least three municipalities would sustain total damages to more than 10% of houses in the northern provinces of the Bicol region. The data allowed PRC to make an informed decision about when and where to implement early actions to mitigate the damages. Based on the data, PRC tested its pre-agreed early actions in Catanduanes and Camarines Norte provinces, starting 72 hours before the typhoon landfall.

For Typhoon Kammuri, PRC was able to implement all three pre-agreed early actions at a small scale:

- Five barangays (the lowest administrative entities) in Catanduanes performed early harvesting and trimming of mature abaca trees. The PRC branch deployed 10 volunteers in the five barangays in the morning of day -3. Each team of volunteers was in charge of validating with the local authorities the list of farms that would benefit from the early action. PRC also recruited 20 workers in each barangay for undertaking the early harvesting.
- In Camarines Norte, municipal authorities selected and provided SSKs to a total of 10 vulnerable households in two coastal barangays. PRC deployed four volunteers and employed five workers per barangay to effectively and quickly install the SSKs.
- Evacuation of livestock primarily targeted two barangays prone to flooding that had previously lost livestock during Tropical Depression Usman in December 2018. PRC recruited 17 workers to support the preparation of a pooling area with appropriate fencing on day -3 at the provincial DRRM training centre. The DRRM office also disseminated information on the afternoon of day -3 and helped coordinate transportation for the following day. However, the rapid shift of the typhoon track in the 24 hours prior to landfall towards the southern provinces of the Bicol region prevented the team from fully demonstrating the added value of this early action.

A month after Typhoon Kammuri's landfall, the FbF team returned to Camarines Norte and Catanduanes to conduct an after-action review and collect feedback from communities that benefited from the early actions. The team also interviewed PRC branches, local government units, and other implementing partners. All interviewees confirmed the relevance of PRC's early actions and their usefulness in reducing the typhoon's impact on livelihoods and homes. The interviews revealed that all participants unanimously considered anticipatory action a positive innovation that complemented the pre-emptive evacuations undertaken on day -1. The review also confirmed PRC's capacity to implement early actions before the typhoon landfall.

In order to strengthen the link between FbF and response, the 510 team proposed the provision of maps of the estimated impact starting after landfall and continuing until the typhoon exits the Philippine Area of Responsibility. This information would allow PRC to prepare for early response.

SSK beneficiaries interviewed confirmed that the kits contained appropriate items for reinforcing their houses. Non-beneficiaries sustained more severe damages than beneficiaries (Figure 6.7) despite strengthening their houses (Figure 6.6), particularly in the province of Catanduanes, which has higher exposure and vulnerability compared to Camarines Norte. The repairs cost up to PHP 2,000 per beneficiary (primarily for roofs) and up to PHP 5,000 per non-beneficiary (primarily for roofs and walls).

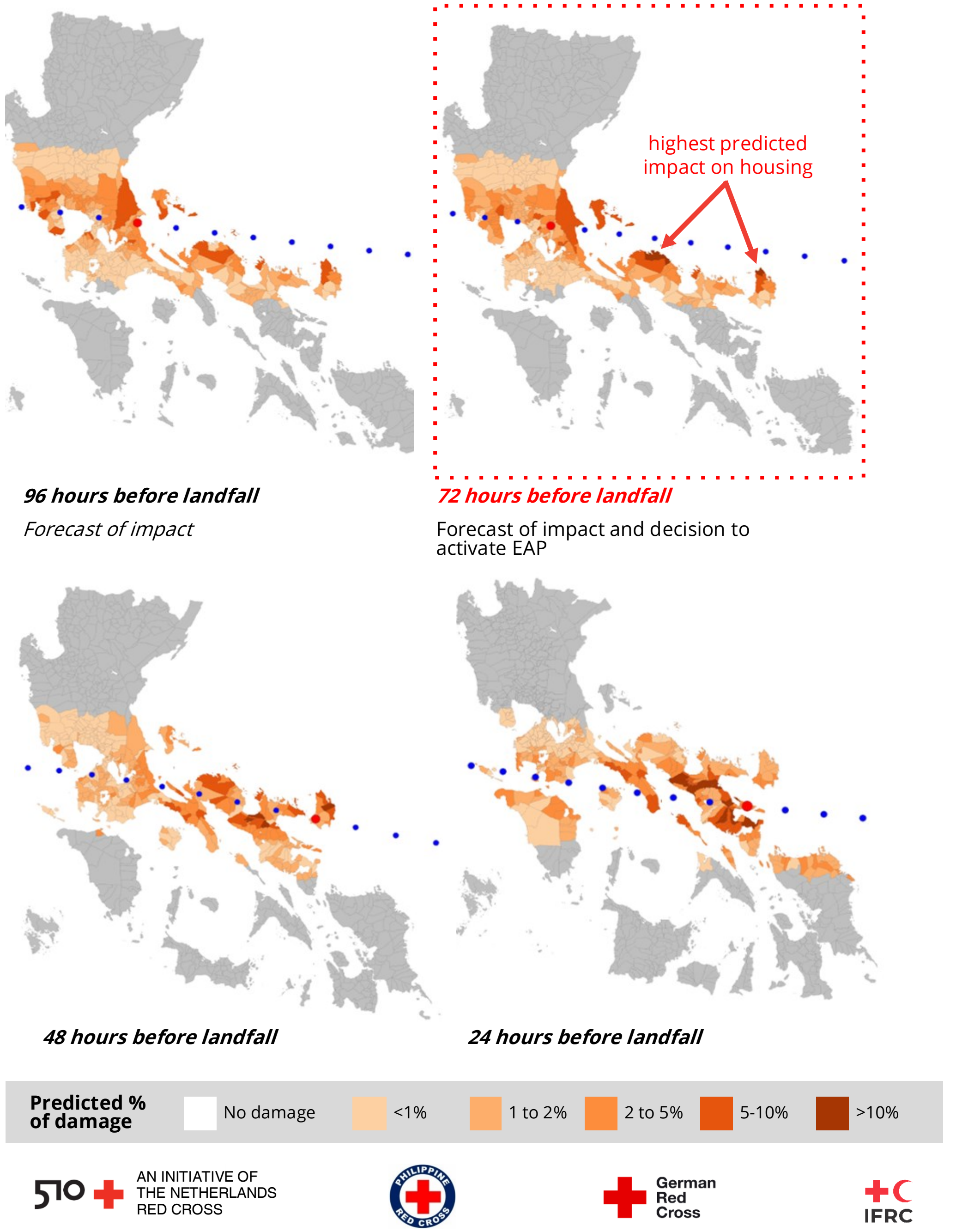

Figure 6.5

Impact-based forecast model by the 510 initiative 96 to 24 hours before the landfall of Typhoon Kammuri (source: 510 initiative of NLRC).

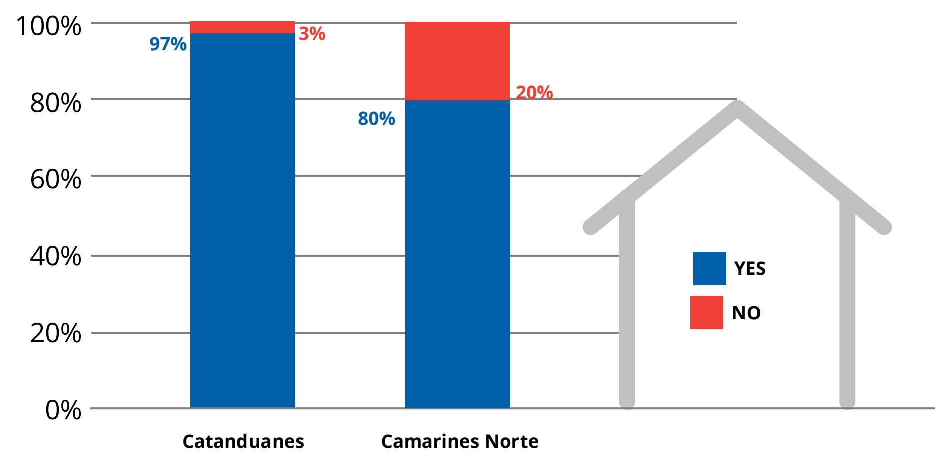

Figure 6.6

Percentage of non-beneficiaries that conducted house strengthening.

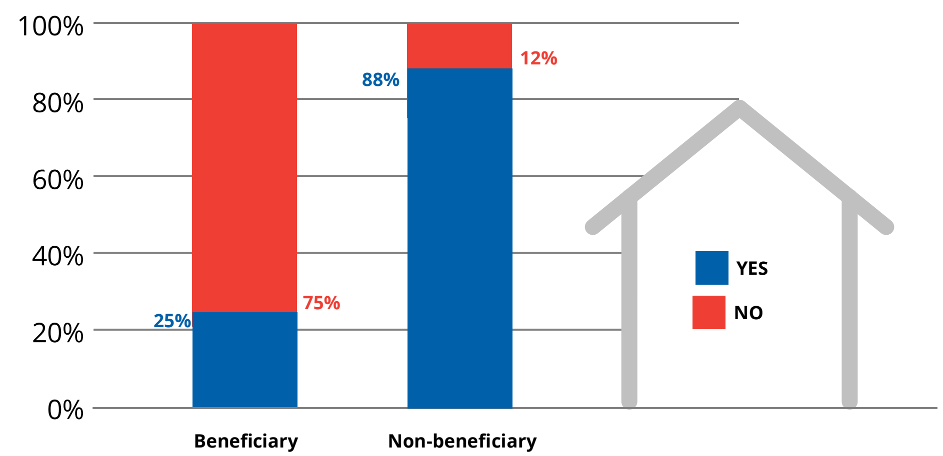

Figure 6.7

Comparison of house repairs needed after Typhoon Kammuri.

Figure 6.8

Cutting of Abaca trees in Catanduanes (source: PRC).

Figure 6.9

Installing SSKs in Camarines Norte (source: PRC).

6.4 FbF For Heatwaves in Viet Nam

During the past 40 years in Hanoi, the number of days with maximum temperatures exceeding 35°C increased at a rate of two to three days per decade, resulting in a total of 175 days with maximum temperatures above 35°C from 2008 to 2012 (Thuc et al., 2016). IMHEN conducted a risk analysis for the FbF project, confirming this trend. The risk analysis found that the number of heatwaves (events with at least two consecutive days reaching over 35°C) has increased by 107% from the 1975–1984 period to the 2005–2014 period, increasing from 45 events to 93 events, respectively (Figure 6.10).

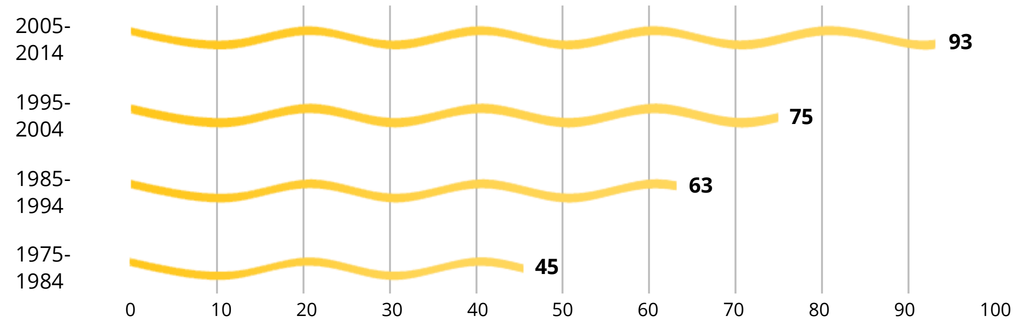

Figure 6.10

Statistics of the number of heatwaves in Hanoi for each decade of the period 1975 – 2014.

The heatwaves also lasted longer in later decades. During the entire 1975–2014 period, 92% of the heatwaves had a duration between two and six days (Table 6.1). However, the ratio of heatwaves with a duration of four to six days increased over time, standing at 21.3% for the period 1975–2014 and 30.1% for the 2005–2014 period.

In Hanoi, heatwave events correlate with a 20% increase in hospital admissions for all causes and a 45.9% increase for respiratory diseases (Phung et al., 2017). In 2018 and 2019, VNRC carried out surveys with more than 1,200 Hanoians to assess the impacts of heatwaves and the vulnerable groups' access to weather forecasts during extreme heat events. The results showed that 66% of the people from vulnerable groups, such as those living in poor neighbourhoods, builders, street workers who ship goods, and street vendors, had experienced four to seven symptoms of heat exhaustion, and 22% of those with symptoms went to the doctor during a heatwave. Additionally, in June 2019, two outdoor workers in Hanoi reportedly died due to exposure to high heat for long hours.

VNRC and GRC, working closely with IMHEN, saw the opportunity to implement anticipatory humanitarian actions in Hanoi. Short-term forecasts make predicting heatwaves possible in the city, with a forecast range of three to 10 days before the event (de Perez et al., 2018). VNRC, GRC, and IMHEN are pioneering the implementation of FbF for heatwaves in an urban context, with the main objective of reducing the impact of heatwaves on Hanoi's most vulnerable populations. As each heatwave can affect a large area, the organisations recognised the need to identify the most at-risk zones. This is particularly true in urban contexts where vulnerability and heatwave hotspots are highly variable and increase due to urbanisation (Trihamdani, Kubota, Lee, Sumida, & Phuong, 2017).

Using the open-source software QGIS and the Database of Global Administrative Areas, VNRC and GRC developed a decision-making methodology. The methodology produced three layers of information—vulnerability (V), exposure (E), and hazard (H)—to identify the urban areas that are most vulnerable to heatwave impacts.

Defining the V and E layers required answering three questions:
1. Which are the most vulnerable populations?
2. Where are those populations located?
3. How are they exposed?

VNRC identified the most vulnerable populations through data collection, literature review, and the application of knowledge, attitudes, and practices surveys. These surveys also assessed the individual needs and living conditions of those vulnerable groups. VNRC used the data from the surveys to assign values to the V and E layers. The V layer quantifies the percentage of people who are poor, elderly, disabled, or under the age of 5 in each ward of the city. The E layer quantifies the rate of people living in slums, in inadequate housing, or without air-conditioning.

Layer H then identifies urban heat islands (UHIs)—the areas with higher concentrations of heat across the Hanoi region (Martin-Vide, Sarricolea, & Moreno-García, 2015). An assessment of heatwaves in Hanoi highlighted that the hottest days mainly occur from May to August.

Additionally, changes in land use in Hanoi are significant from year to year due to rapid urbanisation (Pham, Tong, & Pham, 2013). VNRC used Landsat 8 data, including 21 satellite images, for the summer months (May to August) from 2015 to 2018 to construct a heatwave hotspot map. It includes the data of the maximum temperature during those 21 days. The maximum value is chosen by representing the heat storage capacity of Hanoi, which is an important mechanism for the UHI effect (McGregor, Bessmoulin, Ebi, & Menne, 2015).

Compiling the V, E, and H layers allowed identification and selection of the 10% highest-risk wards in Hanoi for early action implementation to minimise the impacts of heatwaves. The same methodology also identified and selected the 10% highest-risk wards in Danang.

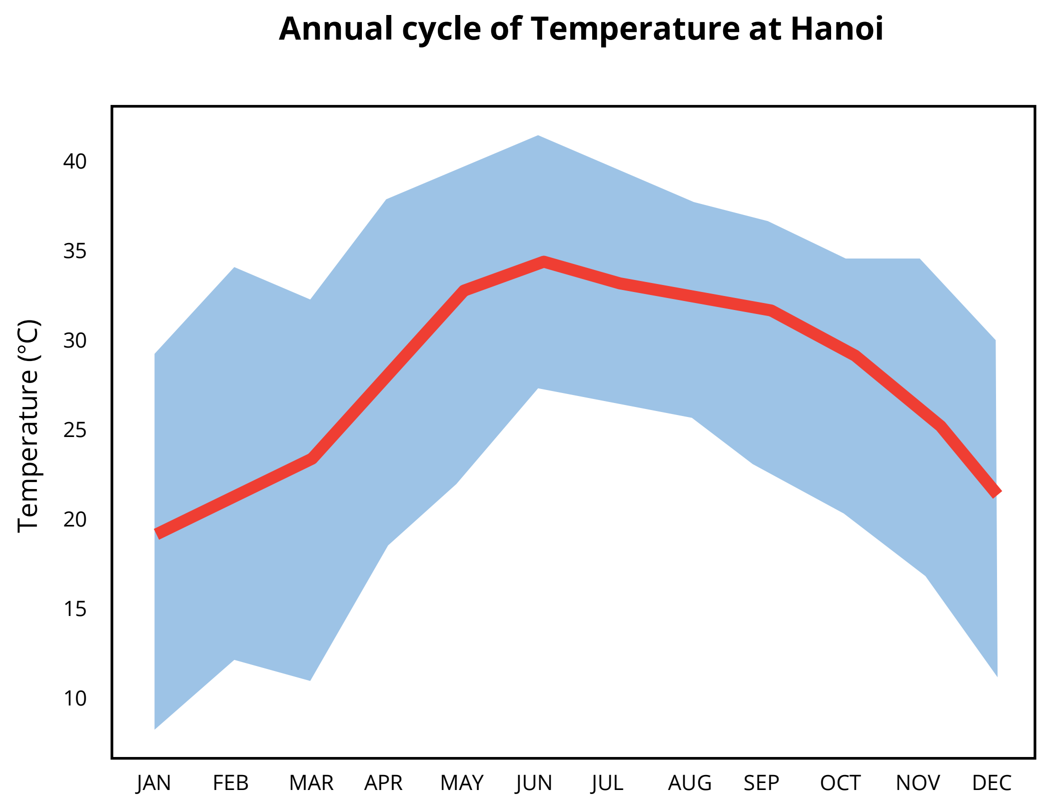

Figure 6.11
Annual cycle of observed maximum daily temperature in Hanoi during 2009-2018. The red line shows mean values, and the blue shade presents the range from minimum to maximum values.

VNRC adapted the impact mapping methodology for cyclones and floods and trained staff from 20 of its branches to develop maps that replicate the FbF approach for other disasters and regions of Viet Nam.

HEATWAVE IMPACT FORECAST MAP IN HANOI URBAN DISTRICTS

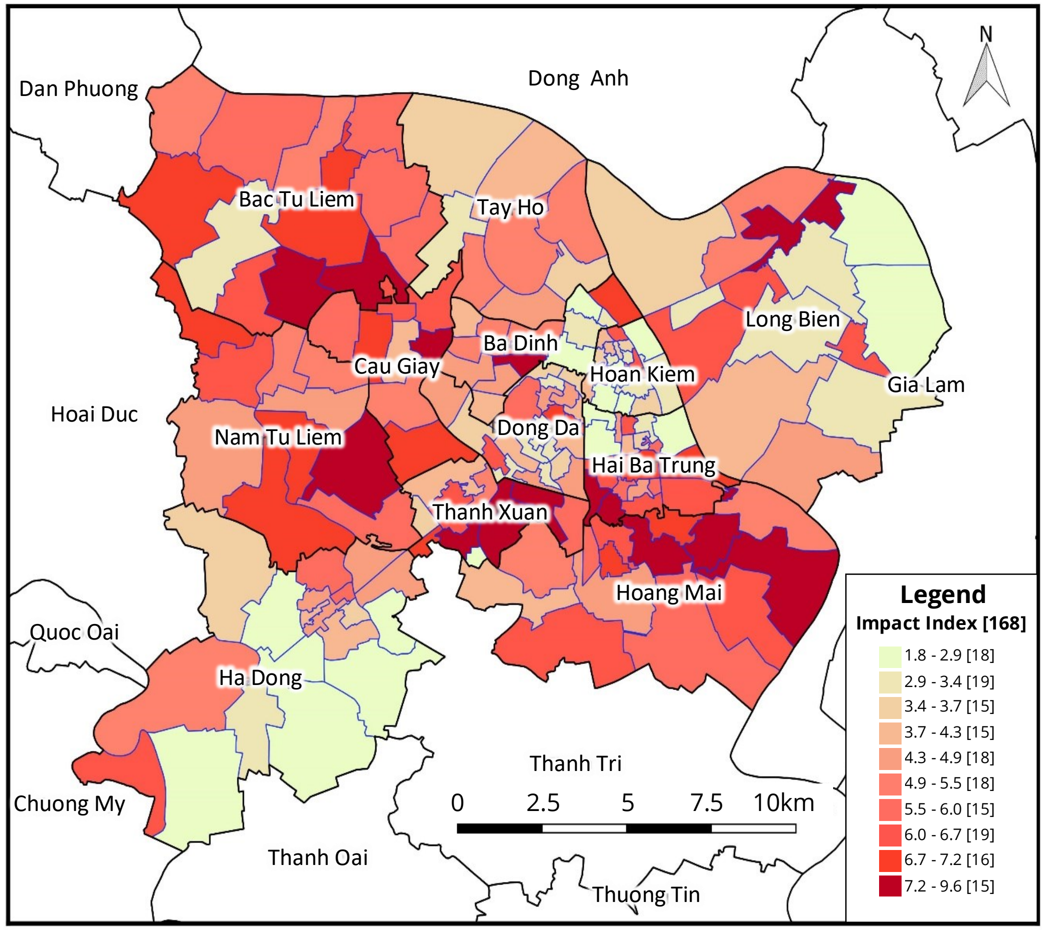

Figure 6.12

The risk levels of Hanoi's 168 wards based on impact mapping methodology (source: VNRC).

The early action for heatwave events involves opening Red Cross cooling centres that provide free access to places with cool shade during the day for vulnerable people, such as outdoor workers. Each cooling centre consists of a tent equipped with a sprinkler system, roof fans, and evaporative coolers that help lower body temperature via skin moisture evaporation. Evaporative cooling is a very efficient way to regulate the body's temperature and prevent harmful effects such as heatstroke. Red Cross cooling buses complement the cooling centres by travelling through the main streets of Hanoi and directing the vulnerable people to the centres. The cooling buses also conduct visits to informal settlements to raise awareness and distribute cold towels and beverages.

The average temperature difference between inside and outside of the cooling centres is 7–10°C. The centres have an emergency care protocol in place whereby volunteers provide individual healthcare based on symptoms that the visitors might be experiencing. If the volunteers identify a high risk of heatstroke, they immediately call an ambulance. The early action also encourages visitors to adopt appropriate behaviour changes. As they gain awareness about heat-related illnesses and experience an improvement in their condition after using the cooling centres, visitors tend to start taking more regular and extended breaks in cool environments, thus reducing potential risks.

Triggers determine when to implement heatwave early action. IMHEN established that the trigger for an extreme heatwave event consists of a forecasted heat index exceeding the 99th percentile during more than two consecutive days. The trigger mechanism has two lead times. A six-day lead time acts as a readiness trigger to start preparing the early action. The FbF protocol is activated only if the conditions of the second trigger still occur at the second lead time of three days. At that point, VNRC automatically releases funding and implements the early action. In summer 2019, the trigger conditions occurred twice, leading to the testing of the early action in selected wards. During the first heatwave, two cooling centres opened in two wards and received a total of 396 visitors, of which 70.5% reported feeling better after their visit. During the second heatwave, four centres and three buses received a total of 1,787 visits in four days and four wards. During the second heatwave, 79% of the visitors were outdoor workers, and over 95% of all the visitors reported feeling satisfied and recommended the reopening of the centres.

In 2020, the early action will scale up to 15 at-risk wards in Hanoi and seven wards in Danang, with a total of 45 tents and 22 buses prepared to handle 20,000 visits. This scaling-up aims to improve performance indicators and confirm the positive impact of early actions.

6.5 Regional FbF Coordination

Coordination and collaboration with FbF and EWEA partners, including the United Nations World Food Programme, the Food and Agriculture Organization, and international non-governmental organisations such as the Start Network, are key to scaling up FbF/EWEA in the Asia-Pacific region. One example of such coordination is the regional technical working group (TWG) on FbF/EWEA and SRSP. Members of the group include GRC/IFRC, the Food and Agriculture Organization, the United Nations World Food Programme, UNICEF, the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia, and other relevant UN agencies.

The regional TWG aims to harmonise FbF/EWEA methodologies and ensure joint advocacy with the Association of Southeast Asian Nations (ASEAN). In 2020, it seeks to develop a repository of effective early actions for specific hazards and conduct an FbF/EWEA feasibility study in Myanmar. This coordination mechanism at the regional level is an example of how to move FbF to the next stage and ensure alignment of regional and national efforts and needs.

TWG members also aim to identify and address some of the challenges of implementing FbF/EWEA. Comparing the lead time for certain hazards to the necessary implementation time for the early actions should lead to an honest discussion about which hazards lend themselves to the FbF/EWEA approach. While the FbF/EWEA mechanism shows some uptake and buy-in at the national level, it remains small-scale compared to the traditional responses. Therefore, the strategies for scaling up anticipatory actions still require refining. Collaboration with humanitarian partners offers one path to do so, but additional methods will likely be necessary as well. Similarly, the logistics and capacity challenges associated with scaling up will require not only creative solutions but also an internal restructuring of processes.

Successful advocacy to government ministries for the integration of the FbF/EWEA mechanism into national- and local-level legislation will require larger empirical datasets on the impact reduction of early actions. For further development of IbF, IFRC and the Climate Centre established coordination mechanisms with WMO, the Climate Risk and Early Warning Systems initiative, the United Kingdom's Meteorological Office, and selected national hydro-meteorological services and DRR agencies. The objective is to jointly contribute to the further development of IbF services tailored to the humanitarian sector. Similarly, the Asia Regional Resilience to a Changing Climate programme, with support from the United Kingdom's Department for International Development and the World Bank, is exploring new ways to sustainably and effectively co-develop IbF services with National Societies.

At the national level, and with a potential regional impact, the Philippine Atmospheric, Geophysical and Astronomical Services Administration will play a key role under the Green Climate Fund in the development of IbF services for typhoons and other hazards aligned with the previous IbF work of PRC.

6.6 Conclusions and Recommendations

IFRC's advocacy efforts with ASEAN aim to promote the FbF approach and institutionalise it by including it in the 2021 – 2025 edition of the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) Work Programme. AADMER serves as a common platform and regional policy backbone for disaster management in the ASEAN region, while the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management is the operational coordination body and engine of AADMER. Both are essential advocacy partners for promoting the institutionalisation of the FbF approach. Because FbF produces vulnerability and exposure assessments before a disaster, it provides an ideal entry point for heightened risk awareness as well as faster or earlier response. Shared understanding of risk can lead to the implementation of preparedness measures coupled with IbF to ensure that resources for response are ready when and where they are necessary. The goal for FbF is not only to prove the concept of anticipation but also act as a catalyst for inspiring other more risk-informed and anticipatory programmes in the ASEAN region and beyond.

While FbF promotes an anticipatory mindset, it also strengthens humanitarian mandates by enabling National Societies to assist people in need more quickly and effectively. As internal processes become more agile in delivering aid and services under FbF, the emergency response processes profit equally. In that sense, FbF also contributes to the enhancement of responses.

Similarly, FbF encourages new ways of thinking in other areas, such as SRSP. Discussions with UNICEF and other stakeholders at the regional and national levels look at how employing the SRSP network can provide quicker identification of beneficiaries. This investigation is in line with global efforts to scale up FbF and to make traditional response or DRR approaches more anticipatory to shorter-term climate events.

With ever-increasing climate change challenges, FbF offers an innovative and localised solution to adapt to the shorter-term climate change effects most heavily impacting vulnerable communities. By implementing the FbF approach, the RCRC Movement and its partners are transforming into a more forward-looking and future-proof network, ensuring that they can meet the needs of the most vulnerable communities now and in the future.

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Three Weeks' Notice: Forecasting Extreme Weather Events with Subseasonal-to-Seasonal Climate Prediction

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ARMOR

Abstract

Subseasonal-to-seasonal climate prediction (S2S) consists of two-week to two-month weather outlook information that can strengthen disaster preparedness. Applying S2S in conjunction with exposure and vulnerability information can sharpen the assessment of risks by bridging weather forecasts (daily to 10 days in advance) and seasonal predictions (three to six months in advance). Successful integration of S2S into disaster preparedness protocols can reduce disaster impacts because the predictions from S2S have a higher update frequency than seasonal predictions and longer lead time than short- and medium-range weather forecasts. S2S predictions are also available at finer spatial resolutions than some seasonal predictions, thus making it possible to implement targeted preparedness measures.

This article illustrates the potential applications of S2S for disaster preparedness. Ongoing efforts by the Association of Southeast Asian Nations (ASEAN) Specialised Meteorological Centre (ASMC) and its collaborators, including the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES), and the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre), are underway to explore the utility of S2S in operational decision-making in Southeast Asia in conjunction with information on the more established weather and seasonal timescales. These efforts include a pilot project (ESCAP, ASMC, & RIMES, 2019), with National Meteorological Hydrological Services and other end users from Southeast Asia to join later in the project.

Keywords: Subseasonal-to-seasonal climate prediction, S2S, forecasting, disaster preparedness

7.1 Introduction: The Importance of S2S Prediction for Disaster Preparedness in Southeast Asia

The ASEAN region experiences the full range of rainfall extremes. On one end, it is exposed to hazards from very high rainfall episodes caused by tropical cyclones or exceptionally active monsoon periods. On the other end, the region also experiences drier conditions that arise from large-scale climate drivers such as El Niño or the positive Indian Ocean Dipole (IOD) events. El Niño events are part of the El Niño Southern Oscillation, an irregular variation of wind and surface temperatures in the tropical eastern Pacific Ocean that occurs on the seasonal timescale. IOD is the irregular oscillation of sea surface temperatures as the western part of the Indian Ocean alternatively warms and cools more than the eastern part. Recent notable events with severe impacts on the Southeast Asian community include Typhoon Phanfone in December 2019 (AHA Centre, 2019) and the 2015/2016 El Niño (Huijnen et al., 2016; Thirumalai, DiNezio, Okumura, & Deser, 2017). Large-scale climate drivers provide opportunities for early warnings either through the identification of apparent precursors or taking advantage of the slow-variation nature of their developments. Climate prediction models can capture, to a certain extent, the development of events because the atmosphere interacts with both the slowly varying surface conditions of the ocean (e.g. sea surface temperature and heat content in the mixed layer) and land surface properties (e.g. the moisture content of soil) (Goddard et al., 2001; Shukla, 1998). Anomalous interactions between the ocean and atmosphere can change large-scale wind and moisture flow, giving rise to drier, wetter, warmer, or colder conditions than normal. Seasonal prediction models can provide a reasonable outlook of rainfall and temperature departures from standard values in seasonal (three-month) averages, potentially making predictions up to six months ahead in the tropics and the region of Southeast Asia (Kumar, Chen, & Wang, 2013; Scaife et al., 2019).

S2S predictions on the scale of two weeks to two months can potentially provide more useful and detailed spatial and temporal information on shorter timescales to complement seasonal predictions. Therefore, the predictions can provide further information on the likelihood of events on timescales shorter than seasonal (such as large-scale flooding). Although the field of S2S is in the infancy stage, S2S has opened up frontiers of research linking rainfall predictions to different applications and sectors with the aim of improving ground response (S2S Prediction Project, 2020).

The availability of dependable, shorter-term predictions will also enhance the outlook of seasonal predictions by providing updated warnings with shorter lead times to supplement coarser information at longer-lead times. For example, seasonal predictions provide a sense of how severely a nearing El Niño may affect rainfall over Southeast Asia for an upcoming summer monsoon season in the northern hemisphere. Subseasonal predictions then complement this by providing information on the week-to-week variations within the season. This subseasonal information can show the severity of potential drier conditions or investigate if a monsoon break or an onset of a wet season can help alleviate an ongoing drought. This example demonstrates how S2S predictions can help provide information to alert at-risk communities of an impending extreme event. While weather forecasts can help with disaster response and disaster preparedness a few days before the event, organisations can use S2S prediction to undertake further preparedness measures such as activating contingency plans, mobilising resources, and preparing for evacuation.

ASEAN Member States adopted shock-responsive social protection mechanisms that can also benefit from S2S by allowing social welfare agencies to gain a better understanding of risk through access to finer spatial resolution of S2S products (Farhat, 2019). Additionally, because S2S products provide information two to four weeks prior to the onset of a hazard, they allow the response teams much more time to prepare resources and deliver assistance to at-risk populations (National Academies of Sciences, Engineering, and Medicine, 2016; White et al., 2017). However, further work is necessary to bridge science and applications and ensure the effective use of S2S predictions through tailored products.

7.2 Case Studies

This analysis investigates S2S potential by looking at two case studies of extreme weather events and comparing gridded observational datasets to the predictions from the European Centre for Medium-Range Weather Forecasts (ECMWF) model and the National Centers for Environmental Prediction (NCEP) extended-range model. Figure 7.1 shows the two case study areas.

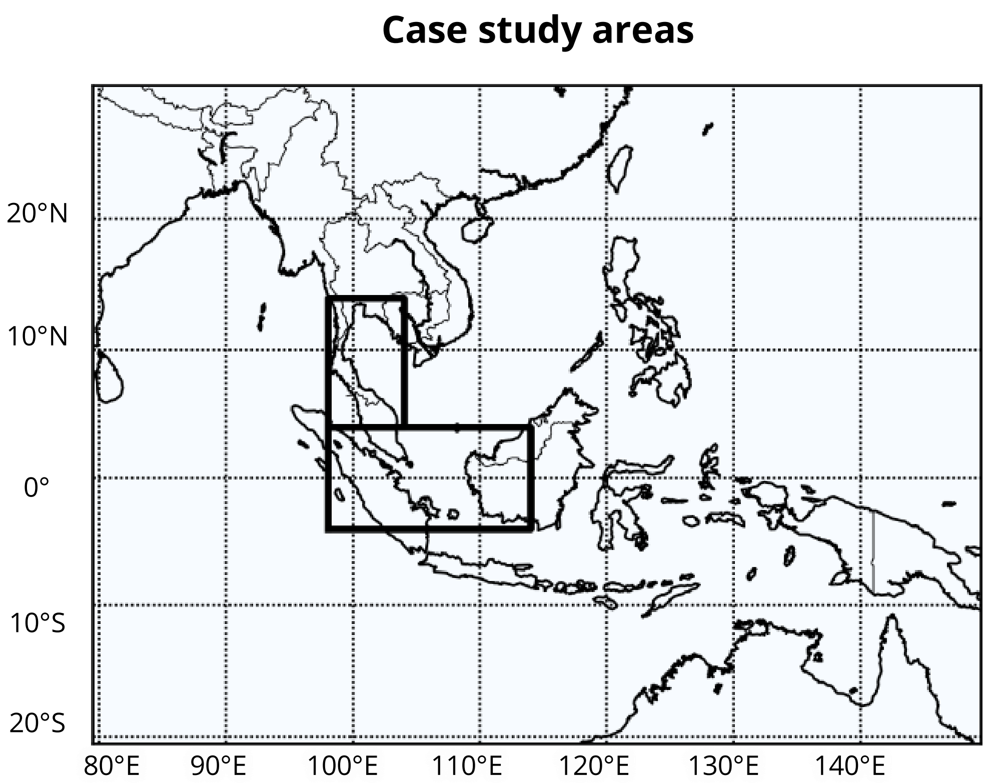


Figure 7.1
Black boxes outlining the two case study areas: flood (top) and dry spell (lower).

7.2.1 Methodology

For each of the two case studies, this analysis first looked at how extreme the rainfall conditions were in the respective "event weeks" by examining two different gridded datasets of rainfall estimates, namely the CPC-MORPHing technique v1 (CMORPH) (Joyce, Janowiak, Arkin, & Xie, 2004; Xie et al., 2017) and the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) (Funk et al., 2015). CMORPH uses primarily passive microwave retrieval satellite data covering both land and ocean areas between 60°N and 60°S from 1998 onwards. The CHIRPS dataset uses global satellite imagery along with station-based rainfall data for 1981 onwards.

Examining two gridded datasets ensures that the satellite estimates of rainfall—which are not always representative of ground truths as they represent averages over the grid boxes, or cells—confirm the severity of the relevant incidents. The analysis calculates the anomaly over the area, which is the total observed rainfall in that week minus the average of rainfall over many years (the "climatology") for the same week period. The larger "positive anomaly" values indicate that the observed rainfall was much higher than average for that time of year. Similarly, larger "negative anomaly" values signify that the observed rainfall was much lower than average for that time of year. The analysis provides the percentile rank of each anomaly relative to the climatology alongside the anomaly. Very small values (e.g. 10th percentile or lower) indicate extremely dry conditions that only occur one out of every 10 times or less. Very large percentile values (e.g. 90th percentile or higher) indicate extremely wet conditions that only occur one out of every 10 times or less. The analysis also looks at the weeks leading up to the main event to provide a relative idea of the conditions of the event week compared to the weeks before it.

After determining the severity of the rainfall events, an examination of the model predictions from the subseasonal models NCEP and ECMWF (Saha et al., 2014; Vitart et al., 2017) aimed to determine if they could predict the development and emergence of the events. The NCEP model issues daily forecasts comprising 16 ensemble members up to 42 days into the future with a horizontal resolution of approximately 100 km, with reforecasts covering the period of 1999–2010 running four times per day. Reforecasts are model forecasts run for past dates with the same model used for the real-time forecasts being examined. Running reforecasts builds a sequence of past runs that can be used to calibrate the forecast system or evaluate its performance. To capture as much uncertainty in the forecasts as possible, this analysis combines each NCEP forecast with the previous day's forecast to increase the number of ensemble members (16 x 2 = 32 forecast members, and 4 x 2 x 12 = 96 reforecast members for climatology). The ECMWF extended-range model issues forecasts every Monday and Thursday, comprising 51 ensemble members running 46 days into the future with varied horizontal resolutions of 0.2° x 0.2° and 0.4° x 0.4° up to forecast day 15 and from forecast day 16 to day 46, respectively. The reforecast component consists of 11 ensemble members up to 46 days for the same day and month of each real-time forecast for the past 20 years (11 members X 20 years = 220 reforecast members for climatology).

This analysis examined the models in two ways. First, it examined the spatial anomalies for the events up to a lead time of three weeks: from the forecast issued the week before the event ("Lead Time 1" or "LT1"), and up to another two weeks before that ("LT2" and "LT3"). These weekly rainfall values are for forecasts from the forecast and reforecast datasets such that week 1 consists of days 4–10, week 2 consists of days 11–17, and week 3 consists of days 18–24. The weeks simulate and cater to the time latency between the generation of a model run and the time at which it becomes available for processing in a real-time environment. Anomalies were computed using Equation 7.1:

$$a = r - \bar{r}$$

Equation 7.1

An anomaly (a) equals [where r is the weekly rainfall total and $\hat{r}$ is the average weekly total over the climatological period (reforecast).] In the case of the forecasts and reforecasts, Equation 1 is calculated after averaging over all ensemble members.

The second method of examining the models consists of assessing their predictions of the likelihood of an extreme rainfall event. This assessment involves determining the thresholds for the highest and lowest 10th percentiles from the model climatology (220 reforecast members for ECMWF and 96 reforecast members for NCEP) for each grid point and each week. Then, counting the number of forecast members (out of 51 for ECMWF and 32 for NCEP) exceeding the relevant intervals obtained previously for the same grid point and week gives the forecast probabilities.

Here, the definition of extreme rainfall is the probability of exceeding the 90th percentile (for floods) and not exceeding the 10th percentile (for dry spells). By definition, there is a 10% chance under normal circumstances for rainfall to be within either of the extreme categories. Therefore, if the models predicted significantly more than a 10% likelihood (this analysis chose 20%, i.e. double the normal chance of occurrence), then the analysis considered them to have reasonably identified a signal of an extreme event. This process continued for the three forecast lead times mentioned above for the event weeks, as well as the weeks before and after the events, to determine the accuracy of the timing of the extreme rainfall events.

The use of established methodologies in forecast verification helped to calculate the model skill of the two models for previous events (Jolliffe & Stephenson, 2012). These calculations evaluated the models' abilities to predict the anomalies and extreme percentiles (90th for floods and 10th for dry spells) for all past reforecast model data of typically 20 to 30 years. Assessing large samples of past events using reforecasts helps to guard against false impressions of model skill (or lack thereof) from single-case analyses types. Thus, model skill assessments complement case study analyses to show a reasonable picture of the models' prediction capabilities in a variety of circumstances for the duration of the assessment period. There are several methods to measure model skill of varying complexities in the scientific literature (Jolliffe & Stephenson, 2012; Wilks, 2011; World Meteorological Organization (WMO), 2018). This analysis uses two of the more common ones: the anomaly correlation coefficient (ACC) and the relative operating characteristic (ROC) scores.

7.2.2 Floods in Southern Thailand (January 2017)

The first case study was the severe flood event in Southern Thailand in January 2017 that also affected northern Sumatra and the east coast of Peninsular Malaysia, where some of the worst flooding occurred. In Thailand, the floods displaced 1.8 million people and 590,000 families, and there were 36 people confirmed dead (United Nations Office for the Coordination of Humanitarian Affairs, 2016). The rainfall anomaly plot (Figure 7.2) for the week 2–8 January 2017 shows the spatial extent of the heavy rainfall areas stretching from as far north as the Chumphon Province of Thailand to the more southern Pahang State in Peninsular Malaysia. As Figure 7.2 shows, the floods also affected northern parts of Sumatra, Indonesia.

The large-scale nature of the event would suggest that a strong, large-scale driver played a role. However, the Madden-Julian Oscillation, which typically contributes to large-scale extreme rainfall patterns during the associated month and during the Northeast Monsoon season in general (Xavier, Rahmat, Cheong, & Wallace, 2014), was not present at the time. The weak La Niña that developed in mid-2016 ended in December 2016 before the 2017 event in question (Turkington, Timbal, & Rahmat, 2019). Based on the upper-level wind anomaly plot (Figure 7.3), the driver for the event was a large-scale wind pattern that brought moisture and therefore heavy rainfall to the region.

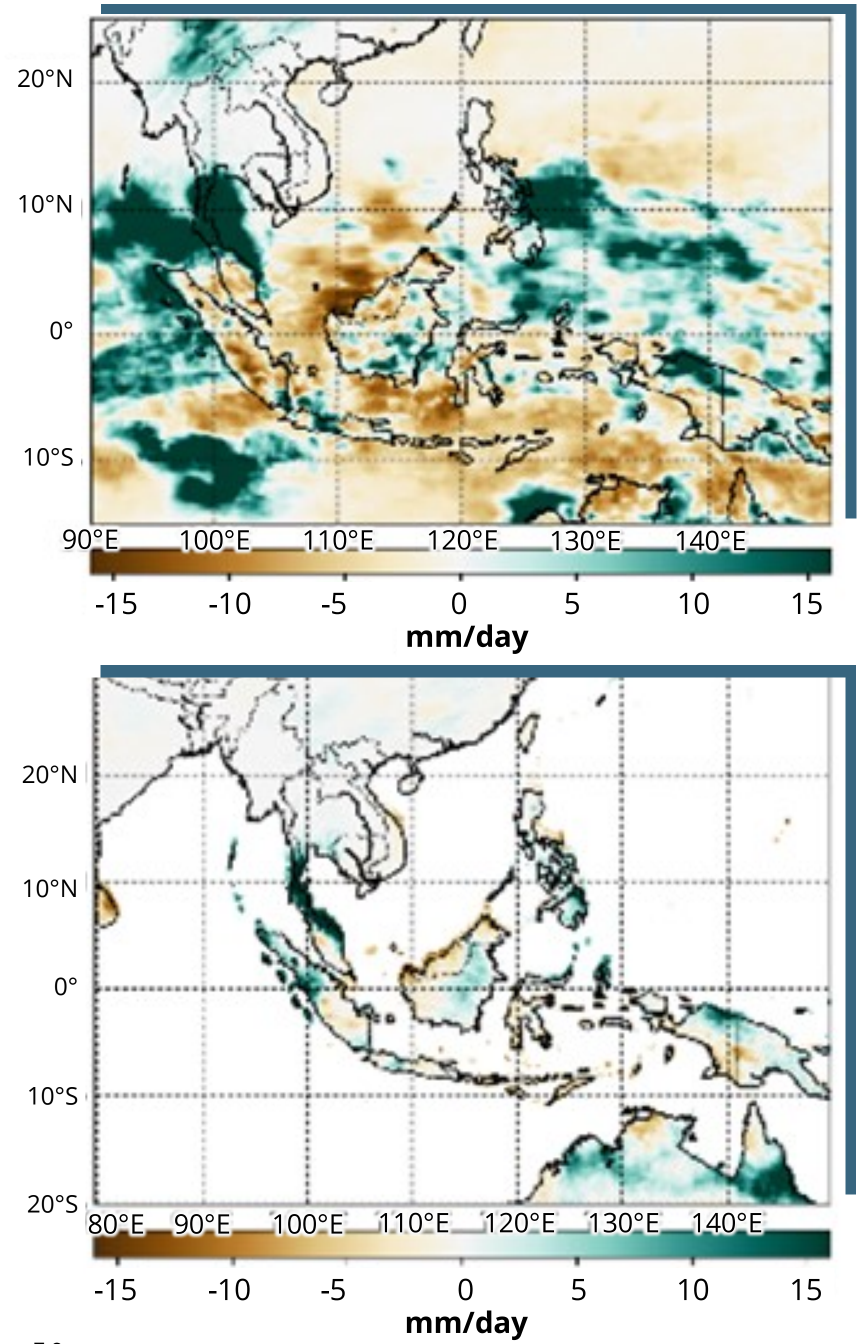
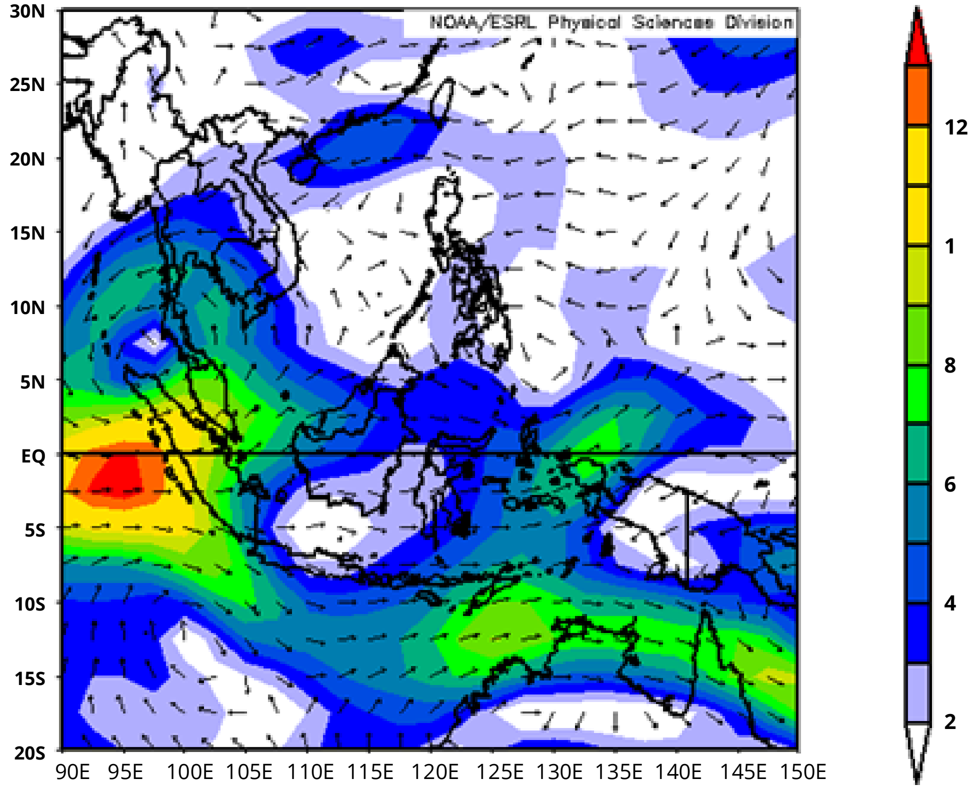


Figure 7.2

Rainfall anomaly (departure from the climatological mean) plot from two different datasets: CMORPH (top) and CHIRPS (bottom). Data are for Southeast Asia from 2 to 8 January 2017 with reference to the same week's climatology from 1998 to 2016 for CMORPH and 1997–2016 for CHIRPS. Positive anomaly (wetter) conditions appear as shades of green.



850mb Vector Wind (m/s) Composite Anomaly (1981-2010 Climatology)
1/2/17 to 1/8/17
NCEP/NCAR Reanalysis

Figure 7.3

850 mb (upper-level height) wind flow anomaly from NCEP/National Centre for Atmospheric Research Reanalysis dataset against 1981–2010 climatology showing a large-scale rotating flow for 2–8 January 2017 over the Andaman Sea and Gulf of Thailand. The wind circulation brought moisture into the region and consequently heavy rainfall.

The period from 12 December 2016 to 15 January 2017 was wetter than the average, with the highest rainfall occurring in the week 2–8 January 2017 (Table 7.1). The amount of rainfall for this week in 2017 was the highest recorded for the same week from all previous years (1998–2016 for CMORPH, and 1997–2016 for CHIRPS), exceeding the 90th percentile classification for very heavy rainfall. The week of 19–25 December 2016 almost reached the 90th percentile threshold as well. The difference in the

rank of the weekly rainfall between the two models may be due to CHIRPS only considering rainfall over land, while CMORPH captures rainfall over both land and sea, as well as other differences in the sources of the data. These differences emphasise the importance of using multiple observation datasets to capture uncertainty in the data.

Week starting from	CMORPH		CHIRPS	
	Rainfall anomaly (mm)	Rank (%)	Rainfall anomaly (mm)	Rank (%)
12 Dec 2016	1.5	73	-21.8	35
19 Dec 2016	37.1	88	51.8	89
26 Dec 2016	5.1	80	8.8	72
2 Jan 2017	149.3	Max	99.0	Max
9 Jan 2017	17.7	86	1.2	53

Table 7.1

The weekly rainfall anomaly (in mm) and associated rank based on climatology for the Thailand flood case study. Positive/negative anomaly values indicate wetter/drier-than-average conditions. Max rank indicates that the value recorded was higher than any previous observation .

Across the region, both models forecast above-average rainfall more than three weeks before the event for the band around latitude 10°N (including the study area) with drier conditions over most of the southern part of the region (Figure 7.4). In both cases, anomalies were smaller for the earlier forecasts, converging towards the higher magnitude anomalies for the most recent forecast issued on 29 December 2016. This decrease in the magnitude of anomalies is a common feature of S2S forecasts as predictions go further out in time due to the wider spread (uncertainty) in the ensemble forecast. While the models correctly predict the large-scale patterns of wetter and drier conditions, there are some differences between the forecasts. For example, the forecasts for Peninsular Malaysia vary between wetter-than-average and drier-than-average, depending on the lead times and models.

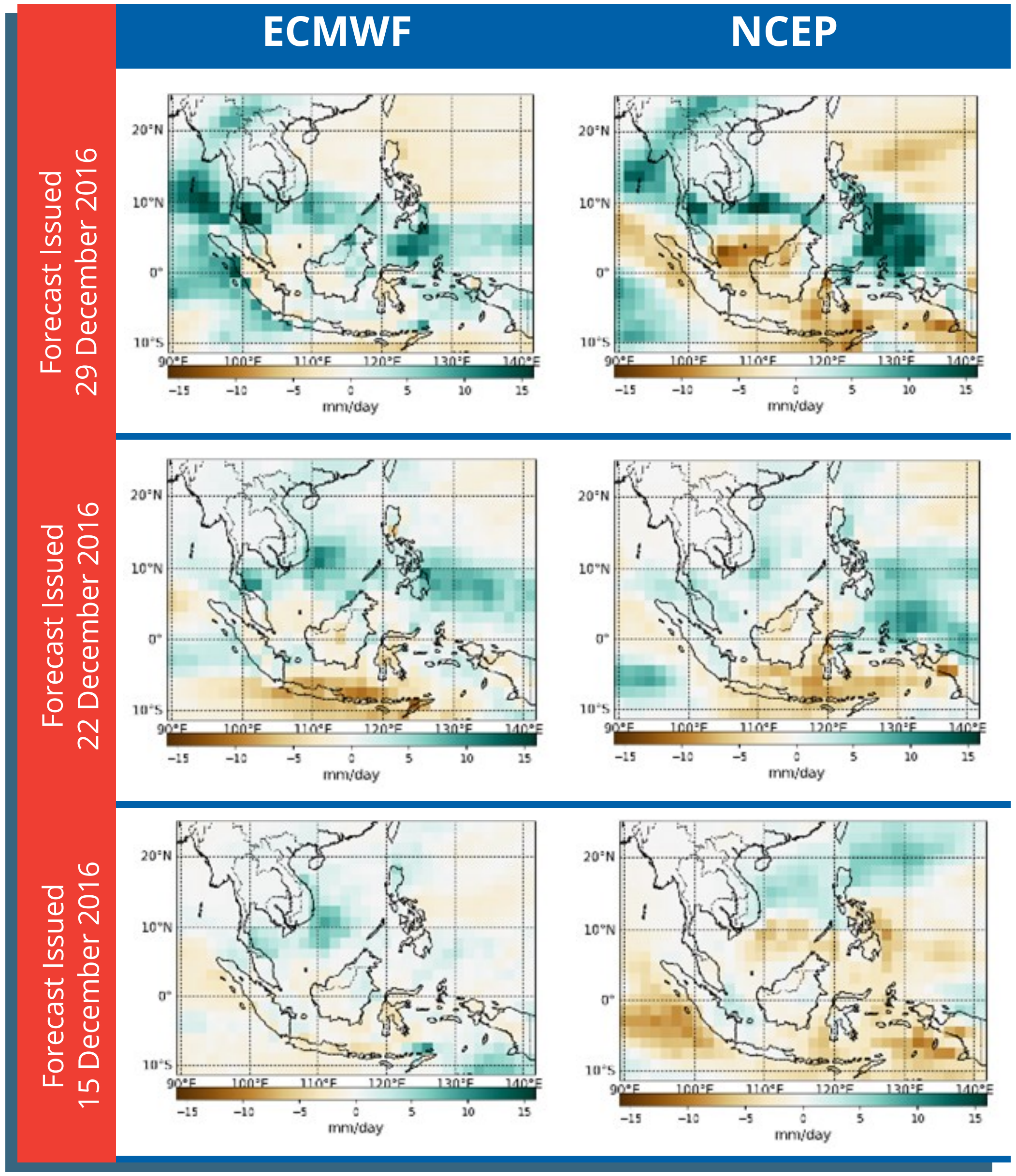


Figure 7.4

The weekly rainfall anomaly (in mm) and associated rank based on climatology for the Thailand flood case study. Positive/negative anomaly values indicate wetter/drier-than-average conditions. Max rank indicates that the value recorded was higher than any previous observation.

During the week of 2 January 2017, the study area experienced heavy rainfall (the highest recorded at the time), and both models indicated an increased chance of heavy rainfall by 22 December 2016, i.e. at LT2 (Table 7.2). Using the LT1 (29 December 2016) forecast, ECMWF and NCEP both predicted a high probability of heavy rainfall (98% and 78%, respectively). For the earlier forecasts, the ECMWF model predicted an increased chance of heavy rainfall (2.9 times more likely) at LT3 (15 December 2016), while the NCEP model forecast an increased chance of heavy rainfall (2.2 times more likely) at LT2 (22 December 2016). In contrast, the models indicated that the weeks before and after 2 January 2017 had lower probabilities of heavy rainfall, highlighting that they did reasonably well in terms of timing. In the instances where the models showed slight increases in chances of heavy rainfall (e.g. NCEP forecasts for 9 January 2017 issued at LT2 and LT3), only one of the two models forecast the increase, suggesting that a user can place higher confidence in forecasts when there is good agreement in multiple models.

Week starting from	ECMWF			NCEP		
	LT1	LT2	LT3	LT1	LT2	LT3
12 Dec 2016	18%	14%	16%	9%	47%	9%
19 Dec 2016	20%	12%	14%	19%	13%	19%
26 Dec 2016	4%	16%	12%	3%	3%	25%
02 Jan 2017 (wettest week)	98%	51%	29%	78%	22%	6%
09 Jan 2017	2%	8%	14%	0%	34%	25%

Table 7.2

The probability of exceeding the 90th percentile at various lead times of LT1, LT2, and LT3 for the ECMWF and NCEP models in the Thailand flood case study. Boxes highlighted in yellow indicate that the rainfall is more than or equal to twice as likely to exceed the heavy rainfall threshold (90th percentile), i.e. ≥ 20% probability.

On average, the models adequately forecast this flooding event both in terms of timing and magnitude, with increasing confidence in very heavy rainfall as the lead times decreased. The heavy rainfall prediction at the S2S scale could have potentially been useful for improving preparedness and minimising population displacement at the time of the event. However, further investigation is necessary to determine whether authorities would find S2S products usable in terms of identifying which areas require evacuation and determining the extent and severity of the flooding. Such decision-making processes may benefit from seamless integration of supplementary shorter-timescale forecasting and monitoring activities.

7.2.3 Dry Spell over Malaysia and Indonesia (August 2018)

In August 2018, dry spell-related haze affected Malaysia and Indonesia. In places like Palembang, Sumatra, visibility dropped down to 1–2 km and disrupted transportation services. In Kalimantan, schools closed and there were reports of 2,000 people suffering from acute respiratory infection (AHA Centre, 2018; The Straits Times, 2018). In Malaysia, the state of Sarawak reported “very unhealthy” levels of air pollutant index readings that reached as high as 228 (New Straits Times, 2018). The ASMC reported a significant increase in hotspot activities and smoke haze over Sumatra, Sarawak, and Kalimantan from the second week of August 2018 (ASMC, 2018). Because August is in a typically drier season of the year for Southeast Asia (Chang, Wang, McBride, & Liu, 2005), much drier conditions during the second and third week of August 2018 made it easier for peatlands to catch fire and generate smoke haze that affected the region (Page et al., 2009; Putra, 2011; Usup, Hashimoto, Takahashi, & Hayasaka, 2004).

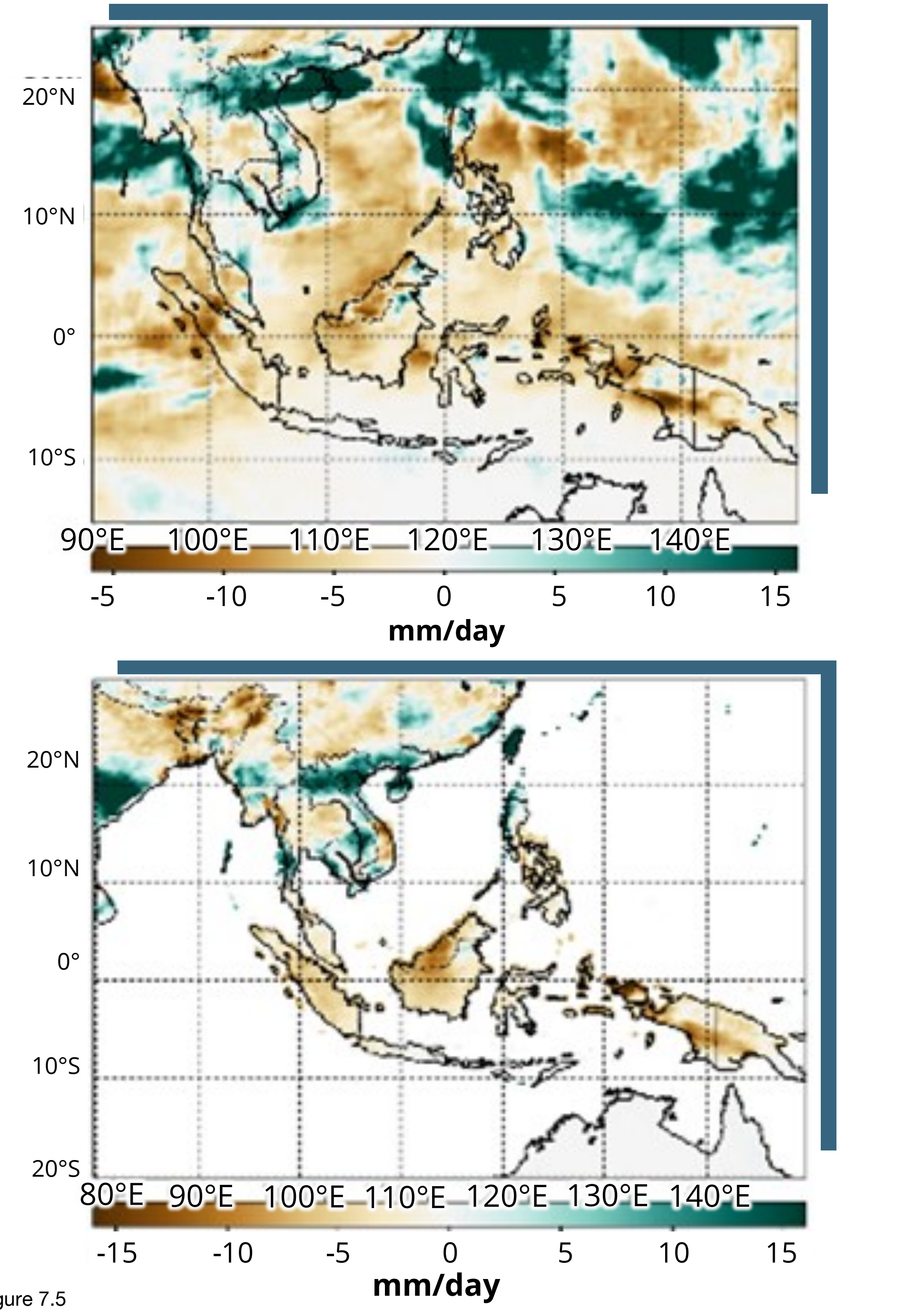


Figure 7.5

Rainfall anomaly (departure from the climatological mean) plot from two different datasets: CMORPH (top) and CHIRPS (bottom). Data are for Southeast Asia from 13 to 19 August 2018 with reference to the same week’s climatology from 1998 to 2016 for CMORPH and 1997–2016 for CHIRPS. Negative anomaly (drier) conditions appear as shades of brown.

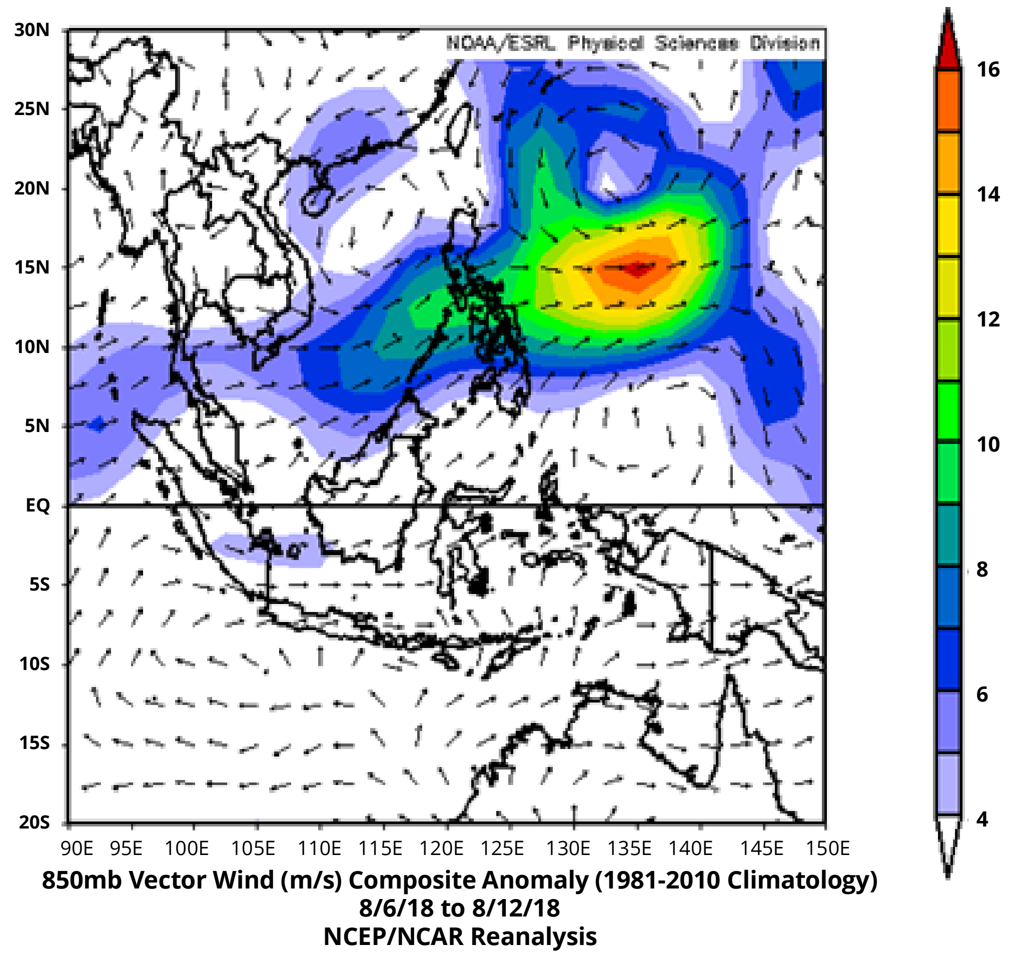


Figure 7.6

850 mb (upper-level height) wind flow showing large-scale wind anomalies (eastward and north-eastward) over the South China Sea and the western Pacific Ocean for 6 – 12 August 2018 from NCEP/ National Centre for Atmospheric Research Reanalysis dataset against 1981 – 2010 climatology. The wind anomalies drew all the moisture away from southern Southeast Asia.

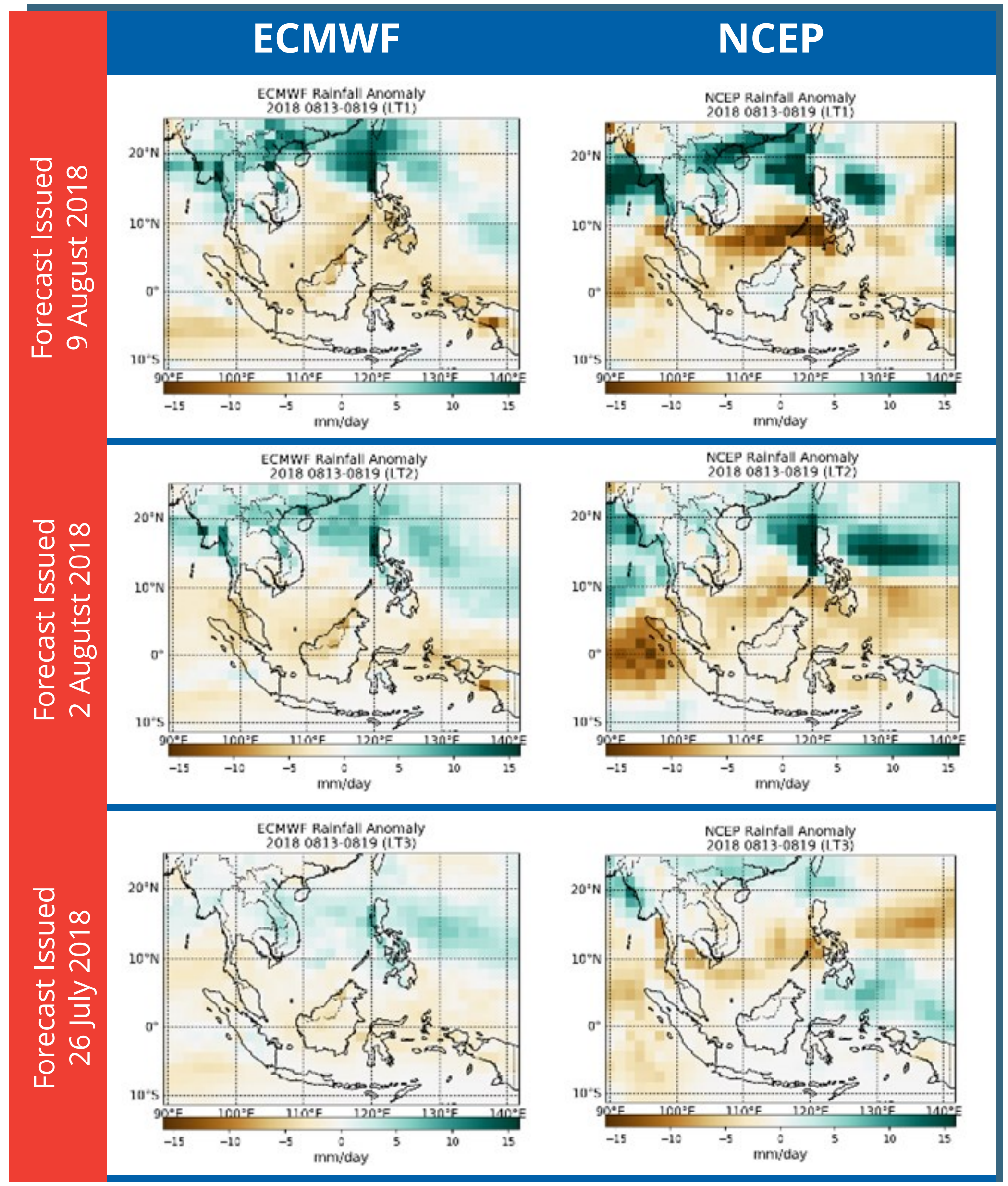


Figure 7.7

The weekly rainfall anomaly for the week of 13 – 19 August 2018 at different lead times for the two models (ECMWF and NCEP).

Rainfall anomaly patterns indicated that the region experienced drier conditions for the start of August 2018 (beginning in July 2018), with improved conditions starting from the last week of August. During the second week of August, drier conditions intensified over Sumatra, Peninsular Malaysia, and large parts of Borneo Island (Figure 7.5). Neither an El Niño nor the Madden-Julian Oscillation was present at this stage to influence the rainfall patterns. The eastern Indian Ocean conditions, although marginally cooler than usual at the surface, were also not strong enough to suggest the IOD influencing the rainfall conditions in the region (Hong, Lu, & Kanamitsu, 2008). Wind patterns showed signs of departures from the norm, with stronger eastward and north-eastward winds over the South China Sea and the western Pacific Ocean (Figure 7.6), which was possibly due to the passage of Typhoon Jongdari further downstream in the earlier part of the week. The spatial extent of this event and the timing of the onset and cessation of the large-scale atmospheric drivers suggest that S2S predictions can provide information on the worsening or improving of dry conditions and consequently help alleviate haze.

Week starting from	CMORPH		CHIRPS	
	Rainfall anomaly (mm)	Rank (%)	Rainfall anomaly (mm)	Rank (%)
30 Jul 2018	15.4	79	5.9	69
6 Aug 2018	-24.6	10	-23.7	7
13 Aug 2018	-34.0	3	-36.7	Min
20 Aug 2018	-12.2	36	-14.8	32

Table 7.3

The weekly rainfall anomaly (in mm) and the associated rank based on the climatology for the haze case study. Negative/positive anomaly values indicate drier/wetter-than-average conditions. Max rank indicates that the value recorded was higher than any previous observation .

The period of 6–26 August 2018 was drier than average for the study area, with the lowest rainfall occurring in the week of 13–19 August 2018 (Table 7.3 and Figure 7.7). The rainfall for this week was the lowest recorded compared to previous years for CHIRPS (1998–2017) and one of the lowest years for CMORPH (1998–2017). Therefore, this week falls within the 10th percentile classification for very low rainfall, and the week 06–12 August 2018 also nears the 10th percentile threshold.

For the week of 13–19 August 2018, both models capture the wet anomalies over the most northern parts of Southeast Asia and show generally dry conditions for the southern half of the region (Figure 7.6). The models predict this pattern over the oceans as early as the forecast from 26 July 2018 (apart from the wetter-than-average conditions to the southeast of the Philippines). Over the land, however, there is some discrepancy. For example, the forecasts issued on 26 July and 9 August 2018 by the NCEP model predicted Borneo to be slightly wetter, while the ECMWF model forecasts on 26 July and 2 August 2018 predicted wetter conditions mainly over eastern Borneo. However, the magnitude of the anomalies in all of these cases is small, indicating that either no large anomalies are likely or that the forecast is uncertain.

Week starting from	ECMWF			NCEP		
	LT1	LT2	LT3	LT1	LT2	LT3
30 July 2018	0%	25%	39%	0%	25%	93%
6 August 2018	2%	6%	20%	0%	3%	25%
13 August 2018 (driest week)	6%	43%	20%	0%	53%	6%
20 August 2018	0%	6%	9%	0%	0%	3%

Table 7.4

The probability of being within the 10th percentile at various lead times of LT1, LT2, and LT3 for the ECMWF and NCEP models in the haze case study. Boxes highlighted in yellow indicate that the rainfall is more than or equal to twice as likely to be within the dry rainfall threshold (10th percentile), i.e. ≥ 20% probability.

The models did not consistently forecast an increased chance of very dry conditions below the 10th percentile for the weeks starting on 6 and 13 August 2018 (Table 7.4), both of which were, in fact, very dry according to the CMORPH and CHIRPS datasets. For the week of 13–19 August 2018, both the ECMWF and NCEP models did predict an increase in the probability of not exceeding the 10th percentile at LT2 (2 August 2018). However, the LT1 (9 August 2018) forecast revised this chance to a lower probability. The forecasts from both models still predicted dry conditions, with all 32 NCEP members forecasting drier-than-average conditions for the week, as well as 44 of the 51 ECMWF members.

Overall, the magnitude of the dry conditions was not forecast well for this event, although the models were confident that there would be less rainfall than average during the main forecast week. Although the signals indicating extreme low rainfall were weak, there remains a potential to combine S2S prediction of low rainfall or rainfall deficit with other information to better predict the occurrence and persistence of haze.

7.2.4 Model Skill

The analysis here includes an additional assessment over a longer period to provide a more thorough understanding of the model skill for predicting the variability in the specific weeks. Without additional investigation, it is not certain that the models' ability to predict the anomalies during the specific events is not merely due to chance. The analysis uses two skill metrics: ACC and ROC (Wilks, 2011; WMO, 2018). The ACC measures the association between the model and the observations. Its values range between 1 (perfect association) and -1, with a value of 0 indicating no skill. The ACC can be calculated using:

$$ACC = \frac{\Sigma(a_{re})(a_{ob})}{\sqrt{(\Sigma {a_{re}}^2)(\Sigma {a_{ob}}^2)}}$$

Equation 7.2

where is the reforecast ensemble mean anomaly, and is the observed anomaly.

To assess the skill of the models for extreme events, the ROC score was calculated for predictions within the 10th and 90th percentile extreme thresholds. This score assesses whether the model can differentiate between events that are above or below the threshold. For example, in the case of the 90th percentile, the ROC score assesses whether the forecasts are different when heavy rainfall is observed compared to when it is not observed. The ROC score varies between 1 (good) and 0, with a value of 0.5 indicating the same skill as random (Kharin & Zwiers, 2003).

			ECMWF			NCEP		
			LT1	LT2	LT3	LT1	LT2	LT3
CMORPH	ACC		0.76	0.46	0.22	0.54	0.29	0.13
	ROC	10	0.71	0.49	0.62	0.59	0.55	0.67
		90	0.91	0.61	0.43	0.57	0.64	0.47
CHIRPS	ACC		0.82	0.55	0.4	0.49	0.41	0.28
	ROC	10	0.72	0.81	0.8	0.35	0.55	0.77
		90	0.91	0.61	0.44	0.67	0.55	0.47

Table 7.5

Skill of the ECMWF and NCEP models at the different lead times for the flood case study period. For both ROC and ACC, a perfect score is 1, while 0 and 0.5 indicate no skill for the ACC and ROC skill metrics, respectively, for the week of 2–8 January.

Although the ECMWF model has reasonable skill at a lead time of one week, its skill drops sharply for longer lead times, particularly in comparison to the CMORPH dataset. For NCEP, there is some skill at a lead time of one week with regards to the correlation (Table 7.5), but the skill for very heavy and very low rainfall is limited for all lead times.

While the skill for the reforecast period is not very high, it is important to note that this flood event was larger than any of the events in the reforecast period assessment. The forecasts in the previous section did capture the heavy rainfall in the weeks prior to the event, indicating that if the event is large enough (and particularly if it is at a large scale), there is a good chance that the forecasts will predict the events.

			ECMWF			NCEP		
			LT1	LT2	LT3	LT1	LT2	LT3
CMORPH	ACC		0.88	0.71	0.67	0.71	0.63	0.57
	ROC	10	0.89	0.62	0.61	0.82	0.53	0.53
		90	0.97	0.76	0.75	0.69	0.71	0.69
CHIRPS	ACC		0.82	0.68	0.68	0.71	0.68	0.63
	ROC	10	0.82	0.81	0.71	0.91	0.53	0.63
		90	0.89	0.68	0.68	0.69	0.71	0.79

Table 7.6

Skill of the ECMWF and NCEP models at the different lead times for the haze case study. For both ROC and ACC, a perfect score is 1, while 0 and 0.5 indicate no skill for the ACC and ROC skill metrics, respectively, for the week 13–9 August.

During August, both models demonstrated reasonable skill in predicting rainfall at lead times of one and two weeks (Table 7.6). The ACC for these weeks varies between 0.68 and 0.88 for the ECMWF model and 0.63–0.71 for the NCEP model. When looking specifically at the probability of staying below the 10th percentile and exceeding the 90th percentile (for very low and very high rainfall, respectively), the ECMWF model was skilful at both lead times of one and two weeks (ACC values 0.62–0.97), and the NCEP model demonstrated skill at a lead time of one week for very low rainfall (ACC values 0.82–0.91) and lead times of one to three weeks for very heavy rainfall (0.69–0.79).

However, the model did not predict very low rainfall at LT1 for the dry spell case study. It is possible that the lack of an obvious large-scale driver for this case made the event difficult to forecast, and a large-scale driver may have allowed the models to forecast it better. This result is similar to that of the southern Thailand case study in that it shows the importance of considering drivers in the assessment of the forecasts. While skill assessment is important for understanding the usefulness of forecasts, higher (or lower) skill alone does not necessarily mean that any specific forecast will be correct.

7.3 Conclusions and Recommendations

This article examined two extreme case studies to demonstrate the potential of S2S predictions at lead times of one to three weeks before the disasters using ECMWF and NCEP models. In the case of the heavy rainfall in southern Thailand in January 2017, the two models' forecasts at LT2 indicated a high probability of heavy rainfall, despite the model skills not being very high for this region and time of year. For the second case study investigating dry spell in Indonesia and Malaysia, the two models did not indicate a strong probability of very low rainfall for August 2018, despite both having better model skill for this region and time of year. However, the models did indicate that conditions would be drier than average in August 2018.

Evaluation of S2S products needs to continue for a larger sample of cases similar to the two examples that this study investigated. There also needs to be a more systematic collection of feedback on S2S predictions from user agencies. ASMC and its collaborators, including ESCAP and RIMES, are working towards sharing operational S2S products on an experimental basis with a target group of disaster managers to collect their systematic feedback for an objective assessment of on-ground skill. It is important to consider that S2S predictions form a part of a broader spectrum of weather and climate products that should all work together to improve decision-making in the areas of preparedness and response. Easy-to-use decision support systems that bring together this range of weather and climate information will better enable disaster managers to put S2S into action.

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Where To Go? Finding Durable Solutions for Disaster-Displaced Persons in Southeast Asia

By Daniel Petz & Muhammad Rum

ARMOR

Abstract

Climate change is a risk multiplier for hydrometeorological disasters and poses additional hazards for low-lying islands, river deltas, and coastal zones due to projected sea level rise. According to the Internal Displacement Monitoring Centre (IDMC), disasters in Southeast Asia already displace about a million people per year, and this number is very likely to rise in the future, given the region's vulnerability to climate impacts. Although most of the Association of Southeast Asian Nations (ASEAN) countries have improved their disaster response in recent years and institutionalised regional efforts to deal with disaster risk management, the response to displacement still poses a significant challenge to many countries in the region.

This paper focuses on the issue of durable solutions for addressing population displacement due to disaster and climate change. While many displaced populations can return to their homes relatively quickly after natural disasters, cases of prolonged displacement are increasing globally. Climate change is likely to exacerbate the situation further as climate hazards might make returning to some areas impossible. This article uses recent cases of displacement, lessons learned in the region, and analysis of government policies to propose potential strategies for dealing with internal displacement. These strategies include displacement prevention, durable solutions, and ways for international, regional, and national actors to improve the region's response to displacement from disasters and climate change.

Keywords: Climate change adaptation, internal displacement, natural disasters, Southeast Asia, ASEAN

8.1 Introduction

The rate of disaster-induced displacement of populations in Southeast Asia has been rising rapidly in recent years and is likely to continue on an upward trend due to the exacerbation of natural disasters by climate change. Although most of the ASEAN countries have improved their disaster response and institutionalised regional efforts to deal with disaster risk management, the response to displacement still poses a significant challenge to many countries in the region. Most ASEAN countries do not possess comprehensive legal and regulatory frameworks to deal with internal displacement, creating an obstacle for overcoming growing challenges relating to climate change.

This paper looks at how countries in the region fare in regards to providing durable solutions to displacement stemming from disasters and climate change impacts. It also investigates how countries can improve their response through the development of national or regional regulatory frameworks and evaluates the role that ASEAN can play to support these efforts.

8.2 Disaster-Induced Displacement in Southeast Asia

This paper follows the Guiding Principles on Internal Displacement definition of internally displaced persons (IDPs) as "persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict situations of generalised violence, violations of human rights, or natural or human-made disasters, and who have not crossed an internationally recognised State border" (United Nations Office for the Coordination of Humanitarian Affairs (OCHA), 2004). The term "disaster-induced displacement" in this paper refers to displacement caused by natural hazards, including rapid-onset events, slow-onset events, and pandemics. Disaster-induced displacement can be either internal (within national borders) or international (crossing an international border). It can also range from short-term displacement on the scale of a few days to long-term (protracted) displacement that can last many years.

Disaster-induced displacement in numbers

Country	2015	2016	2017	2018	Total per country
Brunei Darussalam	0	0	94	0	94
Cambodia	8,900	8,300	15,000	37,000	69,200
Indonesia	204,000	1,246,000	365,000	853,000	2,668,000
Lao PDR	12,000	660	190	19,000	31,850
Malaysia	21,000	18,000	82,000	38,000	159,000
Myanmar	1,618,000	509,000	351,000	298,000	2,776,000
Philippines (the)	2,221,000	5,930,000	2,529,000	3,802,000	14,482,000
Singapore	0	0	0	0	0
Thailand	200	90,000	50,000	4,600	144,800
Viet Nam	9,600	81,000	633,000	143,000	866,600
Total per year	4,094,700	7,882,960	4,025,284	5,194,600	21,197,544

Table 8.1

The number of people displaced by disasters in each country in Southeast Asia for the period 2015–2018 (source: IDMC & NRC, 2015–2019).

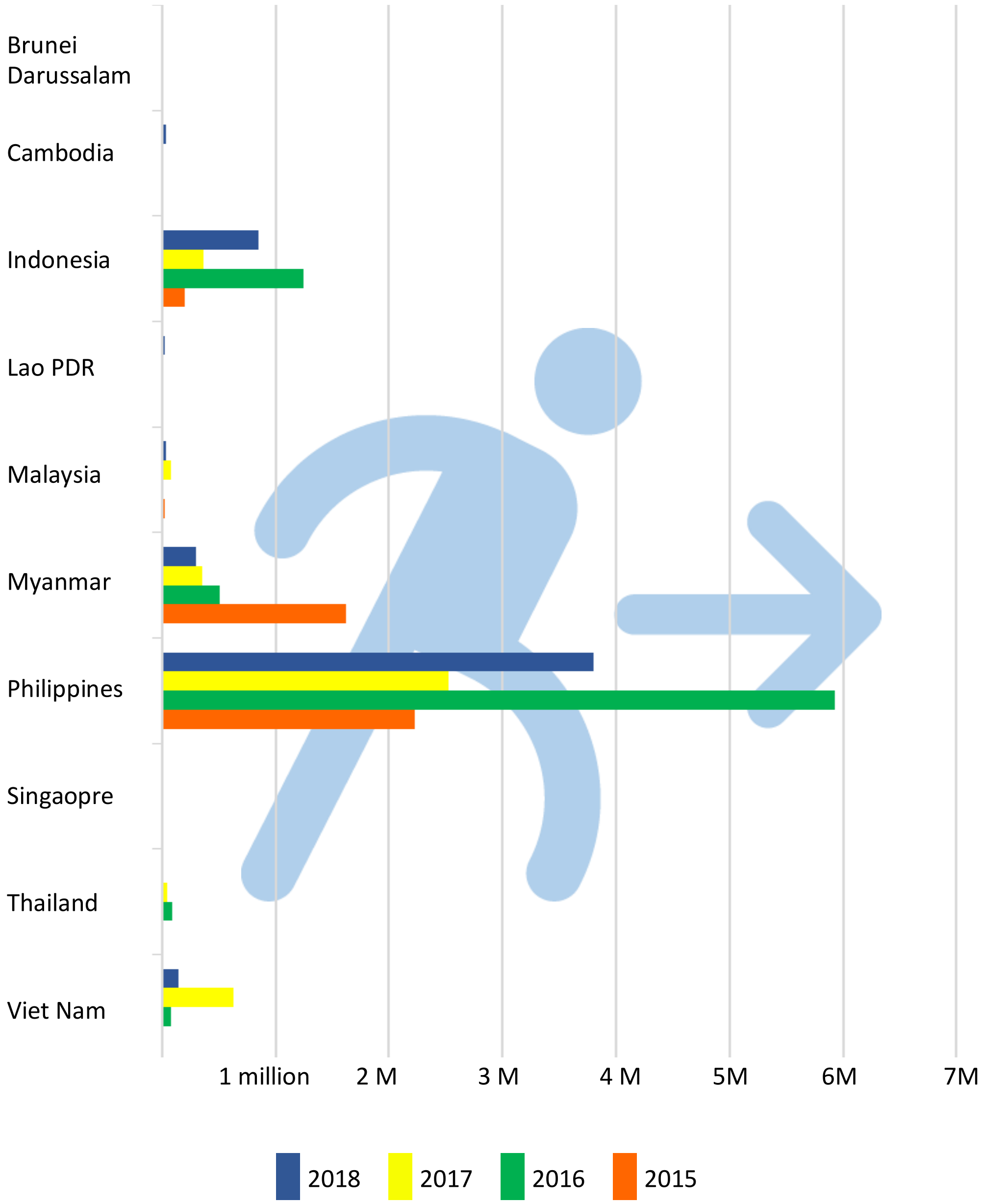

Figure 8.1

Disaster-induced displacement in each ASEAN country for the period 2015–2018 (source: IDMC & NRC, 2015–2019).

Globally, Southeast Asia is one of the regions most affected by disaster-induced displacement. In 2018, with over 5 million people displaced by disasters, Southeast Asia accounted for about 30% of displaced persons globally (IDMC & Norwegian Refugee Council (NRC), 2019). Although there is a lack of comprehensive long-term data series on disaster-induced displacement, thus necessitating reliance on modelling, better data collection on the displacement in recent years shows a detailed and reasonably accurate picture (Table 8.1). IDMC collected data from 2015 to 2018 showing that the impacts of natural hazards in the region caused the displacement of more than 21 million people in total, with the number of displaced surpassing 4 million in each year (Figure 8.1). The most affected countries were the Philippines, Myanmar, Indonesia, and Viet Nam.

Because natural hazards are highly variable from year to year and the data only include four years of events, Table 8.1 and Figure 8.1 provide just a glimpse of the broader phenomenon. ASEAN countries experienced many significant events before 2015, such as the floods in Thailand in 2011 that displaced about 1.5 million people (IDMC & NRC, 2012). A 2014 paper on displacement risk in Southeast Asia and China found that the risk of displacement due to disasters has been growing at a rate even faster than the population growth rate. The uneven distribution of risk also causes Laotians and Filipinos to be more than 10 times as likely to experience displacement than Indonesians (Lavell & Ginetti, 2014, p. 9). Displacement modelling in Southeast Asia from 1970 to 2014 shows an increase in disaster-displaced persons from a high of about 1 million people per year in the 1970s to between 3 and 7 million people per year between 2009 and 2014. Data from 2015 to 2018 indicate a further increase in displacement of between 4 and almost 8 million people per year (Table 8.1).

While the region's location in the Pacific Ring of Fire makes it prone to geophysical disasters, most displacement in recent years has been due to hydrometeorological disasters, in particular tropical cyclones (TCs) and floods. IDMC has found that hydrometeorological disasters accounted for 87% of displaced people globally during 2008 – 2018, with data also showing a rise in the number of events leading to displacement (IDMC, 2019b, p. 8). Among hydrometeorological disasters, floods cause the largest amount of displacement, followed by TCs. The long-term climate risk index looking at fatalities and losses from climate-related disasters during 1999–2018 shows that four ASEAN countries are in the top 10 of the most affected countries in the world: Myanmar (2nd), the Philippines (4th), Viet Nam (6th) and Thailand (8th) (Eckstein, Künzel, Schäfer, & Winges, 2019, p. 9).

8.3 Climate Change as a Displacement Risk Multiplier

One of the main effects of climate change is that it acts as a risk multiplier by increasing the frequency and ferocity of natural hazards and thus leading to more severe disasters. Climate change affects the strength and location of precipitation, leading to heavier rainfall that can cause flooding or landslides. At the same time, it can lead to less rainfall and cause more frequent and prolonged droughts. A recent study has shown that even if the world meets the Paris Agreement's mitigation targets, which is the most optimistic scenario, flood displacement risk is likely to double by 2100 (IDMC, 2019a, p. 5).

TCs are another prevalent type of hazard in Southeast Asia. Climate scientists debate whether warming oceans allow TCs to strengthen more rapidly or maximum wind speeds to rise, but the relative rarity of TC events makes it difficult to obtain proof for these theories (Bindoff et al., 2013; Field et al., 2012; Stott et al., 2016). Several destructive TCs have affected Southeast Asia in recent years, leading to large numbers of displaced persons.

Sea level rise is a climate change hazard that will heavily impact Southeast Asia due to the region's many small islands, low-lying coastal areas, and river deltas. Although sea level rise is a slow-onset hazard, it has the potential to increase the severity of sudden-onset hazards. For example, higher sea levels increase the potential of coastal flooding and flood surges during storms and TCs. Climate change drove a global sea level rise of 11–16 cm in the 20th century, and even with sharp emission cuts, sea level could continue to rise by 50 cm during the rest of the 21st century. In high-emission scenarios, it could rise up to 2 m by 2100 (Kulp, & Strauss, 2019). The Intergovernmental Panel on Climate Change (IPCC) notes that sea level rise will continue for centuries, even if human societies manage to stabilise carbon dioxide concentrations under 500 ppm (Church et al., 2013, p. 1139). Kulp and Strauss (2019) find that even with deep cuts to carbon emissions (Representative Concentration Pathway 2.6), Bangladesh, Viet Nam, and Thailand may face high tide lines extending above areas holding huge swathes of their populations (estimates ranging from 15% to 31%) before accounting for episodic large flooding events. They also project that, under a scenario of continuing high emissions with Antarctic instability (Representative Concentration Pathway 8.5), land currently home to roughly one-third of Viet Nam's population could permanently fall below the high tide line.

In Southeast Asia, major metropolises such as Bangkok, Ho Chi Minh City, and Jakarta might be particularly vulnerable to sea level rise and related hazards due to their low elevation. Additionally, subsidence due to groundwater extraction often accompanies the low elevation and compounds the impacts of hazards. The historically unprecedented 2011 floods in Bangkok and 2020 floods in Jakarta offer early glimpses into what the climate-charged future of these cities may hold. New policies addressing sea level rise should take a long-term perspective of at least 50–100 years, as actions on shorter time scales are likely to lead to a waste of resources and maladaptation. Such unprecedented, long-term, and intergenerational policy planning is challenging and might benefit from the supplementation of short- and mid-term strategies that are at the core of regular policy planning. It might also face a range of feasibility concerns regarding issues of public support, operational implementation, technical challenges, and uncertainties in climate change impact projections. Nonetheless, working to overcome these challenges can lead to significant benefits, particularly in the area of preventing displacement.

This brief discussion of several natural hazards and climate change shows that displacement risk will likely increase in the future for most Southeast Asian countries. However, hazards are only one aspect of displacement risk—displacement is a complex phenomenon that interacts with several factors. Aside from direct climate change impacts on natural hazards, the scope of displacement will depend on how climate change will impact socioeconomic realities in Southeast Asia. For example, climate change impacts such as sea level rise, ocean acidification, and the bleaching of coral reefs will likely have major effects on tourism and fisheries. Furthermore, climate change may negatively impact agricultural yields and thus livelihoods of rural populations. While rapid-onset events will likely lead to displacement, governments in the region should not underestimate the effects of slow-onset events on migration and displacement patterns. Growing populations and urbanisation will also shape the displacement picture in the region by both increasing the at-risk population and making displacement a more urban phenomenon (United Nations Department of Economic and Social Affairs, 2019, p. 17). Governments can, to a certain degree, limit displacement risk through disaster risk reduction (DRR) measures and climate change adaptation (CCA). Population management, urban development strategies, and land use planning will impact the scope of displacement risk in the region and are all factors that policy can significantly influence. The level of global mitigation will especially impact displacement risk, making it imperative for ASEAN Member States to use all policy instruments available (e.g. diplomacy or in-country mitigation) to minimise global warming to 1.5°C above pre-industrial levels.

Most prior disaster-induced displacement in the region has been internal (i.e. displaced persons do not cross an international border), and it is likely that displacement will continue to follow this pattern in the near future (Lavell & Ginetti, 2014). However, conflict in the region has led to refugee movements, and high emission scenarios could lead to large portions of submerged land in some countries. Thus, there is no guarantee that the internal pattern will hold in the future, and governments should prepare provisions for dealing with other scenarios. This preparation is particularly important because disaster-displaced people do not fall under the United Nations Refugee Convention, and there are currently no other regional mechanisms to handle potential displacements (The Nansen Initiative, 2014b, p. 11).

8.4 Durable Solutions to Displacement

The United Nations Inter-Agency Standing Committee has developed a Framework on Durable Solutions based on the Guiding Principles on Internal Displacement (OCHA, 2004; The Brookings Institution, 2010). The Framework argues that achieving a durable solution means that IDPs no longer have specific assistance and protection needs due to their displacement, and such persons can enjoy their human rights without discrimination resulting from their displacement" (The Brookings Institution, 2010, p. 5). It further defines that achieving a durable solution can happen through one of the following:

- Sustainable reintegration at the place of origin ("return")
- Sustainable local integration in areas where IDPs take refuge ("local integration"), or
- Sustainable integration in another part of the country ("settlement elsewhere in the country") (The Brookings Institution, 2010, p. 5).

It is essential to frame displacement in terms of durable solutions because displaced persons' needs do not necessarily end upon return after a disaster, as livelihoods and infrastructure might still be experiencing problems. Additionally, local integration or settlement in other parts of the country might be a complex endeavour due to housing and livelihood needs, loss of documentation, permits, access to government services, or similar challenges.

There exists a common perception that disaster-induced displacement is short-term, and it is easier to find durable solutions for people displaced by natural disasters than those displaced by cases of conflict. While, in some cases, this perception is true, many recent disasters have shown that the impacts of displacement can affect people for many years (for an example, see OCHA, 2017). Even for those who can return, negative financial impacts such as loss of income, needs for repairs and reconstruction, effects on livelihoods, and damages to important infrastructure such as transport, education, and healthcare can last for years. The United Nations Special Rapporteur on the human rights of internally displaced persons argued that, in the context of climate change, durable solutions would likely need to be more complex rather than static and one-dimensional. The Special Rapporteur argues that “they may combine a number of solutions, including movements which are seasonal or temporary, or solutions which include continuity with the place of origin as well as integration in a different part of the country (for example, part of the family returns to the place of origin permanently or on a seasonal basis, while the breadwinner works in another location). Strategies addressing internal displacement should therefore be sufficiently flexible to include and support various scenarios of human adaptation and ensure that durable solutions are based on free and informed consent” (United Nations General Assembly, 2011, p. 19).

Unfortunately, there are relatively few studies that look at durable solutions and the long-term impacts of displacement in Southeast Asia (Stange, Kourek, Sakdapolrak, & Sasiwongsaroj, 2019). A detailed study by Sherwood, Bradley, Rossi, Guiam, and Mellicker (2015) on the aftermath of Typhoon Haiyan (locally known as Typhoon Yolanda) in the Philippines identifies several challenges for durable solutions and can be instructive in highlighting some of the main issues for governments in the region. In November 2013, Typhoon Haiyan displaced over 4 million people, and the study shows that one and a half years after the disaster, only 17% felt that their life had returned to normal (Sherwood et al., 2015, p. 1). The study highlights that, while some durable solutions tied directly to the restoration of housing, a wide range of other issues arose. The main challenge was deciding how to prioritise the complex interlinking justice questions in regards to “inequalities that arise from investing in a holistic range of interventions in particular communities, leaving fewer resources for other areas” (Sherwood et al., 2015, p. 2). For example, over 200,000 households required relocation because their former houses and dwellings were in what became “no-build zones”. Questions of livelihoods were pressing for this group, with many families returning to their places of origin as there was a lack of livelihood opportunities in the resettlement areas far from centres of commercial and economic life. Many of the displaced persons felt that they had a lack of consultation or choice in the matter of their relocation (Sherwood et al., 2015, p. 3 and 30). Similar patterns have occurred in Indonesia, where lack of strict government regulations has led many displaced people to return to the ground zero areas (or red zones) of the 2004 Indian Ocean earthquake and tsunami. The most notable example is the Ulee Lheue, Aceh area, which has now become crowded again after experiencing severe damage during the 2004 tsunami 16 years ago (Wahyuni, Rum, Fitrah, & Octastefani, 2018a). Wahyuni et al. (2018a) found that the main reason people still live in disaster-prone areas is the dependence on their livelihoods there and a lack of alternative economic opportunities from the government. Therefore, a narrow focus on reconstruction and a lack of enforcement of no-build zones leads to IDPs returning to at-risk areas. Thomas (2016) shows that many similar issues arise for displacement due to floods and landslides in Myanmar.

The above cases mirror similar findings from other areas hit by disasters (OCHA, 2017; Sherwood, Bradley, Rossi, Gitau, & Mellicker, 2014; Yonetani, 2017) showing that the process of finding durable solutions is a challenging mid- to long-term operation that requires multisectoral and sustained development interventions, and it might prove challenging for many governments in the region as climate change exacerbates hazards and displacement. Even for short-term displacement, a range of protection challenges arises. The United Nations Inter-Agency Standing Committee suggests that government interventions should use a rights-based approach that aims to protect vulnerable persons (i.e. children, pregnant women, the elderly, and persons with disabilities) in a post-disaster environment (The Brookings Institution, 2011). Doing so allows for the integration of all the basic needs of the victims into a holistic planning and delivery process, preventing discrimination that is often prevalent for vulnerable persons and groups.

In addition to highlighting the challenges facing those who can return after a hazard has passed, the above cases also demonstrate the rising urgency and complexity of planned relocations. Climate change will increasingly complicate the process of finding durable solutions for displaced persons. Over time, return might become too dangerous or costly for many people, requiring other solutions such as planned relocation.

Planned relocation can take place in at-risk areas before disaster strikes as part of anticipatory CCA. Alternatively, as in the case of Typhoon Haiyan, it can also be part of a post-disaster measure to provide durable solutions for those who cannot return. Experience shows that planned relocation is a highly complex endeavour (for an example, see Chun, 2015; Petz, 2015, 2017; Thomas, 2015), but it may still be an important and viable option for areas experiencing high risk of sea level rise and hydrometeorological disasters. Limited resources may inhibit the provision of sufficient protection or adaptation measures to all areas, making retreat the only viable option. Therefore, it is necessary to develop sound criteria based on scientific evidence that identify when relocation is necessary and legal. To avoid arbitrary case-by-case decision-making, legal and policy frameworks should also incorporate complicated issues concerning consent and participation of affected persons, as well as issues of compensation and livelihoods. The recent development of an international guidance document and a toolbox on planned relocation aims to support governments with this difficult task (The Brookings Institution, Georgetown University, ISIM, & UNHCR, 2015; UNHCR, Georgetown University, & IOM, 2017).

Addressing the challenges of disaster-displacement in an age of climate change will require a shift from a reactive to a proactive approach. While most governments in the region have significantly improved their disaster response capacities in recent years (both through legal and institutional reforms), investment in DRR and CCA is still low compared to the costs of disaster response. However, there is clear evidence that investments in DRR, including measures to boost preparedness and community resilience, pay off financially (Kelman, 2013; Lavell & Ginetti, 2014). National displacement policies should thus include a strong element of displacement prevention, such as measures of anticipatory relocation. Governments should also review and support policies on voluntary internal migration of persons who live in high-risk zones. Climate change makes it crucial to include climate projections, land use planning, and urban and rural development policies with mid- to long-term perspectives to keep long-term risk under control.

Having identified several issues that stand in the way of finding durable solutions for disaster-displaced persons in Southeast Asia, the next sections look at legal and policy frameworks at both national and regional levels to identify the displacement-preparedness levels of countries in the region.

8.5 National Laws and Policies on IDPs in Southeast Asia

This section examines various laws and policies regarding IDPs throughout Southeast Asia to provide a clear picture of both the organisation of and potential gaps in protection that IDPs have against disaster and climate change in the region.

Looking at the Global Protection Cluster's Global Database on IDP Laws and Policies (2020), the authors find that no ASEAN Member State currently has a comprehensive law in force on internal displacement. The Philippines is the only country to have passed a comprehensive bill on the protection of rights of IDPs in 2013, but it was vetoed by President Benigno Aquino III, and revised bills also had no success yet (Orchard, 2019, p. 210). In terms of policies on internal displacement, Indonesia is the only country in ASEAN to have a national policy on IDPs from 2001. The brief policy document does not provide any definition of IDPs, nor does it explicitly mention persons displaced from natural disasters or climate change. The document lays out the responsibilities of different agencies and ministries in responding to IDP issues (National Legislative Bodies/National Authorities, 2001). Specifically, it lays out three patterns of national policies on IDPs to: (1) return the IDPs to their normal lives, (2) facilitate the IDPs to start a new life within the new community, and (3) resettle the IDPs to new sites. These patterns are congruent with the three options laid out by the Framework on Durable Solutions. The multitude of actors and the inclusion of both national and subnational stakeholders have occasionally caused conflicts over responsibilities and the chain of command (Wahyuni, Rum, Fitrah, Octastefani, 2018b; Putra & Matsuyuki, 2019).

Cambodia, Myanmar, the Philippines, and Viet Nam have established other instruments that encompass laws or regulations addressing internal displacement. The Global Protection Cluster database shows that Cambodia's Agreement on a Comprehensive Political Settlement of the Cambodia Conflict, Paris Peace Agreements (known as the Final Act of the Paris Conference on Cambodia) has no provisions for displacement from natural disasters or climate change. However, several ASEAN Member States have developed policies relating to disaster management that address disaster-induced displacement. For example, Myanmar has the National Framework for Community Disaster Resilience of 2017, the Philippines has the institutionalised Act number 101211 (the Philippine Disaster Risk Reduction and Management Act of 2010), and Viet Nam has the Order No.07/2013/L-CTN of 28 June 2013 on the Law on Natural Disaster Prevention and Control (Global Protection Cluster, 2020). Indonesia also has three other instruments relating to disaster management, displacement, response, and reconstruction: (1) the Master Plan for the Rehabilitation and Reconstruction of the Regions and Communities of the Province of Nanggroe Aceh Darussalam and the Islands of Nias, Province of North Sumatra, (2) the Law of the Republic of Indonesia Number 24 of 2007 concerning Disaster Management, and (3) Law number 7 of 2012 concerning Handling of Social Conflict.

Most disaster management laws have provisions for supporting and assisting displaced persons and designating institutional responsibilities for disaster prevention response. However, there is typically little mention of displacement -specific protection needs for IDPs, and none of the policies mention durable solutions for displaced persons (Table 8.2).

Member States	National policies on protections for IDPs	Other instruments
Brunei Darussalam	Not available	Not available
Cambodia	Not available	1991: Final Act of the Paris Conference on Cambodia (Agreement on a Comprehensive Political Settlement of the Cambodia Conflict, Paris Peace Agreements)
Indonesia	2001: policies on the handling of IDPs/refugees in Indonesia	2005: Master Plan for the Rehabilitation and Reconstruction of the Regions and Communities of the Province of Naggore Aceh Darussalam and the Islands of Nias, Province of North Sumatra; 2007: Law of the Republic of Indonesia Number 24 of 2007 Concerning Disaster Management; 2012: Law Concerning Handling of Social Conflict (Law No. 7/2012)
Lao PDR	Not available	Not available
Malaysia	Not available	Not available
Myanmar	Not available	2017: Myanmar National Framework for Community Disaster Resilience
Singapore	Not available	Not available
Thailand	Not available	Not available
Philippines (the)	Ongoing debate on a bill on the protection of the rights of IDPs	2009: Philippine Disaster Risk Reduction and Management Act of 2010 (Act No.101211)
Viet Nam	Not available	2007: National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020 2013: Order on the Promulgation of the Law on Natural Disaster Prevention and Control (Order No.07/2013/L-CTN)

Table 8.2

Existing laws and policy instruments in Southeast Asia relevant to IDP protection (source: The Global Protection Cluster, Global Database on IDP Laws and Policies, 2020).

Table 8.2 shows that most ASEAN Member States have no comprehensive framework of policies and regulations to ensure the protection of the rights of IDPs. Because climate change will likely significantly increase displacement risk in the region, the lack of such policies threatens the successful implementation of durable solutions for persons displaced due to disasters or climate change, as this often means that policies to protect IDPs are delegated to a broad array of agencies and ministries, often with no lead agency to coordinate the wide range of IDP protection issues and facilitate the finding of durable solutions. National governments are responsible for guaranteeing the rights of IDPs, thus making national laws and policies important cornerstones for IDP protection. A regional convention could be a starting point to both incentivise the development of IDP-specific laws and policies in the Member States and to mainstream international standards of IDP protection throughout the region. The next section will explore the viability of such regional normative development in Southeast Asia. First, it explores how far ASEAN's work on climate change has developed in recent decades and if there are already regional policies or programmes dealing with disaster-induced displacement. Then, it goes into a brief discussion of whether the African Union (AU) Convention for the Protection and Assistance of Internally Displaced Persons in Africa (the Kampala Convention) could be a model for the ASEAN Member States to replicate.

8.6 ASEAN Policy Development on Climate Change and Displacement

The ASEAN region declared climate change one of its priority sectors through two key policy documents—the ASEAN Declaration on Environmental Sustainability and the ASEAN Declaration on COP-13 to the UNFCCC and CMP-3 to the Kyoto Protocol—at the 2007 ASEAN Summit in Singapore (Overland, 2017, p. 15). At the 2007 United Nations Climate Change Conference in Bali, ASEAN Leaders pledged to prepare a road map for a regional response to climate change, with the aim to complete road map negotiations in two years. In 2009, the 2009-2015 Roadmap for an ASEAN Community adopted ASEAN's climate change agenda (Letchumanan, 2010, p. 50). In both the 2007 and 2009 statements, ASEAN Leaders acknowledged environmental protection and sustainable development as pivotal for long-term socioeconomic development in the region. ASEAN Member States decided to place disaster management and climate change issues under the ASEAN Socio-Cultural Community pillar, based on the vision of this community as the pillar of a caring society. In 2009, the regional organisation established the ASEAN Climate Change Initiative and the ASEAN Working Group on Climate Change (AWGCC). ASEAN environment ministers established the ASEAN Climate Change Initiative as a platform for consultation and coordination of activities for policy formulation, information sharing, capacity-building, and transferring of technology (Letchumanan, 2010, p. 57 – 58). AWGCC is a sectoral body for work on climate change issues, containing a special unit for working to coordinate inter-sectoral cooperation related to climate change (Overland, 2017, p. 15).

Since 2007, ASEAN summits have consistently featured ASEAN Leaders' statements on climate change. In the 2019 ASEAN Summit in Thailand, Member States' Leaders adopted the ASEAN Joint Statement on Climate Change to the 25th Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change and the ASEAN Joint Statement to the United Nations Climate Action Summit 2019. The statements reiterate that all ASEAN Member States have ratified the Paris Agreement and allocated their respective Nationally Determined Contributions. Notable commitments related to disaster- and climate change-induced displacement include the call to strengthen regional capacity for disaster management and emergency response and to prepare the necessary steps to establish ASEAN Disaster Risk Financing and Insurance and the Southeast Asia Disaster Risk Insurance Facility. Through this arrangement, disasters and their impacts due to climate change will likely be the domain of the ASEAN Committee on Disaster Management (ACDM) and the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre), which operates under the ASEAN Agreement on Disaster

Management and Emergency Response (AADMER). Nevertheless, there are no direct mentions of climate change-induced displacement in these documents. This omission indicates that ASEAN has not yet included durable solutions or planned relocation in its strategies to respond to climate change. Similarly, the ASEAN Economic Community Blueprint 2025 does not touch upon the issues of refugees and IDPs in any direct form (ASEAN, 2015). An analysis by Orchard (2018) also found that regional processes for introducing a comprehensive approach for IDPs have been limited to supporting orderly repatriation and resettlement of refugees and IDPs in the 2004 ASEAN Security Community Plan of Action (Orchard, 2018, p. 251).

Thus, the issue of displacement affected by climate change still has not found a place in ASEAN's climate policy. Although ASEAN shows consistent support for climate change causes, the region still needs a better strategy to support durable solutions. The gap in this area is an indication that there is still a lack of regional advocacy for ideas relating to a holistic approach for climate change, IDPs, and durable solutions.

8.7 Methods of Displacement Support for ASEAN Member States

A regional convention could learn from the aforementioned problems of fragmented and inadequate national policies of ASEAN Member States in protecting the rights of IDPs and serve as a harmonisation tool to incentivise governments to develop comprehensive laws and policies on internal displacement. ASEAN has adopted several instruments that can incrementally create a strong foundation and set preconditions for successful norm-building. These instruments include the foundation of the ASEAN Human Rights Declaration in 2012, the ASEAN Intergovernmental Commission on Human Rights in 2011, and the AHA Centre in 2011. All these regional instruments are compatible and interrelated with international norms, such as the responsibility of IDP protection. Their successful creation and implementation might point towards the feasibility of ASEAN adopting a regional convention on IDP rights protection.

Historically, the only region that has seen the development of regional conventions on displacement is Africa. The AU achieved the most important development in this regard in 2009 when it passed the Kampala Convention. The Kampala Convention requires signatories to enact or amend "relevant legislation for the protection of, and the assistance to, IDPs in conformity with their obligations under international law" (AU, 2009, p. 6), and requires countries to designate an authority or body to coordinate IDP policies. Article 1 of the Convention provides a comprehensive definition of IDPs, including IDPs that have been forced to flee because of natural or human-made disasters. By implication, this definition also includes persons affected by climate change. After its introduction in 2009, the Kampala Convention effectively came into force in December 2012, 30 days after its ratification by the 15th state. One question remains: what has made AU Member States accept regional conventions? This study argues that if ASEAN can emulate the preconditions of the Kampala Convention negotiation success, then the introduction of IDP protection provisions into regional law as the basis for harmonisation will be successful.

One of the contributing factors for the success of the Kampala Convention's adaptation might be that the precursor to the AU, the Organisation of African Unity, had already introduced the 1969 Convention Governing the Specific Aspects of Refugee Problems in Africa. This Convention was an advanced regional hard law providing a definition of refugees that was far more comprehensive than that of the United Nations Refugee Protocols. It indicated that AU Member States had already internalised the norms of rights protection (Orchard, 2018). The 2006 Great Lakes Protocol on the Protection and Assistance to Internally Displaced Persons also acted as an important predecessor to the Kampala Convention. Another contributing factor for the success of the relatively quick uptake of the Kampala Convention is the fact that it provided flexibility in the ratification process, allowing it to come into force after 15 Member States had ratified it. By 2019, 29 out of 55 Member States had ratified the Convention, and several Member States had revised their laws and policies or developed new ones (AU, 2020). Despite this flexibility in ratification, the process of policy development has been relatively slow. To support the process, the AU developed a model law in 2018 that Member States can consult when drafting domestic legislation based on the Kampala Convention (International Committee of the Red Cross (ICRC), 2019, p. 19).

The flexible ratification and implementation schedule of the Kampala Convention allows Member States to fulfil their obligations based on prioritisation and capacity. However, this flexibility might contribute to a relatively slow pace of implementation of the Convention by several countries. Nonetheless, the Kampala Convention is a critical normative development in the region. Given that ASEAN Member States face very different levels of displacement due to disasters and climate change, flexibility of ratification and implementation might be an asset. As such a convention would, by definition, not deal with cross-border movement, a certain degree of flexibility would not pose any major bilateral issues.

In terms of being a possible inspiration for a regional instrument on the level of ASEAN, one important consideration is that there is a major difference between the AU's and ASEAN's practice of adopting regional agreements and conventions. The AU has a lower threshold on its signatories and ratifications, while ASEAN regionalism requires a consensus of all Member States to sign and ratify before an agreement comes into force. However, ASEAN could use the clausula of the "ASEAN minus X" formula (see ASEAN Charter Article 21 and Emmers, 2017) to hasten the speed of negotiation and ratification if it deemed it to be urgent for the common interest. In the "ASEAN minus X" formula, the implementation of a regional agreement or convention allows different speeds of ratification and implementation based on national needs and readiness.

The policy recommendation of this paper takes into account the above factors and preconditions. ASEAN could use the existing norm-building mechanism in the region as the foundation of a newly negotiated regional convention. The adoption of the ASEAN Charter in 2008, the establishment of the ASEAN Intergovernmental Commission on Human Rights in 2011, and the ASEAN Human Rights Declaration of 2012 all introduced universal values in the region. These instruments and regional bodies can also foster the adoption of IDP rights protection. In concurrence with the impacts of climate change, ASEAN should first strengthen inter-sectoral collaborations — especially the AWGCC, the ACDM, and the AHA Centre — under the banner of the ASEAN Socio-Cultural Community to highlight the urgency of disasters and displacement related to climate change. ASEAN should then negotiate the new regional convention in a relatively rapid process through talks, signing, and immediate entry into force, following the example of AADMER after the 2004 Indian Ocean earthquake and tsunami. Although the completion of its ratification instrument took about four years, AADMER took only four months of negotiations. Meanwhile, other agreements such as the ASEAN Agreement on Transboundary Haze Pollution took roughly 13 years to complete the ratification process. The strong political will of the ASEAN Leaders and the staff at the ASEAN Secretariat will be crucial for the success of the negotiation of a new regional convention. However, such a process should also accommodate space for Member States to assess their preparedness. An incremental approach to the signature and ratification process could be pivotal to such a convention's success due to the centrality of the ASEAN Way principles.

The relative scarcity of ASEAN's engagement with displacement issues in the past may make the political viability of a regional convention at this moment uncertain. The process of considering and assessing both the necessity and viability of such a convention might provide some opportunities to strengthen and improve the response to internal displacement in the region. Such a process might include more detailed studies and assessments of national laws and policies to determine the degree to which a convention might be of value. This evaluation might also provide Member States with the opportunity to review their legal and policy frameworks for dealing with internal displacement. ASEAN could also encourage and support knowledge-sharing workshops between national and regional disaster management and CCA communities to discuss issues of internal displacement such as durable solutions, planned relocations, and the integration of international frameworks into national and regional policies. Cooperation between ASEAN and the AU can also support the assessment of need and viability for a convention by discussing the benefits and challenges of developing a regional convention and sharing best-practices on displacement as well as disaster and climate risk management.

ASEAN should address climate change and displacement on the regional level by fostering strong cooperation between entities working on climate change and disaster management issues. The AWGCC and ACDM Working Group on Prevention and Mitigation might be natural partners in terms of issues of climate change displacement, highlighting the benefits of strengthening cooperation between them. The AADMER Work Programme 2016 – 2020 offers several platforms for cross-sectoral coordination, and ASEAN also highlights the need to incentivise innovations for more comprehensive disaster management and disaster response (ASEAN, 2016). ASEAN's continuous development of operational capacity on disaster risk management since 2011 through the AHA Centre indicates that many efforts might benefit from further cooperation with the Centre. It remains to be seen if there is any interest of ASEAN collectively and of the Member States to develop additional operational capacity when it comes to managing climate change issues, as well as what institutional location such capacity might have.

As the operational arm of AADMER, the AHA Centre might also be able to improve the regional response to displacement by integrating disaster- and climate-induced displacement issues into several of its existing programmes. The AHA Centre has regularly held the biennial ASEAN Regional Disaster Emergency Response Simulation Exercise (ARDEX), which can help maintain coordination and networking between disaster management organisations and other stakeholders across the region. Future ARDEX scenarios could focus on hydrometeorological disasters that cause displacement and whose impacts might worsen due to climate change. Catastrophic disasters that have led to large-scale displacement, such as Typhoon Haiyan and Cyclone Nargis, might provide templates for such scenarios. More specifically, integrating climate change and displacement issues into the tabletop exercises of ARDEX can help raise awareness and understanding of them.

ASEAN should also promote the mainstreaming of displacement issues relating to climate change into various capacity-building programmes. The AHA Centre can integrate climate change and displacement issues, including discussion of relevant international frameworks and guidance, into its general curriculum for disaster management through the Executive Programme. The inclusion of climate-related displacement issues in the AHA Centre Executive Programme's curriculum might allow for sharing among National Disaster Management Organisations about these issues and create awareness and understanding of displacement and planned relocation issues. The AHA Centre could also evaluate if the training curriculum for its Emergency Response and Assessment Team comprehensively addresses displacement issues and data.

Strengthening cooperation between ASEAN and academic institutions might lead to more research on climate-induced displacement in the region. Given the large gaps in research on the topic in the region, this research could help provide important data points and scientific results to further help the AHA Centre in preparing reports and analysis. Thus, academic findings could strengthen the ASEAN Joint Disaster Response Plan.

Another area in which ASEAN could become active is the issue of cross-border displacement. While cross-border displacement from disasters has historically not been frequent in Southeast Asia, the rise in displacement risk caused by climate change (particularly in scenarios where warming will exceed 1.5°C and cross tipping points) also raises the risk of increased cross-border displacement. An analysis of current climate policies finds that the probability of keeping warming to 1.5°C, given the lack of commitment of many countries, becomes ever more unlikely, with current projections amounting to a warming of about 3°C by the end of the century (Climate Action Tracker, 2019). The IPCC (2018:12) argues that global emissions would have to decrease by 45 percent by 2030 (from 2010 level) to reach the 1.5°C target. Meanwhile, global emissions have been rising globally until 2019, with media and policy circles increasingly focusing on the topic of "climate refugees" in recent years. However, people who cross state borders because of disasters or climate do not fall within the definition of refugee in the 1951 Refugee Convention and thus face a range of legal and protection concerns. The Nansen Initiative is one international attempt to create a protection agenda for persons crossing international borders in the context of natural disasters and climate change. The Initiative held a regional consultation in Southeast Asia (The Nansen Initiative, 2014a and 2014b) and successfully developed the protection agenda (The Nansen Initiative, 2015). This agenda can provide a starting point for discussions on the strengthening of regional mechanisms related to cross-border displacement.

There are also international precedents of countries having taken into account persons displaced by disasters and climate change. For example, Finland has included humanitarian protection for persons displaced by environmental disasters in the 2004 Aliens Act (Hush, 2017). Similarly, the 2005 Swedish Aliens Act allowed subsidiary protection for persons fleeing environmental disasters. However, both countries suspended these schemes in the face of the European Refugee Crisis, with Finland repealing its humanitarian protection provisions in 2016, and Sweden suspending it from 2016 to 2019 (Hush, 2017). The United States of America also has provisions to grant Temporary Protected Status — including to persons who flee from natural disasters — with 317,000 persons currently holding that status. For example, persons from Nicaragua and Honduras gained Temporary Protection after hurricanes in 1998, as well as persons from El Salvador and Haiti after these countries experienced earthquakes (Cohn, Passel, & Bialik, 2019). Although cross-border displacement is not necessarily the most pressing problem for ASEAN Member States at this time, preliminary discussions on possible protection measures for persons displaced across borders might pay off in the future. This forethought could allow for policies to already be in place in the case that climate change impacts should worsen and lead to significant cross-border displacement in the region.

8.8 Conclusions and Recommendations

This paper has established that climate change is likely to contribute significantly to a rise in displacement risk in Southeast Asia, a region that is already among one of the most affected on Earth. The authors have noted that while disaster management capacities in the region have improved in recent years, gaps in the protection of persons displaced by disasters and climate change still exist. Existing disaster management policies also put little focus on the issue of durable solutions for those displaced persons. This paper also identified several issues surrounding planned relocation of those at risk or affected by disasters and highlighted the importance of pre-emptive displacement risk reduction through a range of measures, from disaster preparedness to CCA.

By analysing legal and policy frameworks in the region, this paper identified a lack of comprehensive laws and policies on internal displacement. However, these are crucial issues that national governments need to address, and ASEAN should also determine the viability of playing a potential role in strengthening the legal and policy environment in the region. Hence, this study promotes several policy recommendations as well as further collaboration between the AWGCC and the ACDM Working Group on Prevention and Mitigation to link IDP issues to pre-existing operational infrastructures. It also recommends integrating displacement issues more comprehensively into existing programmes of the AHA Centre.

This study has also promoted the use of evolving regional norm-building frameworks to assess the possibility of negotiating a new regional convention on IDPs. It highlighted that the establishment of a regional convention on internal displacement might be a worthwhile enterprise to address the challenges of climate change and displacement in the future. It also identified other areas where ASEAN could support governments in the region, such as research and capacity-building regarding IDP rights protection and planned relocation. Finally, this study suggested that there could also be a role for ASEAN to support regional solutions to improve protection for persons facing cross-border displacement in the context of disasters and climate change.

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Policies Tackling Climate Risks: Is ASEAN Moving to the Right Direction?

By Gaynor Tanyang

ARMOR

Abstract

This paper aims to contribute to the limited literature on the intersection of climate and disaster management policy in the Association of Southeast Asian Nations (ASEAN) region, especially in the wake of the Paris Agreement and the Sendai Framework for Disaster Risk Reduction (SFDRR). Although significant variation exists, all 10 ASEAN Member States (AMS) have policies in place on both climate action and disaster risk reduction (DRR), as the ASEAN region strives to forge a more resilient future. ASEAN's enhanced regional disaster preparedness and response mechanisms constitute a key strategy to achieve climate adaptive capacity.

Institutional arrangements in the 10 AMS for both climate action and disaster management are diverse, but the overarching challenge is to establish a platform to address the intersections of climate and disaster risk governance at the local, national, and regional levels. Additionally, many of the policies in the region, including at the ASEAN level, address social vulnerability considerations and the necessary public investments to reduce risk for vulnerable populations. These national policies and regional plans have the potential to contribute to the achievement of SFDRR. However, ASEAN will need to monitor the progress of DRR, climate adaptation, and resilience in a cohesive and integrated manner.

Keywords: Climate change policy, National Adaptation Plan, Sendai Framework for Disaster Risk Reduction, climate change adaptation, climate change mitigation, climate research, disaster governance, local governance

9.1 Introduction

Within the ASEAN region, four countries rank as the most at-risk to climate change for the period 1999–2018: Myanmar (2nd), Philippines (4th), Viet Nam (6th), and Thailand (8th) (Eckstein, Künzel, Schäfer, & Winges, 2019, p.9). However, the Climate Risk Index 2020 underscores that some countries have a high-risk ranking due to the disproportionate influence of a single exceptional catastrophe. One example of a single event affecting the overall ranking of a country is Cyclone Nargis in Myanmar in 2008. At the same time, countries such as the Philippines fall into different categories despite continually experiencing extreme weather events over the long-term, such as Typhoon Bopha (2012), Typhoon Haiyan (2013), and Typhoon Mangkhut (2018) (Eckstein et al., 2019).

This paper seeks to contribute to the limited literature on the intersection of climate change and disaster management policy in the region and in the wake of the Paris Agreement and SFDRR. The primary areas of inquiry are:

- Policy links between climate change and increased disaster management capacity
- Institutional arrangement for integrating disaster management and climate adaptation efforts
- Supportive policy for strengthening science-based research and technical cooperation on hydro-meteorological phenomena
- Policy concerning vulnerability and inclusion concerns
- Financing and investment policy on climate and disaster resilience, and
- Mechanisms for measuring progress and impacts of implementation of the preceding points.

The analysis consists primarily of a review of policies available publicly on the internet or via other sources. The official website of the United Nations Framework Convention on Climate Change (UNFCCC, 2020a) provided a starting point for gathering climate-related policies. In some countries, policies are not available in English. When possible, the translation was obtained from the climate change law database by the Grantham Research Institute on Climate Change and the Environment (Climate Laws, n.d.), other sources, or by use of Google translate as a last resort. The analysis aimed to review at least one climate-related policy per country and includes a total of 44 policy documents (Figure 9.1).

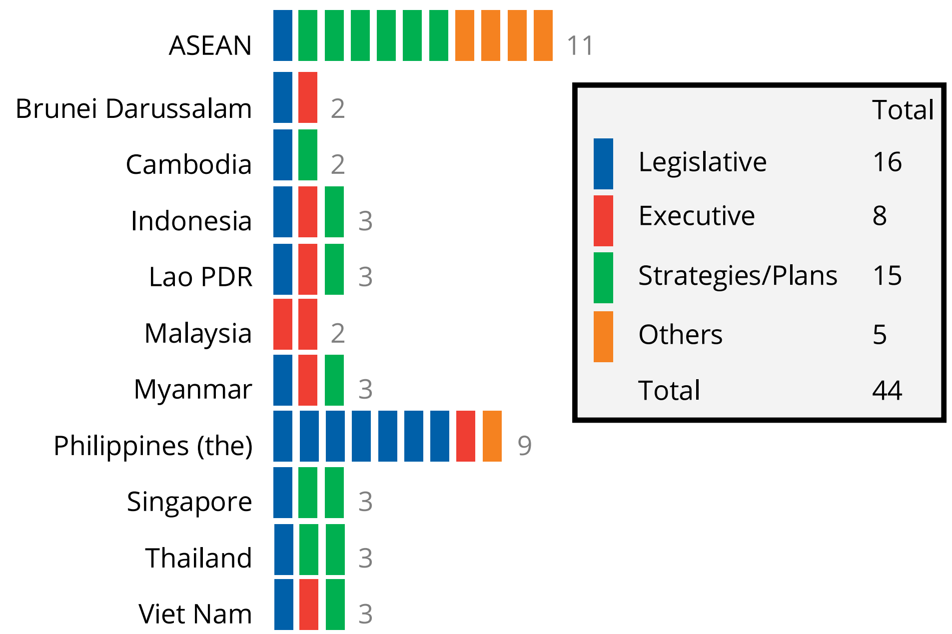


Figure 9.1
Number of policies per entity included in the policy review, separated by type.

In this paper, the term "policy" includes laws, regulations, guidelines, frameworks, plans, strategies, and similar documents that serve as a legal foundation or guide for government action on climate impacts and in disaster management. In the context of ASEAN as an inter-governmental body, "policy" also includes statements or declarations issued by ASEAN.

9.2 Climate Change and Disaster Management Policy in ASEAN

This section provides an overview and highlights of national policies on climate change in the 10 AMS and an in-depth discussion of the paper's main areas of inquiry.

9.2.1 National Policies on Climate Change

All AMS are signatories to the UNFCCC, and nine out of 10 AMS have some form of policy addressing climate change. Five countries (Indonesia, Malaysia, Myanmar, the Philippines, and Viet Nam) have adopted a national policy dedicated to climate change in different forms, such as an executive policy (as in Malaysia and Myanmar), Central Executive Committee resolution (as in Viet Nam), or a legislative act or law (as in the Philippines), or ministerial-level policy (Indonesia).

Indonesia's Ministry of Environment and Forestry issued the Ministerial Regulation Number P.33/Menlhk/Setjen/Kum.1/3/2016 (Direktorat Jenderal Pengendalian Perubahan Iklim, n.d.), which provides guidelines on the preparation of climate change adaptation actions and their integration in development plans at the subnational level or specific sectors (food security, energy independence, health, settlement, infrastructure, and coastal and small islands).

In Malaysia, the National Policy on Climate Change aims to accomplish three goals: (1) mainstream climate change response through effective management of resources and enhancement of environmental conservation, resulting in strengthened economic competitiveness and improved quality of life, (2) integrate responses into national policies, plans, and programmes to increase the resilience of development against the impacts of climate change, and (3) strengthen institutional capacity to better harness opportunities to reduce the negative impacts of climate change (Ministry of Natural Resources and Environment Malaysia, 2009).

Similarly, Myanmar's Climate Change Policy (Climate Laws, 2019a) aims to provide long-term direction and guidance to promote adaptation and mitigation. The policy looks to integrate climate change considerations into national priorities and across all levels and sectors. It also intends to create and maximise opportunities for sustainable, low-carbon, and climate-resilient development to ensure benefits for all.

In 2011, Viet Nam's Central Executive Committee adopted Resolution 24/NQ-TW Active Response to Climate Change, Improvement of Natural Resource Management and Environmental Protection Resolution (Climate Laws, 2013a). The Resolution, complemented by the Prime Minister's Decision 2139/QD-TTg outlines the following goals for the timeframe of 2020 – 2050: (1) improve the country's capacity for natural disaster forecasting, warning, and climate change monitoring, (2) foster societal awareness of the prevention of natural disasters and adaptation to climate change, (3) gradually reduce the loss of life and property caused by natural disasters, and (4) proactively prevent and limit the impact of a surge, inundation and flooding, or saline intrusion due to sea level rise in coastal areas (Climate Laws, 2019b).

The legislature of the Philippines passed both the Climate Change Act of 2009 and the People's Survival Fund Act. The People's Survival Fund Act establishes a fund for climate change adaptation. The Climate Change Act (Official Gazette of the Republic of the Philippines, 2009) sets forth five core policy statements: (1) the law reiterates the role of the state to "afford full protection and the advancement of the right of the people to a healthful ecology", (2) the state adopts the protection of the climate system "on the basis of climate justice or common but differentiated responsibilities and the Precautionary Principle to guide decision-making in climate risk management", (3) the law promotes the incorporation of a "gender-sensitive, pro-children, and pro-poor perspective in all climate change and renewable energy efforts", calling for the cooperation of all stakeholders to contribute to this objective, (4) the law recognises that DRR will "enhance climate adaptive capacity," and that the state shall "integrate DRR into climate change programs and initiatives", and (5) the law directs all government agencies to "systematically integrate climate change" in various phases of policy formulation, development planning, poverty reduction, and other development approaches.

Brunei Darussalam is in the process of consulting stakeholders for its climate policy (Kon, 2020). The country's Energy White Paper does not clearly articulate its goals on climate adaptation (Climate Laws, 2013b).

9.2.2 Development of Climate Change Strategies

The UNFCCC encourages its signatories to develop National Adaptation Plans (NAPs) (UNFCCC, 2011), emphasising that their development should rely on nationally identified priorities and the Sustainable Development Goals. Nine ASEAN countries have national climate change plans or strategies (Figure 9.2) , and some of them developed their plans one to seven years before the Paris Agreement in 2015.

Indonesia has several regulations governing the reduction of greenhouse gas (GHG) emissions and emissions from deforestation and forest degradation. Its two-year policy for climate change adaptation (Ministerial Regulation Number P.33/Menlhk/Setjen/Kum.1/3/2016 Guidelines for Preparation of Climate Change Adaptation Action) is expected to lay the groundwork for mainstreaming climate adaptation into the national medium-term planning processes (Direktorat Jenderal Pengendalian Perubahan Iklim, n.d.).

Cambodia
- Climate Change Strategic Plan (CCCSP) 2014-2023

Indonesia
- National Action Plan for Climate Change Adaptation 2013-2014
- Presidential Decree 61/2011, National Action Plan to Reduce GHG Emissions (RAN-GRK)

Lao PDR
- Strategy on Climate Change (2010)

Malaysia
- National Policy on Climate Change (2010)

Myanmar
- Climate Change Strategy and Master Plan 2018-2030
- Climate-Smart Agriculture Strategy (2015)

Philippines
- National Climate Change Action Plan (2011)
- Philippine National REDD-plus Strategy (2010)
- Framework Strategy on Climate Change (2010)
- Philippine Strategy on Climate Change Adaptation (2009)

Singapore
- Climate Action Plan (2016)
- National Climate Change Strategy (2012)

Thailand
- Climate Change Master Plan 2015-2050
- Strategic Plan on Climate Change (2008-2012)

Viet Nam
- National Climate Change Strategy (2011)

Figure 9.2
Climate change policies in ASEAN

Climate change agencies	National focal point to UNFCCC	National focal point to AADMER
Brunei Darussalam		
Brunei National Council on Climate Change; Climate Change Secretariat	Ministry of Development	National Disaster Management Centre
Cambodia		
National Climate Change Committee; Climate Change Technical Team; Department of Climate Change	Ministry of Environment; General Secretariat of National Council for Sustainable Development	National Committee on Disaster Management
Indonesia		
National Council on Climate Change	Ministry of Environment and Forestry	Badan Nasional Penanggulangan Bencana (National Agency for Disaster Management)
Lao PDR		
National Steering Committee on Climate Change	Ministry of Natural Resources and Environment	National Disaster Management Office; Ministry of Labour and Social Welfare
Malaysia		
(Inter-agency structure yet to be established)	Ministry of Energy, Science, Technology, Environment and Climate Change	National Disaster Management Agency
Myanmar		
National Environmental Conservation and Climate Change Committee	Environmental Conservation Department; Ministry of Natural Resources and Environmental Conservation	Department of Disaster Management; Ministry of Social Welfare, Relief and Resettlement
Philippines		
Climate Change Commission; Climate Change Office; Cabinet Cluster on Climate Change Adaptation, Mitigation, and DRR	Climate Change Commission	National Disaster Risk Reduction and Management Council
Singapore		
Inter-Ministerial Committee on Climate Change	Strategy Group, Prime Minister's Office	Singapore Civil Defence Force
Thailand		
National Climate Change Policy Committee; Climate Change Coordinator under the Office of the Prime Minister; Office of Natural Resources and Environmental Policy and Planning	Climate Change Management Coordination Division; Ministry of Natural Resources and Environment	Department of Disaster Prevention and Mitigation
Viet Nam		
Central Economic Commission	Ministry of Natural Resources and Environment	Viet Nam Disaster Management Authority

Table 9.1
Climate change agencies and national focal points to UNFCCC and AADMER.

The monitoring of the implementation of these policies is the responsibility of the relevant climate change agency or national focal point (Table 9.1).

Myanmar aims to achieve its resilience and adaptation goals within 13 years by dividing its strategy into three phases (Climate Laws, 2019a). Phase 1 (three years) focuses on policy, strengthening institutional arrangements, capacity-building, and establishing financial mechanisms. Phase 2 (eight years) is the implementation of the mechanisms that Phase 1 established. In this phase, initiatives inform development choices for achieving sustainability. The third phase begins in the first year and extends throughout the 13 years.

In its Second National Communication to the UNFCCC, Brunei Darussalam emphasised the importance of prioritising investment in disaster preparedness, mitigation, and response, in line with the implementation of the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) Work Programme and SFDRR (ASEAN, 2005). Its domestic goals related to coastal, forestry and biodiversity conservation, water resources management, food security, and strengthening public health resilience (Energy and Industry Department-Prime Minister's Office of Brunei Darussalam, 2017).

The monitoring of the implementation of these policies is the responsibility of the relevant climate change agency or national focal point (Table 9.1).

9.2.3 Planning for Climate Change Adaptation at the Local Level

Optimally, successful climate adaptation action comprises a combination of national and local efforts as well as global solidarity. The local strategies of different AMS vary in terms of the requirements in planning, institutional arrangements, involvement of communities and local stakeholders, financing mechanisms, and thematic focus.

Under the Cambodia Climate Change Strategic Plan 2014–2023 (National Climate Change Committee, 2013), the Secretariat of the National Committee for Sub-National Democratic Development will prepare a guideline for mainstreaming climate change into sub-national planning. The strategic policy does not clearly identify the local structure responsible for carrying out the planning. Instead, it bases the structure on the overall decentralisation strategy for strengthening financial and institutional processes for local adaptation. The policy also indicates the principle of subsidiarity, ensuring that the most qualified ministries or local governments manage the resources. The guiding principles for the plan development reinforce the use of science-based, ecosystem-based, and community-based approaches, as well as the leveraging of knowledge, innovation, and behavioural change in developing solutions for adaptation and mitigation.

In Indonesia, the ministerial regulation on the preparation of climate change adaptation action includes stages towards the development of action plans at regional, provincial, district, city, and municipality levels. The stages include: identifying target climate change impacts and the areas they affect; preparing climate vulnerability and risk studies; preparing climate change adaptation action options; setting priorities for actions concerning climate change adaptation; and integrating climate change adaptation actions into development policies, plans, and programmes.

Lao PDR's climate change strategy indicates as a guiding principle the incorporation of climate adaptation and mitigation in all levels of planning. The 8th Five-Year National Socio-Economic Development Plan 2016 – 2020 (Ministry of Planning and Investment, 2016) aims to create a map of vulnerable areas and develop medium- and long-term NAPs and provincial and sectoral plans. Its goals for climate adaptation articulate the need to strengthen national capacities for anticipating and responding to climate change natural disasters.

Malaysia's climate change policy provides a national framework for the increased collaboration and capacity at the federal, state, and local government levels (Ministry of Natural Resources and Environment Malaysia, 2009). It uses this collaboration to promote community-based climate change responses and programmes.

The Philippines' Climate Change Act (Official Gazette of the Republic of the Philippines, 2009) mandates the development of Local Climate Change Action Plans by local government units at the barangay (lowest political unit), municipality, city, and provincial levels. The plans should indicate the necessary personnel, resources, and logistics for accomplishing implementation. Guidelines assist local governments in developing these plans and integrating them into the Comprehensive Development Plan and Comprehensive Land Use Plans, which are the medium-term development plans that all local government units must have as a basis for the allocation of their annual local budgets (Housing and Land Use Regulatory Board (HLURB), 2014).

Viet Nam's national strategy provides for the building of communities' capacity to respond to climate change (UNFCCC, n.d.). Specifically, it aims to strengthen the role of local authorities and grassroots mass organisations, diversify livelihoods, and promote local knowledge in developing low-carbon livelihood options.

Overall, the level of clarity or detail by which national climate change frameworks and strategies are rolled out at lower levels of governance vary in direct relation to the policy framework and sophistication of decentralised planning and resource allocation in each country.

9.2.4 Policy Trends and Analysis Across the 10 AMS

Overall, the direction and focus of national climate change policies and plans vary depending on the exposure of AMS to climate risks, level of economic development, and character of governance in the country. More economically advanced countries that have less climate risk exposure also tend to be smaller, such as Brunei Darussalam and Singapore. As such, their climate policies are more robust at the activity level. Alternatively, many countries with high exposure to climate risks, such as Indonesia, the Philippines, and Thailand, are also developing economically and have more complex climate policy environments. Meanwhile, the UNFCCC-defined LDCs of Cambodia, Lao PDR, and Myanmar articulate a framework with significant influence from international development language. Viet Nam's climate policy posturing is unique in that it anchors to its middle-income status and a highly centralised planning structure. The policy articulates a focus on agriculture and water resources management in its climate adaptation agenda.

It is also worth noting that the policy environment conducive to decentralised planning also encourages local-level climate planning. Cambodia, Indonesia, Lao PDR, Myanmar, and the Philippines demonstrate this trend. Furthermore, the Philippines' devolution framework empowers local government units to generate, allocate, and use financial resources independently.

Regarding climate mitigation, the top four economies in the region (Singapore, Brunei Darussalam, Malaysia, and Thailand) (ASEAN Stats Data Portal, 2018) have placed emphasis on the gradual transition to energy-efficiency and low-carbon development. The majority of the climate policies in Indonesia, one of the top countries with emissions from forestry, address improving forestry management under the regime of reducing emissions from deforestation and forest degradation in developing countries.

9.2.5 A Closer Look Into Strengthening Regional Climate Resilience

Policy Linkages Between Climate Change and Disaster Management

While all AMS have adopted national policies on disaster management, only the disaster management laws of the Philippines and Viet Nam specifically mention climate change. Nonetheless, the approach across the region to strengthen national and regional disaster monitoring, early warning, preparedness, response, awareness, and institutions is a key aspect of climate adaptation for ASEAN. Hazard and risk monitoring, conducting risk assessments, and establishing early warning systems (EWSs) are all crucial for connecting climate change and disaster management policies. The following examples show such policy linkages between the national climate change strategies and DRR.

The Strategy on Climate Change of the Lao PDR (Climate Laws, 2010) calls for "integrating climate change measures into current risk management strategies and planning processes" as part of water resource management as an adaptation strategy. For Malaysia, one of the key strategies is to "conduct systematic reviews and harmonise existing legislation, policies, and plans, taking into account and proposing relevant balanced adaptation and mitigation measures, to address… DRR." Viet Nam focuses on strengthening agricultural and livelihood development both as a climate adaptation and disaster risk management strategy. Other approaches include the use of disaster mitigation strategies such as the construction of upland water reservoirs, sea and river dykes, saline water intrusion management, and mangrove forest management to protect against sea level rise and other climate-related hazards.

Institutional Arrangements on Climate Change and Disaster Management

The climate change offices are typically part of the ministry of environment or the office of the Head of State, particularly in cases where the structure consists of an inter-agency coordinating mechanism. To highlight an example, Cambodia transferred its Climate Change Department to the General Secretariat of the National Council for Sustainable Development and renamed it as the Department of Climate Change. In this position, it aims to "ensure economic, environmental, social, and cultural balance within the Kingdom of Cambodia" (Department of Climate Change, 2014).

The current policies do not clearly specify the platform or mechanism for the integration of the agencies responsible for climate and disaster governance adaptation (see also Maeda, Sivapuram, & Shivakoti, 2019; Lassa & Sembiring, 2017). An exception is the Philippines, in which the Secretary of National Defense, in his capacity as Chair of the National DRR and Management Council, sits in the Advisory Board of the Climate Change Commission. The Climate Change Commission is also a member of the country's disaster management council at the national level. The Cabinet Cluster on Climate Change Adaptation, Mitigation, and DRR takes the lead in the effective coordination, harmonisation, and complementation of policies and programmes on climate risk management, DRR, and sustainable development (Department of Environment and Natural Resources (DENR), 2020).

Strengthening Science-Based Research and Technical Cooperation on Hydro-Meteorological Phenomena

Across all the AMS except Brunei Darussalam (information not available), the climate change or disaster management policies outline weather monitoring, climate data management, and related research and technical cooperation. Some countries focus their research on the development of technology for management and reduction of GHG emissions.

The national laws emphasise the following: strengthening risk data collection, management, and sharing; building sector-specific data to enhance vulnerability analysis, particularly in agriculture, water resources management, urban work, and gender data disaggregation; developing EWSs; strengthening risk monitoring institutions and knowledge sharing; and increasing investment in risk monitoring and research.

Singapore, as the region's technology hub, has an "ecosystem" of technical and research agencies and initiatives that monitor energy emissions (Climate Laws, 2016a). Some countries, such as Indonesia and Lao PDR, have specific laws on the establishment and strengthening of hydrological and meteorological observation agencies. However, the survey of policies in this paper does not include these laws due to time constraints.

9.2.5.1 Policy Considerations of Social Vulnerability and Inclusion

The considerations on social vulnerability in the climate change policies and strategies are the following:

- Identification of the different impacts and disparities that climate change causes for men, women, and children (Republic of the Philippines, 2009, Section 13)
- Identification of and provision of assistance to vulnerable groups such as women, children, older persons, and persons with disability (Cambodia Disaster Management Law Article 18; Lao PDR Disaster Management Law Article 14)
- Participation of vulnerable groups and the public in the various phases of disaster management and climate change adaptation (Cambodia Disaster Management Law Article 37; the Philippines' Climate Change Act, Section 5)
- Participation of several stakeholders in the planning and implementation of climate change responses (Indonesia Ministerial Regulation on Climate Adaptation Article 13; Malaysia Climate Change Strategy Priority 4; the Philippines' Climate Change Act, Section 16; Viet Nam Central Executive Committee Resolution No. 24 Task 4)
- Ensure that climate change strategies are gender-sensitive and culturally appropriate (Cambodia Climate Change Strategy Guiding Principle 8; Myanmar Climate Change Strategy Section 7; Myanmar Climate Change Strategy Result 5; the Philippines' Climate Change Act, Section 2)
- Inclusion of climate change and disaster risk management in school curricula and extra-curricular activities (Cambodia Climate Change Strategic Plan 2014 – 2023, Strategic Objective 5; the Philippines' Climate Change Act, Section 15; Singapore Climate Strategy; Thailand Climate Change Master Plan)
- Promotion of behavioural responses to climate change, including the use of energy-efficient appliances (Malaysia Climate Change Policy Priority 4; Singapore Climate Strategy)
- Development and implementation of plans for public entities, private organisations, NGOs, and communities to collaborate on climate change (Malaysia Climate Change Policy Priority 4), and
- Promotion of community-based climate change responses and programmes (Malaysia Climate Change Policy Priority 4; the Philippines' Climate Change Act, Section 2)

There are several notable provisions in the existing climate change policies. The guiding principles under Myanmar's climate change strategy promote inclusiveness, climate justice and equity, and gender equality and women's empowerment. The principle of climate justice and equity states the aim to "promote and protect the rights of the people of Myanmar, in particular the poorest, most vulnerable, and marginalised segments of society, including indigenous peoples, all ethnic groups, local communities, women, children, the elderly, and persons with disabilities, to live in a healthy environment and a fair, equitable, and sustainable society" (Climate Laws, 2019a).

The Philippines' Climate Change Act (Official Gazette of the Republic of the Philippines, 2009) states that one of the functions of the Climate Change Commission is to "coordinate and establish a close partnership with the National DRR and Management Council in order to increase efficiency and effectiveness in reducing people's vulnerability to climate-related disasters". Furthermore, the law directs the Department of Interior and Local Government to focus on women and children as the country's most vulnerable to climate-related disasters. In addition to the disaster management law's identification of vulnerable and marginalised groups, the Philippines also has other laws that govern their protection during crisis and emergency situations. These protective laws include the Magna Carta of Women, Children's Emergency Relief and Protection Act, Expanded Senior Citizens Act of 2010, and the Magna Carta for Disabled Persons (Official Gazette of the Republic of the Philippines, 2010).

In Singapore, as part of the initiative to include climate change in the school curricula, there are also games targeted to older students to help them understand climate change negotiation processes. The country also uses programmes such as the Climate Change Climate Challenge, the Build It Green Club, and the National Climate Change Competition to give children and young adults interactive opportunities to learn about the various aspects of climate change and sustainable practices.

In Thailand, the National Climate Change Master Plan 2015–2050 (Climate Laws, 2016b) pays special attention to the country's ageing population. It works to support the well-being of the elderly population by ensuring the development of relevant infrastructure and services.

Viet Nam focuses heavily on supporting agricultural communities affected by climate change by raising their adaptive capacity and providing livelihood support to disaster-affected communities.

9.2.5.2 Financing and Investment Policy on Climate and Disaster Resilience

Funding mechanisms for climate adaptation, mitigation, and DRR are diverse in the ASEAN region. The provisions in national policies for the different types of investments in resilience include the establishment of special funds or budgetary allocations, grants, fiscal incentives, public-private partnerships, risk pooling or insurance schemes, and development of financial tracking tools (Figure 9.3).

The Republic Act 10174 (Official Gazette of the Republic of the Philippines, 2012) established into law the Philippines' People's Survival Fund. This fund supports climate adaptation of local governments and communities, with one of the criteria for the use of the fund being responsiveness to gender-differentiated vulnerabilities.

ASEAN Member State	1	2	3a	3b	4	5	6	7	7	8	9	10	11
Brunei Darussalam													
Cambodia								■	■	■	■		
Indonesia				■									
Lao PDR	■	■						■		■		■	
Malaysia					■	■	■					■	
Myanmar	■				■			■	■	■	■		■
Philippines	■	■	■	■	■		■	■		■			■
Singapore		■			■								
Thailand			■			■	■					■	
Viet Nam			■		■	■		■		■		■	

- **1** research or establishment of a climate change fund
- **2** establishment of disaster management fund or environmental fund
- **3a** inclusion of climate change programmes and activities as well as subsidies in annual national budgets
- **3b** and in local government budgets
- **4** financial and fiscal incentives
- **5** use of fiscal disincentives such as polluter-pays mechanism
- **6** mobilising public-private partnerships and corporate social responsibility
- **7** involvement of financial and insurance sectors, including development of risk financing mechanisms
- **8** receipt of donations and grants
- **9** accessing the Green Climate Fund
- **10** market mechanisms such as carbon trading, Clean Development Mechanism
- **11** integrating climate investment monitoring in planning and financial management systems including use of climate change marker or tagging

Figure 9.3

Initiatives on increasing investments in disaster and climate resilience

According to the report by LDC Expert Group (2018), six countries have accessed the Green Climate Fund in the development of national action plans for climate change: Indonesia, Lao PDR, Myanmar, the Philippines, Thailand, and Viet Nam.

9.2.6 Regional Initiatives and Actions

9.2.6.1 Climate Action Under the ASEAN Vision 2025

Three pillars form the backbone of the ASEAN Community: the ASEAN Political-Security Community (APSC), the ASEAN Economic Community (AEC), and the ASEAN Socio-Cultural Community (ASCC). The last pillar, ASCC, envisages that the region will become, by 2025, one that "engages and benefits the peoples, and is inclusive, sustainable, resilient, and dynamic" (ASEAN Secretariat, 2015a).

The six elements of the ASCC Blueprint 2025 (Figure 9.4) are crucial strategic areas that, when combined, can contribute to regional resilience against disaster and climate risks. However, the strategic areas of action under each element set disaster resilience apart from climate adaptation, as well as from social protection and other aspects, to be in line with the sectoral structure in the way the ASEAN operates. The resulting challenge is to achieve these goals in an integrated manner. The targets under the ASCC Blueprint 2025 include:

- Promoting policy coherence and links to synergise initiatives on DRR, climate change adaptation and mitigation, humanitarian actions, and sustainable development
- Developing technological and managerial competencies as well as institutional and human capacities in the region to address climate challenges

Figure 9.4
Six elements of the ASCC Blueprint 2025

Figure 9.5

Initiatives on increasing investments in disaster and climate resilience

- Leveraging innovative and sustainable financing mechanisms, particularly for social protection, in light of increasing climate and disaster risks through partnerships with the private sector and other stakeholders
- Strengthening comprehensive, multi-sectoral, multi-stakeholder, and climate-aware planning, including mainstreaming climate change risk management and GHG emission reduction in sectoral planning
- Strengthening global partnerships and supporting the implementation of relevant international agreements and frameworks
- Promoting robust scientific and evidence-based policies on climate change adaptation, and
- Promoting and considering indigenous and traditional knowledge and practices in responding and adapting to the impacts of climate change.

The two other ASEAN Community pillars, APSC and the AEC, do not substantially address the issue of climate change. The intersection of economic development, sustainability, regional peace and security, and resilience is more prominent in the ASEAN Community Vision 2025 on Disaster Management (ASEAN Secretariat, 2015b). It calls for a "multi-layered and cross-sectoral governance approach" that will drive the integration of ASCC, AEC, and APSC on disaster management and emergency response.

9.2.6.2 AADMER and Regional Climate Action

AADMER, signed by its parties in 2005 and ratified in 2009, does not mention climate change. However, its goals of disaster prevention, mitigation, and preparedness are strategic actions to contribute to climate adaptation within the ASEAN region (ASEAN, 2005).

The existing strategic plan for implementing the regional agreement is the AADMER Work Programme 2016–2020 (ASEAN Secretariat, 2016). It provides for several regional- and national-level actions on climate adaptation under four of its eight Priority Programmes (Figure 9.5).

9.2.6.3 Science-Based Research and Technical Cooperation on Hydro-Meteorological Phenomena

ASEAN has produced several plans and guidelines on disaster management that are also important to climate adaptation, including: the Disaster Management Research Roadmap for the ASEAN Region (APEC Climate Center, 2017) as part of the ASEAN Science-Based Disaster Management Platform; the ASEAN Regional Risk and Vulnerability Assessment (RVA)–guidelines for the implementation of an ASEAN Risk Index (Bell, Bausch, Morath, & Livengood, 2017); and the ASEAN Risk Monitor and Disaster Management Review First Edition (AHA Centre, 2019).

The ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre) has been working with ASEAN Dialogue Partners, UN agencies, the Red Cross and Red Crescent Movement, and technical and scientific institutions in several initiatives (AHA Centre, 2017). Among others, the initiatives include:

- Monitoring of multiple types of hazards in the region under the Disaster Monitoring and Response System
- Coordinating with agencies that have the capacity for satellite imaging, both intergovernmental and private, to augment gaps in data availability, particularly when a major or catastrophic disaster occurs
- Producing information products such as Flash Updates, Situation Updates, and Monthly Disaster Overviews about potential, ongoing, and past disasters, and
- Organising of AHA Centre Information Management Network and the ASEAN Science-Based Disaster Management Platform as places for knowledge sharing among information management professionals and scientists, respectively.

Still, many disaster management practitioners find it difficult to find or access data. The challenge is particularly present with regards to data for better understanding of social vulnerability and improving the effectiveness of disaster response (see also Tanyang, 2019).

9.2.6.4 Social Vulnerability and Inclusion Concerns

The ASEAN Vision on Disaster Management 2025 aims to “move the implementation of AADMER forward to a people-centred, people-oriented, financially sustainable, and networked approach by 2025” (ASEAN Secretariat, 2015b). The AADMER Work Programme 2016–2020 has also identified key outcomes and benefits in the participation of specific vulnerable groups in the region. Both policy documents put emphasis on women, youth, and children. In the next cycle of the AADMER Work Programme, its inclusiveness can still expand to consider other at-risk groups, such as persons with disabilities, the elderly, and other socially and culturally marginalised populations (ASEAN Secretariat, 2016).

In 2015, ASEAN Leaders released the Declaration on Institutionalising the Resilience of ASEAN and Its Communities and Peoples to Disasters and Climate Change (ASEAN, 2015). It calls for the role of ASEAN to foster the evidence-based understanding of climate and disaster risk in all its dimensions of vulnerability, capacity, and exposure by “taking into account the range of costs and benefits of effective risk management and adaptation for the most vulnerable groups.”

A crucial aspect of this area is migration as a result of climate and disaster emergencies. Data systems must be able to account for the variety of types, seasonality, and patterns of displacement and displaced populations. The implications of migration patterns for disaster preparedness and response planning are diverse in terms of identification of types of assistance (goods or cash transfers), selection of priority of assistance, provision of assistance, modes of delivery, and last-mile solutions in logistics to ensure that assistance reaches all groups of people with the highest need. Post-disaster migration also increases the requirements for protection against abuse, exploitation, and trafficking, especially among vulnerable girls and boys.

Other important humanitarian concerns include the provision of livelihood assistance as well as nutrition and health needs that must be based on the evolving demographics and post-disaster needs. Additionally, the mode of delivery of assistance becomes more appropriate and responsive when data include gender, age, and disability contexts. For example, in the delivery of shelter assistance after Typhoon Haiyan, beneficiaries could choose between receiving cash or direct assistance in the repair of the damaged houses. This option was particularly beneficial to those who cannot manage shelter repair on their own, including single parents, persons with disabilities, and the elderly (Tanyang, 2019).

Overall, there exists a foundation of policies for ASEAN to pursue its people-oriented goals for the collective development of the ASEAN Community. However, progress will require further design and targeting in future planning cycles to ensure that appropriate services and benefits reach at-risk groups.

9.2.6.5 Financing and Investment Policy on Climate and Disaster Resilience

The regional financing mechanism for disaster and climate resilience in ASEAN focuses on the area of disaster risk financing and insurance (DRFI). In 2012, ASEAN created the ASEAN DRFI programme and produced a report on the framework and options for implementation. The following year, ASEAN established the ASEAN Cross-Sectoral Coordination Committee on Disaster Risk Financing and Insurance, the ASEAN Insurance Forum, the ASEAN Committee on Disaster Management (ACDM), and the ASEAN DRFI Roadmap (ASEAN, n.d.-a).

The Southeast Asia Disaster Risk Insurance Facility (SEADRIF) was launched in 2019, aiming to provide climate and disaster risk management and insurance solutions to AMS. Initially, the countries targeted by the facility were Lao PDR and Myanmar. However, a feasibility study is taking place to assess the inclusion of Cambodia in the regional catastrophe risk insurance pool. Singapore, Japan, and the World Bank are supporting the facility under the auspices of the ASEAN Plus Three Cooperation (SEADRIF, 2018).

AADMER established the ASEAN Disaster Emergency and Relief Fund (ADMER Fund) as a funding pool of voluntary contributions from AMS and other donors. The ADMER Fund helps with the implementation of the AADMER Work Programmes and quick deployment of assistance during emergencies. Maintaining resources in the ADMER Fund has been challenging for ASEAN. In addition to voluntary contributions to the ADMER Fund, each AMS provides a mandatory USD 90,000 annual contribution to the AHA Centre Fund which the AHA Centre uses for its programmes, projects, staff, and overhead costs. Overall, ASEAN and AHA Centre projects are primarily funded by Dialogue Partners.

The ASEAN Joint Disaster Response Plan (AJDRP) is an operational framework and strategy for mobilising greater resources for responding to disasters in the region, of which a majority of incidents have been the result of extreme climate events (AHA Centre, 2017). The framework also enhances regional standby arrangements such that AMS and other partners will pre-identify resources within their capabilities that any disaster-affected AMS may call upon when they are in need. This AJDRP framework sits within the broader vision of One ASEAN One Response (AHA Centre, 2018) and requires collaborative engagement not only between regional governments but also between the wider humanitarian community.

The ASEAN Vision 2025 on Disaster Management also emphasises partnerships and innovations as well as finance and resource mobilisation. It highlights the necessity of exploring non-traditional sources for funding the implementation of AADMER and in building the region's resilience. Collectively, both traditional and non-traditional modes of financing DRR and climate change will increase the region's ability to adapt and respond to the increased disaster risks brought about by climate change.

9.2.6.6 Regional Institutional Arrangements on Climate Change

Multiple sectoral bodies within ASEAN tackle the issue of climate change. For example, the ASEAN Working Group on Climate Change is one of the mechanisms under the ASEAN Ministerial Meeting on the Environment (ASEAN, n.d.-b). Within the ASEAN structure, other sectors such as agriculture and forestry, energy and transport, science and technology, and disaster management also have commitments to climate action.

The ASCC Council is responsible for cross-pillar and cross-sector collaboration. The ASEAN Vision 2025 on Disaster Management further seeks to leverage the role of the Secretary-General of ASEAN and the ASEAN Secretariat to deepen the integration and broaden collaboration amongst the three community pillars. The ASEAN Vision 2025 on Disaster Management further underscores the potential strategic role of the Secretary-General of ASEAN as a champion for DRR and climate change adaptation.

Disaster risk management resides under the purview of the ACDM and consists of the heads of the National Disaster Management Organisations of the 10 AMS. It drives the strategic policies and the implementation of AADMER, including strategies related to climate change adaptation under the AADMER Work Programme. ACDM also coordinates with its counterpart sectoral bodies for the implementation of AADMER, such as in the Joint Task Force Meeting to Promote Synergy with Other Relevant ASEAN Bodies on Humanitarian Assistance and Disaster Relief. This meeting consists of ACDM and representatives from the different sectoral bodies such as the military, health, social welfare, finance, and others as a means for increasing coordination and collective ASEAN response during disasters.

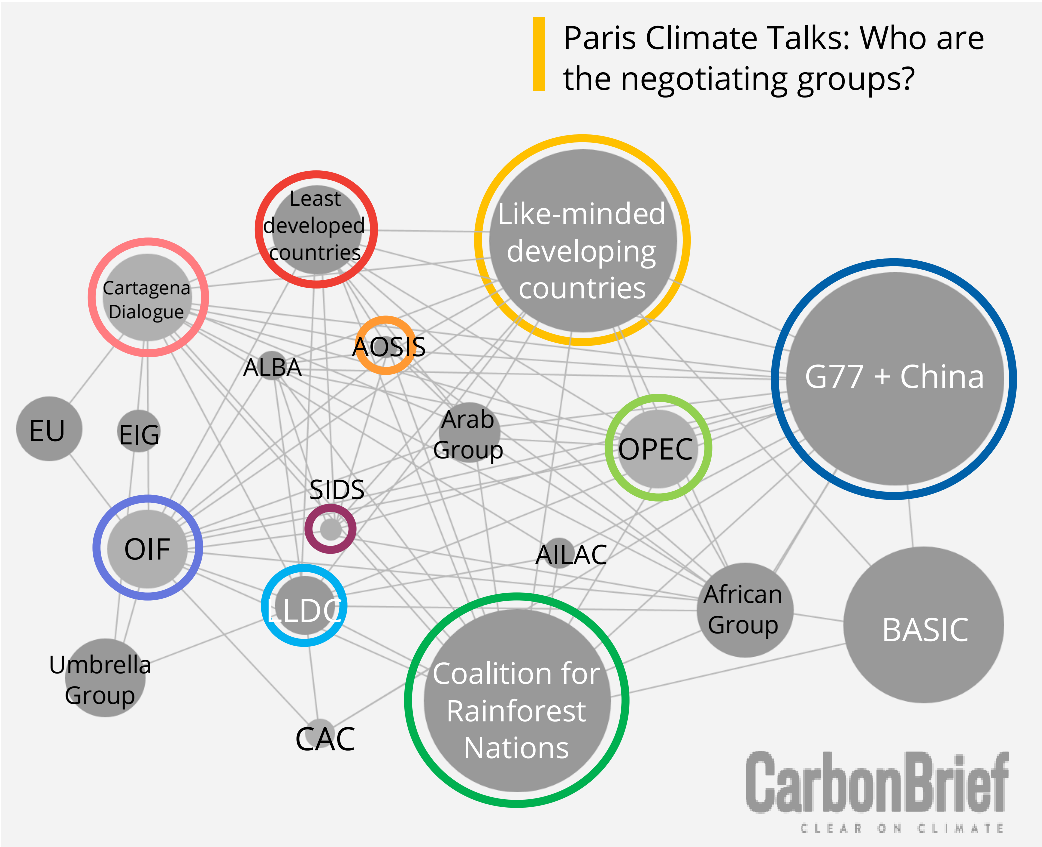
9.2.6.7 ASEAN and AMS in UNFCCC

All AMS are signatories to the UNFCCC and Paris Agreement and are also parties to the Kyoto Protocol and Non-Annex 1 Parties of the UNFCCC (UNFCCC, 2020b). However, ASEAN as an intergovernmental body is not considered as a Negotiating Group within the UNFCCC. Instead, the AMS supported and advanced ASEAN's positions on climate change. For example, Viet Nam issued the ASEAN statement to the UNFCCC Subsidiary Body for Scientific and Technological Advice 44 in 2014 ahead of the Paris Agreement negotiations. Additionally, in November 2019 in the 35th ASEAN Summit, the ASEAN Leaders issued the ASEAN Joint Statement on Climate Change to the 25th Session of the Conference of the Parties to the UNFCCC (ASEAN, 2019).

The AMS are also members of different climate negotiating blocs under the UNFCCC (Figure 9.6). Three of the AMS are LDCs, namely Cambodia, Lao PDR, and Myanmar. The 10 AMS are all members of the Group of 77 (G77), the largest permanent intergovernmental organisation of developing countries in the UN (now consisting of 134 countries). Malaysia, the Philippines, Indonesia, and Thailand served as Chairs in the G77 (G77, 2020).

Indonesia, Malaysia, and Viet Nam are members of the Like-Minded Developing Countries Group, while Singapore is a member of the Alliance of Small Island States and the non-negotiating group Small Islands Developing States. Cambodia, Indonesia, Lao PDR, Malaysia, Singapore, Thailand, and Viet Nam are members of the Coalition of Rainforest Nations, and Lao PDR is also a member of Landlocked Developing Countries (CarbonBrief, 2015).

In 2013, the Philippines chaired the Climate Vulnerable Forum (CVF), a UNFCCC non-negotiating group of the most climate-vulnerable countries across different continents (CVF, 2020). This platform also initiated the Vulnerable Twenty (V20) Group of Ministers of Finance of the Climate Vulnerable Forum as a cooperative initiative for strengthening economic and financial responses to climate change (CVF and V20, 2020). Other AMS in the Climate Vulnerable Forum are Cambodia and Viet Nam.



Least Developed Countries: Cambodia, Lao PDR, Myanmar

Like-Minded Developing Countries: Indonesia, Malaysia, Viet Nam

G77+China: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam

Coalition for Rainforest Nations: Cambodia, Indonesia, Lao PDR, Malaysia, Singapore, Thailand, Viet Nam

LLDC: Lao PDR

Cartagena Dialogue: Indonesia

AOSIS (Alliance of Small Island States): Singapore

SIDS (Small Islands Developing States): Singapore

OPEC: Indonesia

OIF: Cambodia

Figure 9.6

UNFCCC negotiating groups (source: CarbonBrief, 2020)

These examples demonstrate that there are several opportunities for ASEAN as a whole to influence the Paris Agreement implementation through its AMS participation in various UNFCCC negotiation blocs.

9.3 SFDRR: Metrics for Climate Adaptation

At the heart of the Paris Agreement are the Nationally Determined Contributions. They embody the individual efforts of each country to pursue domestic mitigation measures and achieve the emissions goals of the Paris Agreement. If Nationally Determined Contributions are the gold standard for measuring progress towards global carbon emissions targets, what about for climate adaptation?

> "[Climate] adaptation solutions take many shapes and forms, depending on the unique context of a community, business, organisation, country, or region. There is no 'one-size-fits-all solution'—adaptation can range from building flood defences, setting up EWSs for cyclones, and switching to drought-resistant crops, to redesigning communication systems, business operations, and government policies. Many nations and communities are already taking steps to build resilient societies and economies, but considerably greater action and ambition will be needed to cost-effectively manage the risks, both now and in the future" (UNFCCC, 2020b).

SFDRR seeks to achieve seven global targets. These targets translate into 38 indicators to measure progress during the implementation of SFDRR (UN Development Programme (UNDRR), 2019a). The Sendai Framework Monitor (UNDRR, 2019b) provides information on the progress of the achievements of the targets, and in 2017, United Nations Office for Disaster Risk Reduction (UNISDR) released the technical guidance for monitoring and reporting on them (UNISDR, 2017).

SFDRR Indicator	Number of countries that adopt and implement national DRR strategies in line with SFDRR 2015–2030 (E-1)					
Countries with climate and disaster management policy provisions* relating to SFDRR indicators	Brunei Darussalam	○	Malaysia	●	Thailand	●
	Cambodia	●	Myanmar	●	Viet Nam	●
	Indonesia	●	Philippines	●	ASEAN**	●
	Lao PDR	●	Singapore	○		

Percentage of local governments that adopt and implement local DRR strategies in line with national strategies (E-2)					
Brunei Darussalam		Malaysia	○	Thailand	●
Cambodia	●	Myanmar	●	Viet Nam	●
Indonesia	●	Philippines	●	ASEAN**	●
Lao PDR	●	Singapore			

Total official international support (ODA and other official flows) by multilateral agencies for national DRR actions (F-2)					
Brunei Darussalam	●	Malaysia		Thailand	●
Cambodia	●	Myanmar	●	Viet Nam	●
Indonesia	●	Philippines	●	ASEAN**	○
Lao PDR	●	Singapore			

Number of international, regional, and bilateral programmes and initiatives for the transfer and exchange of science, technology, and innovation in DRR for developing countries (F-5)					
Brunei Darussalam		Malaysia	○	Thailand	●
Cambodia	●	Myanmar	●	Viet Nam	●
Indonesia		Philippines	●	ASEAN**	●
Lao PDR	●	Singapore			

Number of developing countries receiving support from international, regional, and bilateral initiatives to strengthen their DRR-related statistical capacity (F-8)					
Brunei Darussalam		Malaysia		Thailand	
Cambodia		Myanmar	●	Viet Nam	
Indonesia		Philippines		ASEAN**	
Lao PDR	●	Singapore			

Number of countries that have multi-hazard monitoring and forecasting systems (G-2)					
Brunei Darussalam		Malaysia	●	Thailand	●
Cambodia	●	Myanmar	●	Viet Nam	●
Indonesia	●	Philippines	●	ASEAN**	●
Lao PDR	●	Singapore	●		

Number of countries that have accessible, understandable, usable, and relevant disaster risk information and assessments available to the public at the national and local levels (G-5)					
Brunei Darussalam		Malaysia		Thailand	
Cambodia	●	Myanmar		Viet Nam	●
Indonesia	●	Philippines	●	ASEAN**	○
Lao PDR	●	Singapore	●		

Legend: (●) At least one policy accounts for the SFDRR indicator; (○) There is a policy but it is not clear whether it fully satisfies the SFDRR indicator as stated

* The climate and disaster management policies included in this analysis are based on Table 1. This table does not suggest the achievement of the indicator.

** Based on AADMER and AADMER Work Programme 2016–2020

*** Based on ASEAN Vision 2025: Forging ahead together

Table 9.2
Climate change policies and SFDRR Indicators.

Table 9.2 shows how the climate change policies in AMS include the relevant SFDRR indicators. The selected indicators in Table 9.2 focused on Global Targets E, F, G because they directly relate to policy development and implementation. The criteria for determining that the policy includes an indicator is a clear articulation of the requirements for each indicator, either fully or partially, within the policy.

Table 9.2 shows that the significant gaps in policy when it comes to meeting the SFDRR targets (measured by the SFDRR indicators) are, by the level of significance:

1. Quality and capacity of statistical data
2. Accessibility of climate and disaster risk information by the wider public
3. International support to transfer and exchange science, technology, and innovation in DRR

AADMER has also underscored, as one of its principles, prioritising disaster prevention and mitigation. Succeeding work programmes may wish to evaluate if and how countries are achieving this goal.

9.4 Conclusions and Recommendations

The analysis in this paper shows that strengthening existing regional platforms can enhance cross-sectoral collaboration and venues for multi-stakeholder engagement to increase resilience. The ASEAN disaster risk management and climate action system already has several cross-pillar, cross-sectoral, multi-stakeholder platforms and mechanisms. Maximising these existing platforms can help craft broader strategic goals and measurable outcomes that will also ensure the cohesive and integrated achievement of plans. Based on observations in the paper, the most important areas for cross-sectoral collaboration are:

- Data and information sharing for enhanced disaster and climate RVAs;
- Investment and financing for resilience particularly in prevention and mitigation; and
- Mobilising ASEAN capacities and resources for response and recovery.

Focusing on disaster and climate risk reduction, the Joint Task Force Meeting to Promote Synergy with Other Relevant ASEAN Bodies on Humanitarian Assistance and Disaster Relief is an important platform led by ACDM that could benefit from expansion. It could play the role of a broader coordination platform for disaster risk monitoring, prevention, mitigation, preparedness, response, and recovery, whether natural, climate-induced, or human-made. ACDM can also tap into the role of the Secretary-General of ASEAN and the ASEAN Secretariat to further tighten policy and operational cohesion for all types of risks. Additionally, the AJDRP can engage actors within and outside the ASEAN architecture with a focus on scaling and speeding up the regional response.

This paper also underscores the importance of monitoring progress in the implementation of both climate and DRR regional policy statements and targets. There are several regional policy statements that provide valuable starting points for ASEAN to assess the overall regional progress in achieving resilience. The ASEAN Community Vision 2025 aims to achieve "a resilient community with enhanced capacity and capability to adapt and respond to social and economic vulnerabilities, disasters, climate change, as well as emerging threats and challenges." The Declaration on Institutionalising the Resilience of ASEAN and its Communities and Peoples to Disasters and Climate Change (ASEAN, 2015) further emphasises the elements of achieving resilience as follows:

> "…reducing existing disaster and climate-related risks, preventing the generation of new risks and adapting to a changing climate through the implementation of economic, social, cultural, physical, and environmental measures which address exposure and vulnerability, and thus strengthen resilience."

The declaration outlines 11 strategic actions to achieve this vision of resilience that align with SFDRR and assign ACDM as the focal point for cross-sectoral cooperation on resilience-building at the regional level. Monitoring in this regard will help identify and address challenges in the following areas:

- Policy gaps that impede the achievement of targets under SFDRR and climate adaptation goals, including development of a statistical database for enhancing vulnerability and capacity analysis and enhancement of the inclusiveness of climate and disaster management actions to involve vulnerable groups.
- Vulnerability analysis and inclusion of vulnerable groups as agents, not just beneficiaries, in achieving resilience
- State of international aid flow towards climate and disaster resilience, particularly for the most at-risk countries in the region, and
- Factors that impede or enhance concerted efforts on climate and disaster resilience among ASEAN sectoral bodies.

Additionally, the alignment between SFDRR, the AADMER Work Programme, and national DRR priorities can be strengthened further. ACDM can facilitate a regional stock-take of the implementation of DRR-CCA priorities by the AMS. It can also evaluate how AADMER implementation further adds value to national initiatives as a contribution to the global targets of disaster and climate risk reduction.

Reducing climate and disaster risks requires sustaining research and analyses of policy and practice. This paper outlines several national and regional plans that identify actions relating to strengthening science-based research. Common interventions in research, hazard monitoring, and knowledge sharing can be pursued bilaterally or as part of the next AADMER Work Programme. Twinning is another possible strategy wherein two countries participate in a learning and exchange process to improve each other's capacities and systems.

There should also be a focus on enhancing data on vulnerability and capacity to meet the information requirements under the ASEAN RVA guidelines and SFDRR. The availability of such data will increase the region's disaster response preparedness in major and catastrophic disasters, enabling quick projections of impact on and needs of the affected populations. In an ideal scenario, the availability of satellite imagery provides spatial data of the impact of disasters, while the availability of statistical and demographic data on population and essential lifelines will help in quickly deriving estimates of needs. This data support will enable faster and more effective decision-making during the first critical days after a disaster. Additionally, having downscaled data to the lowest subnational level possible in advance will enable the AHA Centre to preposition appropriate disaster relief to vulnerable groups.

International funding support for enhancing the climate and disaster information systems (data, personnel, and hardware) should be a priority in the development of the next cycle of regional strategic planning, particularly in the development of the new AADMER Work Programme.

Bringing attention to the gaps in national and regional capacities and funding for climate and disaster resilience will require the leveraging of AMS presence in various global climate and disaster management fora. The ASEAN region is one of the most disaster-prone regions affected by extreme weather events. ASEAN can leverage its success as a model in regional collaboration in disaster management to encourage the proactive strategies that overcome the limitations of response-focused strategies. Specifically, it can call for increased investment to enhance regional and national strategies on disaster risk monitoring, early warning, prevention, mitigation, and preparedness. By sharing its experience and lessons in strengthening institutions, systems, and regional collaboration mechanisms, ASEAN may be on a path not only to becoming a global leader in disaster management but more importantly in achieving the resilience of its people.

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