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BRIDGING SCIENCE & DECISION MAKING

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ASEAN RISK MONITOR AND DISASTER MANAGEMENT REVIEW

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ARMOR

1st edition

INTRODUCTION

ARMOR

Bridging Science and Decision Making

The ASEAN Risk Monitor and Disaster Management Review (ARMOR) is important for several reasons. Firstly, until this point there has been no authoritative publication that provides risk profile information specifically regarding the ASEAN region. Secondly, with an ever-growing body of accumulated knowledge and information on disaster in the region, there is an urgent need to provide critical analysis and synthesis that can inform policy making and disaster management operations, both within the region and outside. Finally, ARMOR will importantly become the first regular publication to showcase best practices, trends and innovations in disaster management in ASEAN.

ARMOR aims to fill these gaps. It aims to consolidate knowledge related to risk monitoring and disaster management within the ASEAN region, and seeks to provide a space for the sharing of best practices and latest research and analysis, while showcasing innovations and inspiring disaster managers and researchers across the region and the world.

To achieve this status, ARMOR will serve several functions. First, the publication will provide the most up-to-date risk profiles, data and trend analyses pertaining to natural disasters and climate risks, based on the latest monitoring and research initiatives, to inform decision making and policy development within ASEAN. Secondly, ARMOR will facilitate the sharing of best practices and lessons learnt from past operations, while also seeking to bridge the gap between research and operations within the region.

Accordingly, ARMOR supports the implementation of the ASEAN Vision 2025 on Disaster Management, by taking ownership of knowledge and ensuring application of relevant disaster management science for the region. It will also provide a platform for aspiring researchers and practitioners to contribute to this regional vision, and ensure collective efforts for ASEAN to become a pioneer in disaster management. These aims are also in line with the role of the AHA Centre as the network coordinator in developing disaster management-related standards, providing a platform for exchange of knowledge and best practices, and developing the next generation of regional disaster management leaders.

This first edition of ARMOR will cover a wide range of topics. **Chapter 1** on the Trillion Dollar Multi-Hazard Risk Landscape in Southeast Asia will describe the risk profiles of each country in ASEAN. **Chapter 2** on Most-at-Risk Cities in ASEAN That Must be Watched will discuss the findings from research regarding cities in ASEAN that face considerable risks of disaster. **Chapter 3** on Why Climate Change Matters for ASEAN explores the potential threats that climate change will bring to the ASEAN region, particularly in terms of water, food, and health security. **Chapter 4** on the State of Early Warning System in ASEAN provides a snapshot of the current early warning system within ASEAN, and how it was tested in recent disasters. **Chapter 5** Natech: The Silent and Potentially Deadly Threat in ASEAN discusses the growing potential risk of Natech (technological incidence/disasters triggered by natural hazards) in the ASEAN region, and how ASEAN can work to mitigate such risks.

Chapter 6 on Application of Breaks for Additive Season and Trend (BFAST) for Drought Monitoring proposes an innovative way to accurately and immediately identify drought events, that can be utilised by policy makers to engage in early and significant interventions. **Chapter 7** on Regional Knowledge Hub for Disaster Management: Strategy, Policy and Practice in ASEAN proposes options and strategies for the AHA Centre to fully realise its role as a knowledge hub for disaster management. **Chapter 8** on Regional Centrality and the Shift of Humanitarian Landscape: The Case of ASEAN discusses the evolving roles of the AHA Centre by comparing two uniquely different emergency response operations – super typhoon Haiyan and the earthquake and tsunami in Central Sulawesi.

Chapter 9 on Achieving the ASEAN 2025 Vision for Disaster Management: Lessons from a Worthy Journey looks back on some of the key lessons learned from ASEAN's experience in humanitarian assistance and disaster relief, and discusses options for ASEAN to explore and move forward. **Chapter 10** on Utilisation of Space-based Information for Supporting Emergency Response and Recovery was written based on actual emergency response experiences in which space-based information was utilised alongside direct field observation to inform operational decision making.

The first step of something new is always special, but is also often the most challenging. The AHA Centre could not manage this first step without the support from numerous individuals who contributed their time and energy to ensure the launch of the first ARMOR publication. The AHA Centre is grateful for this support and contribution, and looking forward to continuing this collaboration into future editions of ARMOR.

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CHAPTER

Trillion Dollar Multi-Hazard Risk Landscape in Southeast Asia

Authors:
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ARMOR

Abstract

Southeast Asia is a diverse region with interconnected communities constantly facing risks related to varying hazards. In 2018, the combined nominal GDP of Southeast Asian countries ranked fifth globally, amounting to USD 2.89 trillion. However, due to the constant risk of natural hazards, the region's exposed capital stocks amount to USD 8.35 trillion, or three times its combined economy. A catastrophic disaster in the region would certainly push the ASEAN region's Member States back in their tracks. In order to reduce disaster impact and risk, overall understanding of disaster risk – including all of its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics, and environment – is important for decision-makers, policy-makers, and the general community to plan initiatives aimed at improving resiliency. This paper explores two risk scores, INFORM and RVA, to determine the risk level of each ASEAN Member State. The risk score described is a simplistic and "big picture" view of the reality. Users of these scores should be aware of the method's limitations, and remember that real humanitarian risk is a complex and multi-dimensional issue, which may not be completely characterised by numbers or indicators alone.

Keywords: risk index, risk and vulnerability assessment, regional risk profiles

Southeast Asia is a diverse region, with interconnected communities constantly facing risks related to varying hazards. Since the establishment of the Association of Southeast Asian Nations (ASEAN) on the 8th of August, 1967, the region has grown considerably in strength and geographic scope – from the first five (5) founding members to the current 10 (ten) Member States as of April 30th 1999. Despite this significant growth, the region has not been spared of the wrath of natural hazards. Some of the notable high-impact, large scale disasters recorded include:

- **2004** Indian Ocean Tsunami
- **2008** Cyclone Nargis
- **2013** Typhoon Haiyan (Yolanda)

These disasters caused unprecedented devastation and considerable economic loss. Combined damage costs from these disasters are estimated at a staggering USD 22.5 billion, with 278,000 fatalities. At the global level, the Sendai Framework (United Nations Office for Disaster Risk Reduction, 2015) – consisting of seven global targets and translated into four priorities for action – was conceived in order to reduce disaster risk and losses. The framework's priorities are largely centred on disaster risk management, disaster risk governance, investment in disaster risk prevention and reduction, and integrating disaster risk reduction into development measures.

Disaster risk reduction practices must be multi-hazard and multi-sectoral, inclusive and accessible, in order to be efficient and effective as recommended by the framework. Achieving this would require an understanding of disaster risk, including all of its dimensions

- vulnerability, capacity, exposure of persons and assets, and hazard characteristics and environment. In order to gain better understanding of the multi-hazard risk landscape of the region, this paper explores and compares two (2) reports that utilised international standards in risk estimation.

As part of the first global movement, Index for Risk Management (INFORM) was developed to serve as a composite indicator for identifying countries at-risk of humanitarian crisis and disaster that could overwhelm national response capacity. INFORM is a risk-assessment tool that is designed to support decisions about crisis and disaster prevention, preparedness and response, with its main function to support prioritisation, risk profiling, and trend analysis. The global INFORM model is a composite index that identifies "countries at-risk from humanitarian emergencies that could overwhelm current national response capacity, and therefore lead to a need for international assistance" (INFORM Guidance Note, p. 20).

On the other hand, the Pacific Disaster Center completed its development of the ASEAN Regional Risk and Vulnerability Assessment (RVA) in April 2018. Utilising a composite risk approach, they measured multiple drivers of risk, conceptualising the RVA as a function of Multi-Hazard Exposure, Coping Capacity, and Vulnerability. Their multi-dimensional methodology has been aligned with the United Nations International Strategy for Disaster Reduction's risk evaluation standards, a tool which is extensively used for disaster-related study.

Both indexes used similar methodologies. The main difference is that INFORM is dynamic, with the scores evaluated on an annual basis, while RVA considers data over a 20-year period. Also, INFORM uses a 1 to 10 score ranking, while RVA ranges from 0 to 1. The main basis of the risk scores are calculated with a multiplicative equation in which each of the dimensions are treated equally as shown in **Equation 1.1.**

$$Risk = Hazard \,\&\, Exposure^{\frac{1}{3}} \times Vulnerability^{\frac{1}{3}} \times Lack\ of\ Coping\ Capacity^{\frac{1}{3}}$$

Equation 1.1 Risk Formula analyses three dimensions - hazards and the exposure of people and assets to them, vulnerability of people and assets to these hazards, and the lack of capacity to cope

Comparing the overall risk scores presented by both indexes, Indonesia, Myanmar, and the Philippines received higher scores of risk. Given such high-risk scores, these Member States were also included in the ASEAN Joint Disaster Response Plan as the three most disaster-prone countries. Myanmar and the Philippines were ranked higher for risk by INFORM, while Indonesia and the Philippines were ranked higher for risk by RVA. It is interesting to note that Myanmar displayed a significant gap between their overall scores when comparing the two rankings (Figures 1.1 and 1.2). This is largely due to the ongoing conflict risk in Myanmar that is measured by INFORM. Of note is that RVA only calculates risk based on natural hazard exposure, vulnerability and coping capacity to natural disasters, while INFORM assesses individual countries' risk by considering the above criteria and adding conflict risk, vulnerability and coping capacity. However, this article will only focus on the natural hazards exposure scores of INFORM in comparison with RVA.

Risk Scores Comparison (INFORM vs RVA)

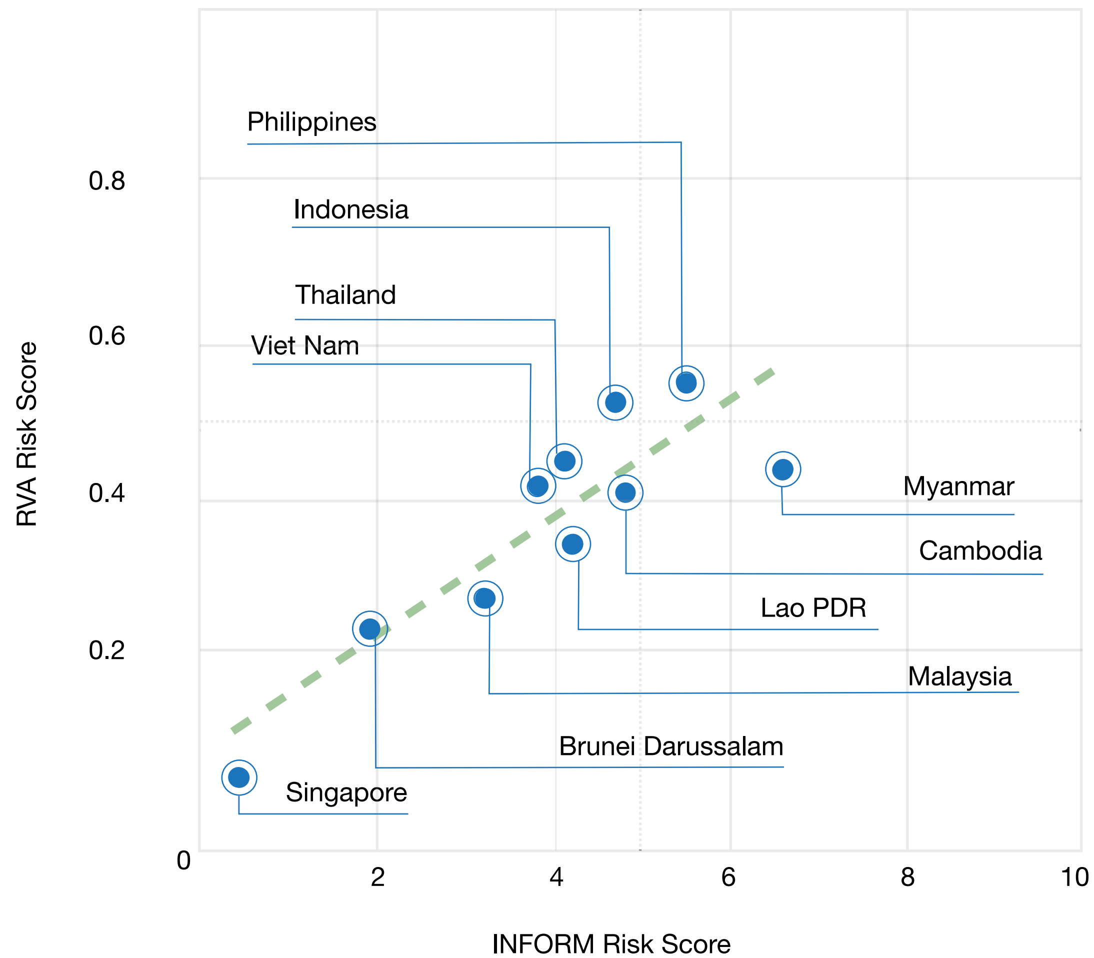


Figure 1.1 Comparison of Risk Scores for both indexes (by country and total records of disasters) shows that Myanmar has the largest distance from the trend line (green broken line), which suggests the largest gap between indexes is incurred by Myanmar.

Overall Risk Scores Comparison

Figure 1.2 Comparison of Overall Risk Scores (by country) reflects the discrepancy in the temporal factor of methodologies used between indexes, as evident by Myanmar's significant gap. INFORM includes the ongoing conflict in Myanmar, thereby incurring a larger score than the 20-year period computation by the RVA.

The scores are broken down further into the three respective components, namely (i) Hazard & Exposure, (ii) Vulnerability, and (iii) Lack of Coping Capacity. These components usually form the main functions guiding any multi-hazard risk index. However, for the hazard score, this study only examines the component of natural hazards, instead of including human-induced hazards (due to its dynamic nature). Through the study, both indexes were found to utilise different indicators. To combine results, both indexes rankings were averaged throughout this paper.

MULTI-HAZARD EXPOSURE

INFORM				RVA		
MEMBER STATE	INDEX	RANK	AVERAGED RANGE	RANK	INDEX	MEMBER STATE
PHILIPPINES	8.5	1	1	1	0.954	PHILIPPINES
INDONESIA	7.8	3	2	2	0.928	INDONESIA
MYANMAR	8.1	2	3.5	5	0.405	MYANMAR
VIET NAM	7.3	4	3.5	3	0.606	VIET NAM
THAILAND	6.4	5	5	4	0.473	THAILAND
CAMBODIA	5.7	6	6	5	0.307	CAMBODIA
LAO PDR	4.8	8	7	7	0.222	LAO PDR
MALAYSIA	5.1	7	8	9	0.243	MALAYSIA
BRUNEI DARUSSALAM	2.2	9	9	8	0.270	BRUNEI DARUSSALAM
SINGAPORE	0.1	10	10	10	0.018	SINGAPORE

Figure 1.3 Multi-Hazard Exposure Results (by country and ranking) is consistent for the top five most at-risk to natural hazards: the Philippines, Indonesia, Myanmar, Viet Nam, and Thailand.

Despite differences in both indexes, Philippines, Indonesia, Myanmar, Viet Nam, and Thailand scored as the top five (5) Member States with ASEAN's highest natural hazard risk score (Figure 1.3). Both indexes identified that hydro-meteorological hazards were the main drivers of risks across the region. Geophysical hazards form a significant amount of risks, however the Philippines and Indonesia scored higher for volcanic and earthquake risk. Based on data recorded between July 2012 and January 2019, a total of 1,604 disasters of varying scales were experienced within the ASEAN region (Figure 1.4 and 1.5). Hydrological and meteorological disasters account for 85.17%, which includes floods, strong winds, tropical storms, and droughts (Figure 1.4). Geophysical disasters on the other hand, account for the remaining 14.83%, with landslides most common followed by earthquakes, volcanic eruptions, and an almost insignificant number of tsunami occurrences. Comparing historical records with the natural hazard risk score, it can be noted that monitoring efforts for Myanmar, Cambodia, and Lao PDR should be strengthened.

Breakdown of Disasters in ASEAN
(July 2012 - January 2019)

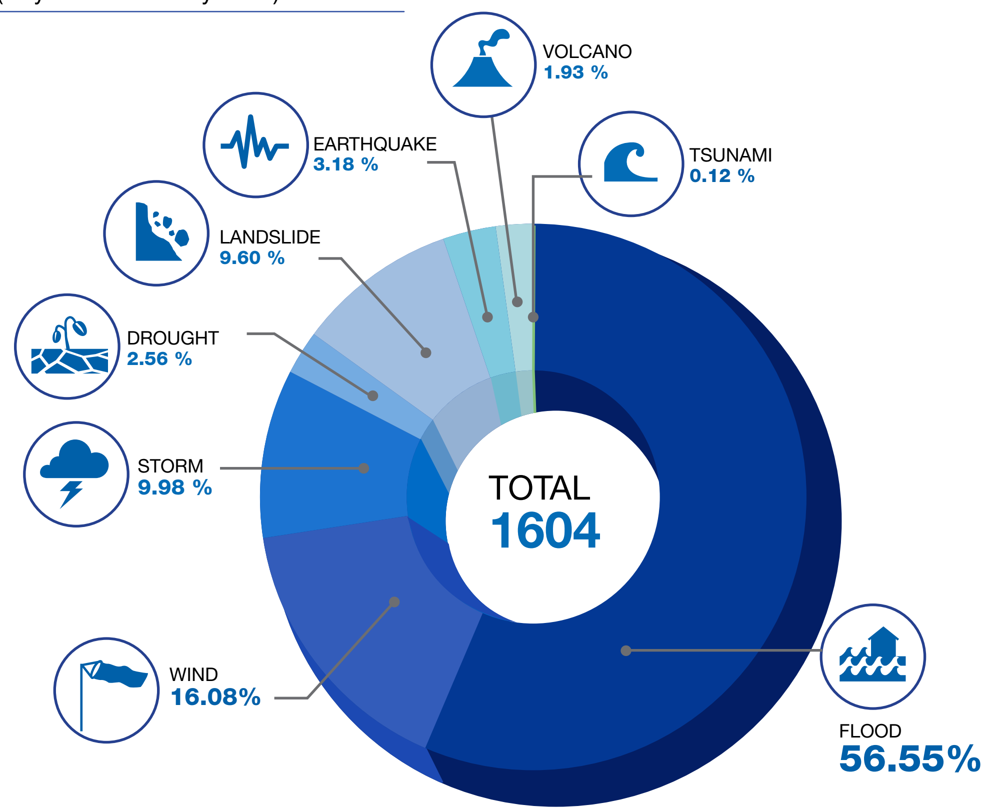


Figure 1.4 Breakdown of Disasters in ASEAN (by type) shows that the overwhelming majority of occurrences are hydro-meteorological in nature - hazards that can be mitigated and prepared for (ADINet, 2019).

Distribution of Disasters in ASEAN
(July 2012 - January 2019)

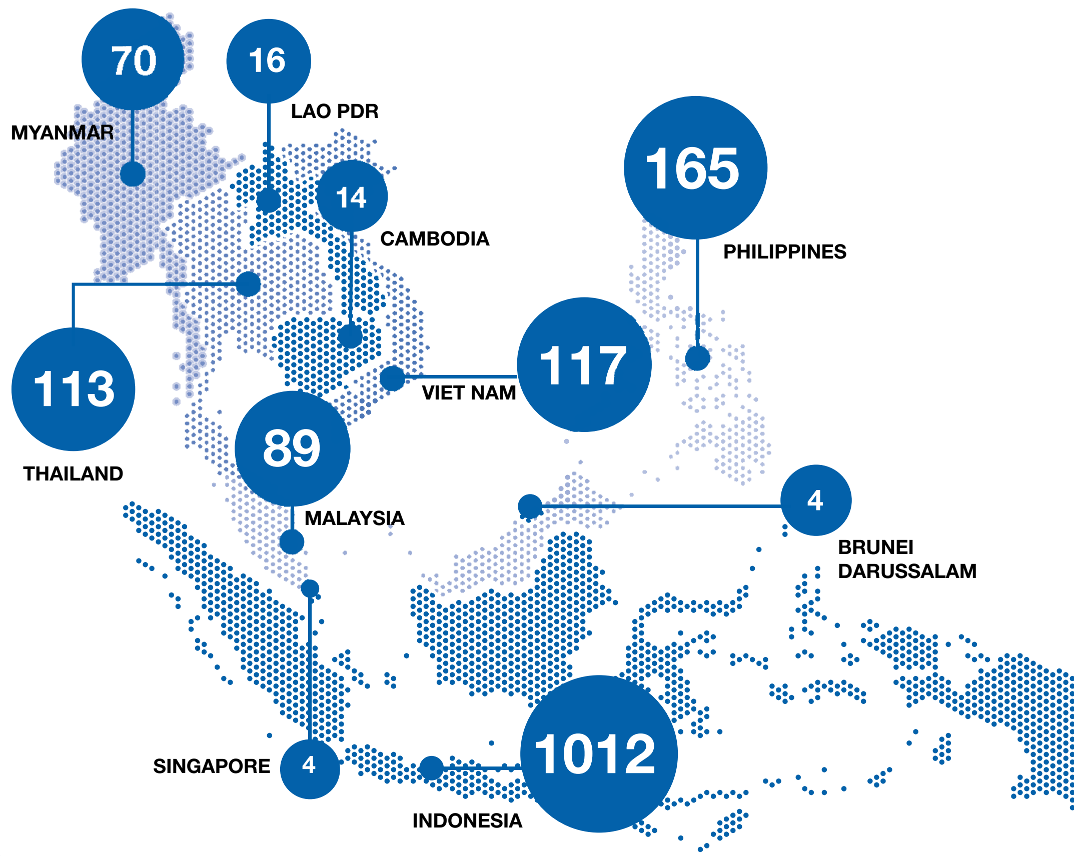


Figure 1.5 Breakdown Distribution of Disasters in ASEAN (by country) show that majority, or 63% of all disasters, occurred in Indonesia. The Philippines follows with a 10% share, while the remaining 27% is divided among the rest of the region (ADINet, 2019).

MEMBER STATE	FLOOD	WIND	STORM	DROUGHT	LANDSLIDE	EARTHQUAKE	VOLCANO	TSUNAMI
BRUNEI DARUSSALAM	3	-	-	-	1	-	-	-
CAMBODIA	5	1	7	1	-	-	-	-
INDONESIA	616	191	16	25	101	34	27	2
LAO PDR	10	1	3	-	2	-	-	-
MALAYSIA	76	1	5	-	5	2	-	-
MYANMAR	35	6	16	1	9	3	-	-
PHILIPPINES	60	22	51	-	17	11	4	-
SINGAPORE	3	1	-	-	-	-	-	-
THAILAND	60	15	23	11	3	1	-	-
VIET NAM	39	20	39	3	16	-	-	-

Table 1.1 Distribution of Disasters in ASEAN (by country and hazards) shows that Indonesia is most at-risk to all types of disasters, except storm which is designated to the Philippines (ADINet, 2019).

Floods and tropical cyclones have been identified as two of the main hazards that affect a number of the Member States. Even though Singapore and Brunei Darussalam have low scores for floods on both indexes, there have been increasing reports of flash floods due to erratic weather patterns. Most of the floods were caused by either monsoons or cyclones. According to Loo, Billa, & Singh (2015) floods reported in Southeast Asia are associated with the Southwest Monsoon downpour, and are found to be most frequent in Cambodia, Indonesia, the Philippines, Thailand, and Viet Nam. The paper, however, neglected to include Myanmar, which was assessed by the RVA to have 12% of its population exposed to floods. Based on the report, it was estimated that 11% (69 million) of the total population in ASEAN are exposed to floods, with an estimated USD 897 billion worth of capital stock vulnerable to flood damage.

Distribution of Disasters in ASEAN
(July 2012 - January 2019)

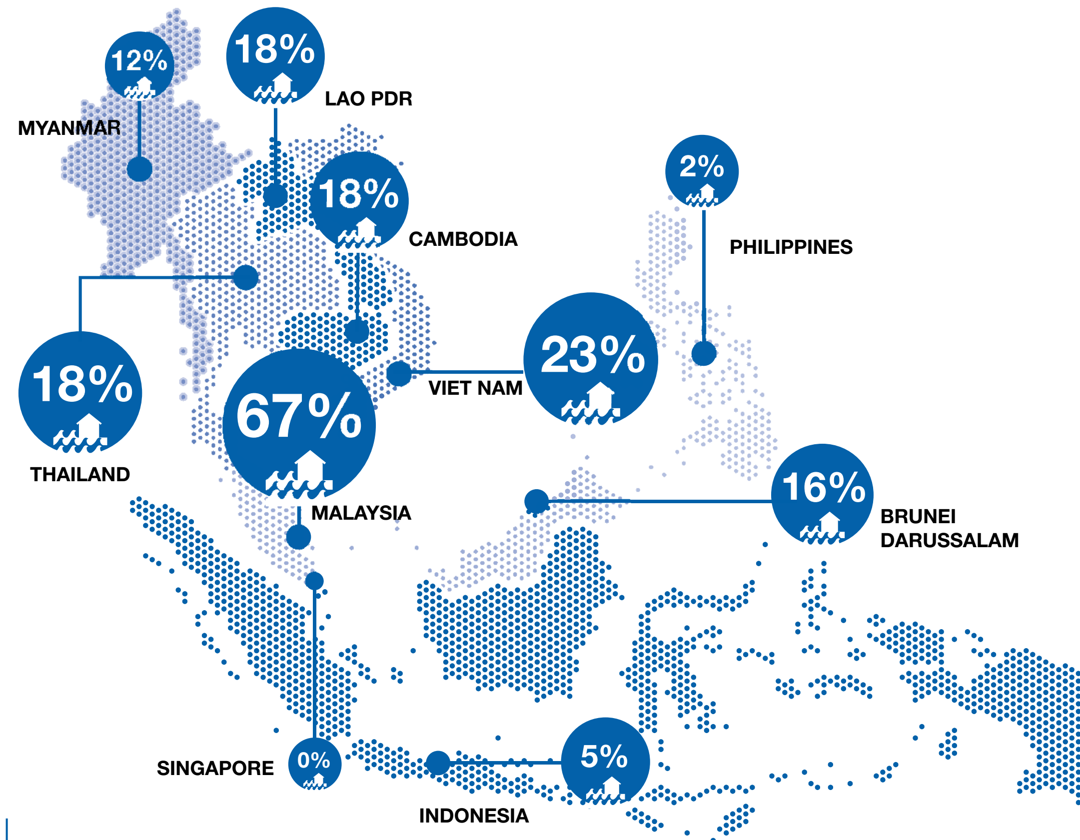


Figure 1.6 Percentage of Population Exposed to Floods (by country) is highest in Member States located in the central areas of the ASEAN region - Malaysia, Viet Nam, Cambodia, Lao PDR, Thailand, and Brunei Darussalam.

Based on recorded data, people residing in the northern ASEAN region are regularly exposed to tropical cyclones, which was also consistent with the RVA's assessment (Figure 1.7). Based on the report, it was estimated that 59% (379 million) of the total population in ASEAN is exposed to Category 1 or greater tropical cyclone. An estimated USD 3 trillion dollars of capital stock is vulnerable to such damaging wind occurrences, which holds a high potential to affect the resiliency of the country should a catastrophic event occur.

Population Exposed to Tropical Cyclones

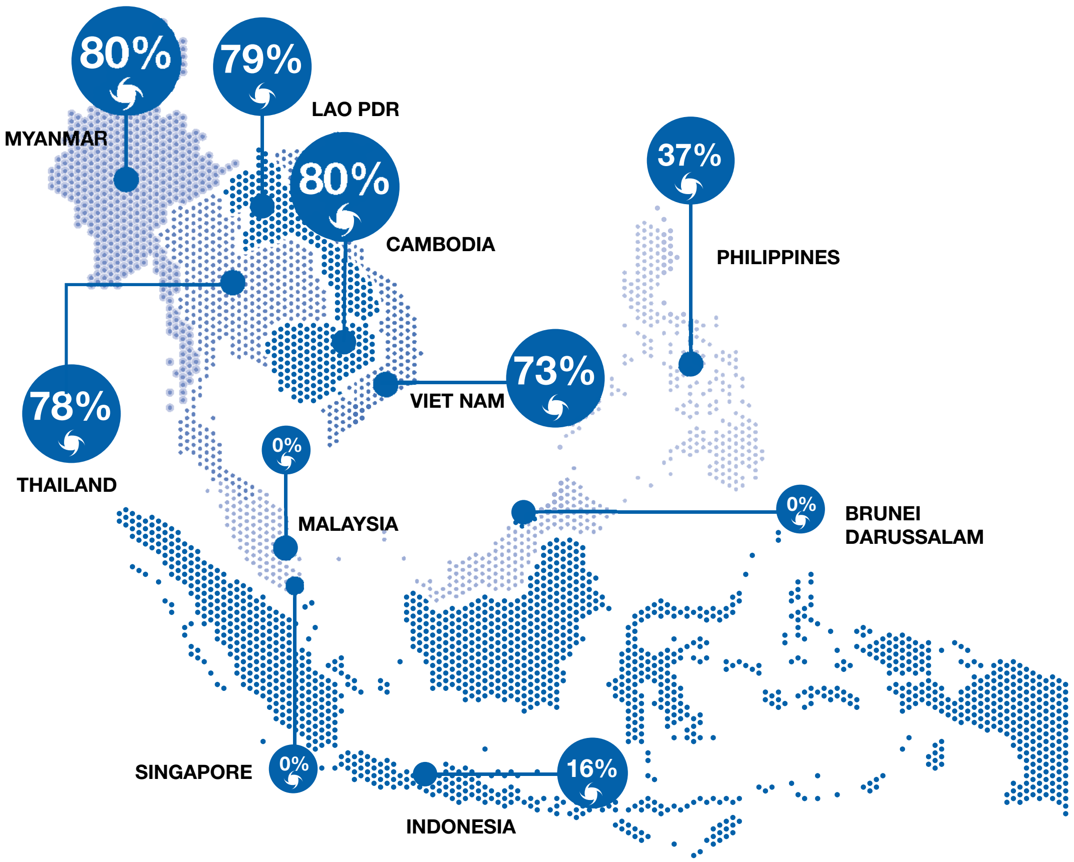


Figure 1.7 Percentage of Population Exposed to Tropical Cyclones (by country) is highest in Member States located in the Mekong sub-region - Cambodia, Myanmar, Lao PDR, Thailand, and Viet Nam. All of these Member States have over 70% of their population exposed to at least Category 1 tropical cyclone.

In relation to floods, Loo, Billa, & Singh (2015) also point out that increasing intensities of rainfall during monsoons do not only contribute to major flooding events, but also trigger major landslide events. Even though landslides only contributed to 9.60% of the recorded disasters in the past seven years, usually formed by largely localised events, these incidents still hamper and hinder logistical access to affected communities or villages, greatly affecting humanitarian operations in emergency response. It is estimated that 3% of the total ASEAN community is exposed to landslides, largely occurring in mountainous and remote areas (Figure 1.8).

Landslide Hazard Exposure Zones

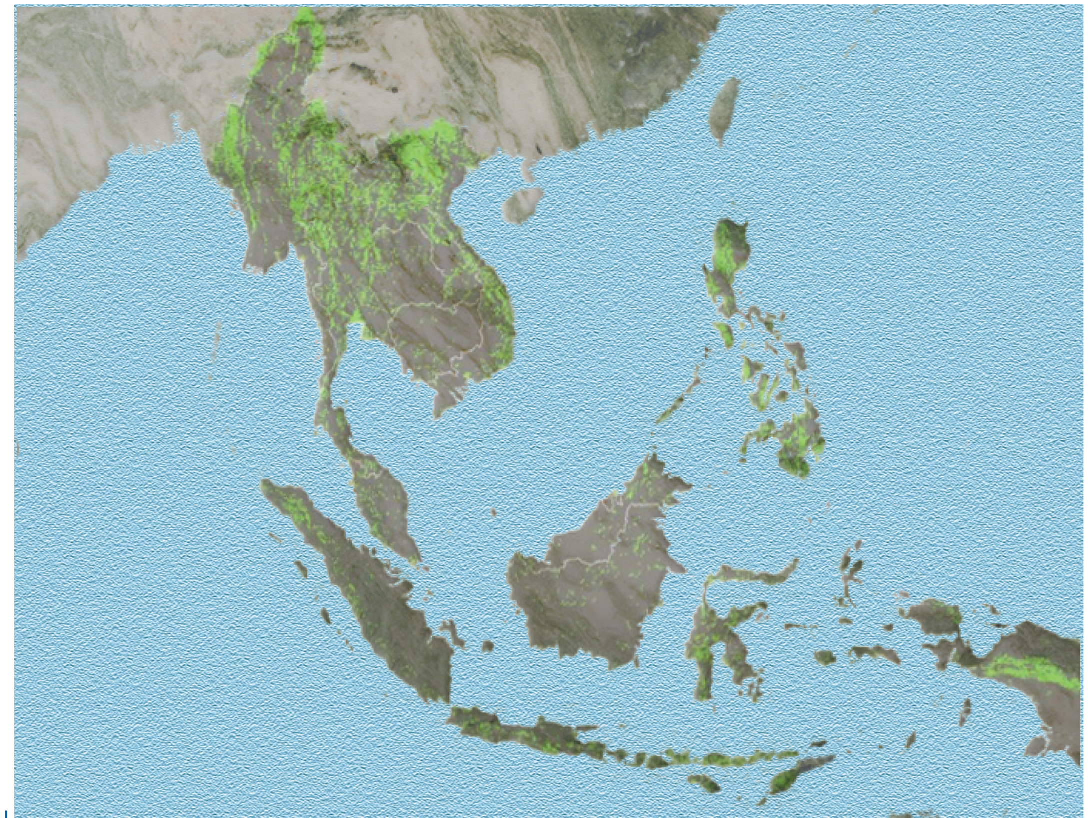


Figure 1.8 Landslide Hazard Exposure Zones are mostly located in the mountainous portions of Indonesia, Mekong sub-region, and the Philippines.

Shifting focus towards geophysical hazards, ASEAN sits between and along several tectonic plates – including the Indian, Australian Plate, Eurasian Plate, Philippine Plate, and Carolina Plate (AHA Centre, 2018; NASA, 2010; UN OCHA, 2013) – forming part of the "Ring of Fire" within which frequent occurrences of earthquakes, volcanic activity, and tsunamis induced by geophysical factors are reported. Although volcanic eruptions (Figure 1.9) and earthquakes (Figure 1.10) only constitute 5.11% of total recorded disasters (Figure 1.4), throughout the past seven years the risk associated with such hazards is higher compared to floods.

It is estimated that 37% of the total ASEAN population are exposed to earthquakes of Modified Mercalli Intensity (MMI) 7 and above, with even an estimated 35% (245 million) of the total ASEAN population is exposed to volcanic activity. As a resultant hazard, the exposure to tsunami is estimated to be less than 1% (4.1 million) of the total ASEAN population – a population primarily located in coastal areas of countries located along the tectonic plates. The combined figures of capital stock exposed to such geophysical hazards is estimated at a staggering USD 4.48 trillion. Despite the low frequency of hazard occurrence, the magnitude of impact resulting from these hazards remains larger than more common hydro-meteorological hazards (combined USD 3.87 trillion dollars).

Volcanic Hazard Exposure Zones

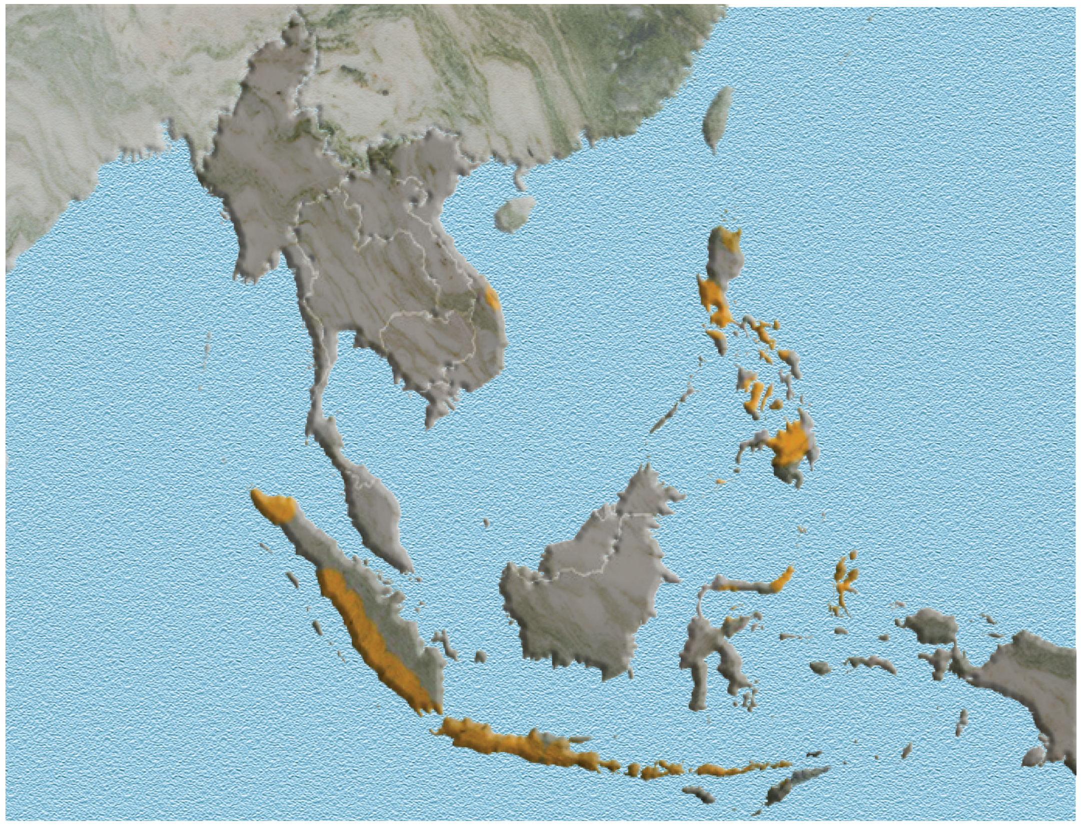


Figure 1.9 Volcanic Hazard Exposure Zones are located along the Pacific Ring of Fire, which transects Indonesia and the Philippines. A small part of Viet Nam is also exposed to volcanic hazards.

Earthquake Hazard Exposure Zones

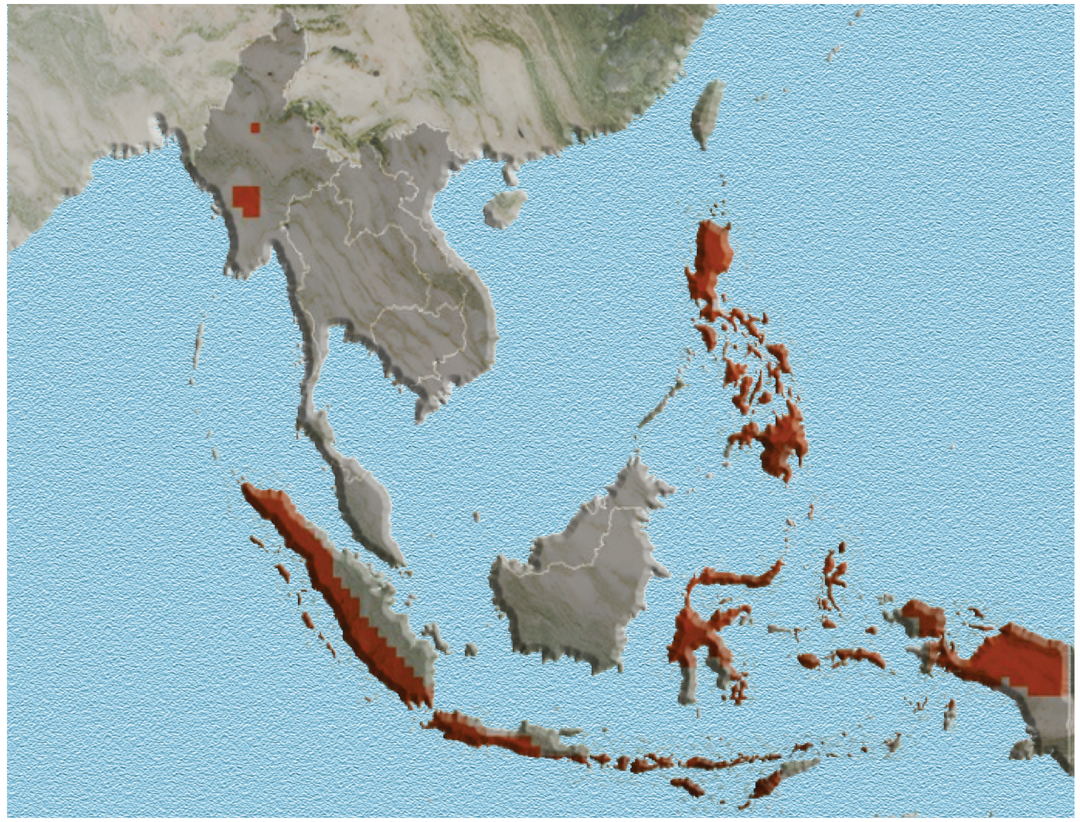


Figure 1.10 Earthquake Hazard Exposure Zones are also located along the Pacific Ring of Fire, and cover most of Indonesia and the Philippines. A small part of Myanmar is also exposed to earthquake hazards.

The combined total value of capital stock at-risk of exposure to the aforementioned hazards is valued at USD 8.35 trillion. This is approximately three times the size of ASEAN's 2018 nominal GDP (USD 2.89 trillion), which also forms the world's 5th largest. Large-scale or catastrophic disasters resulting from these hazards would negatively impact the development of some nations, as high amounts of resources would have to be channelled towards recovery and rehabilitation. Therefore, having a detailed understanding of vulnerability, coping capacity, and resilience is crucial to better tackle challenges or issues that may impede risk mitigation or reduction.

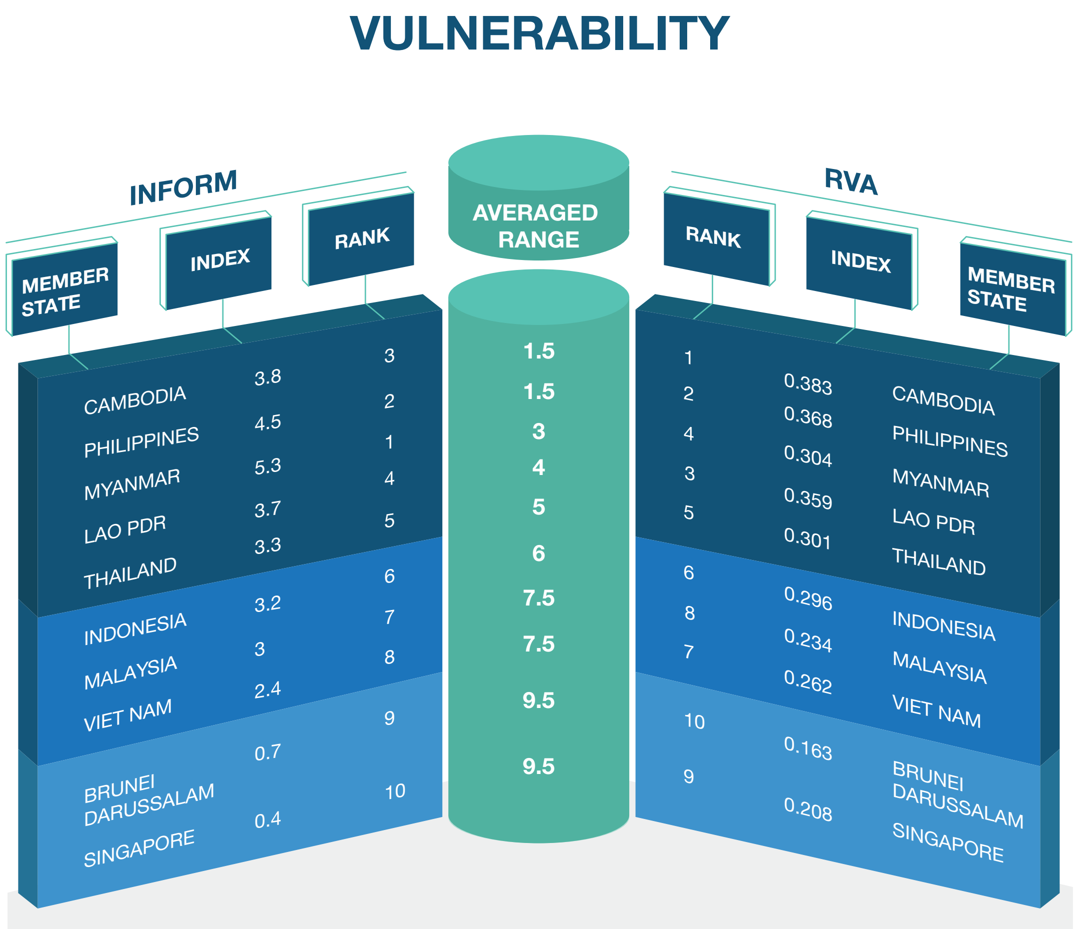


Figure 1.11 Vulnerability Results (by country and ranking) on both indexes ranks Cambodia and the Philippines as the top-most vulnerable ASEAN Member States.

Throughout the region, it was assessed that Cambodia and the Philippines had the highest vulnerability levels (Figure 1.11). Common challenges that contribute to such vulnerability include recent disaster impacts, economic constraints, population pressures, access to clean water, and information access. Vulnerability in the Philippines is largely driven by recent disaster impacts, while Cambodia is largely driven by access to information. Cambodia has the lowest literacy rate (73.9%) of all the ASEAN nations, and increasing education access remains a high priority for the nation as only 13.4% of the population hold a tertiary education (UNESCO UIS, 2018). In the case of the Philippines, its high ranking is based on its high multi-hazard exposure score, as the nation is largely affected by tropical typhoons, floods, storm surges, earthquakes, and volcanoes. Weather in the Philippines is largely influenced by the Southwest Monsoon (Habagat) and the Northeast Monsoon (Amihan) events, which may give rise to the formation of tropical cyclones originating from the Pacific Ocean, which eventually result in heavy rain and destruction as the cyclones make landfall.

Finally, coping capacity looks at an individual Member State's ability – or in the case of the figures, lack of ability – to absorb, respond to, and recover from disruptions to their country's normal function (including social and economic activities). The results (Figure 1.12) are independent of hazard risk, with ranking based on the countries' coping capacity alone.

Examining the results in Figures 1.11 and 1.12, Cambodia, Myanmar, and Lao PDR display the highest vulnerability and lowest capacity to cope. Drawing data from the World Governance Indicator developed by World Bank (Figure 1.13), these identified countries are weaker in aspects of government effectiveness, regulatory quality, and Rule of Law. Such aspects contribute largely to the governance indicator, and when coupled with economic constraints and infrastructure capacity, such weaknesses in these indicator areas can have a profound effect on the resilience of the country. Faced with such constraints and limitations, these countries may take longer to recover and return to normality, resulting in potentially significant decreases in social and economic activities.

LACK OF COPING CAPACITY

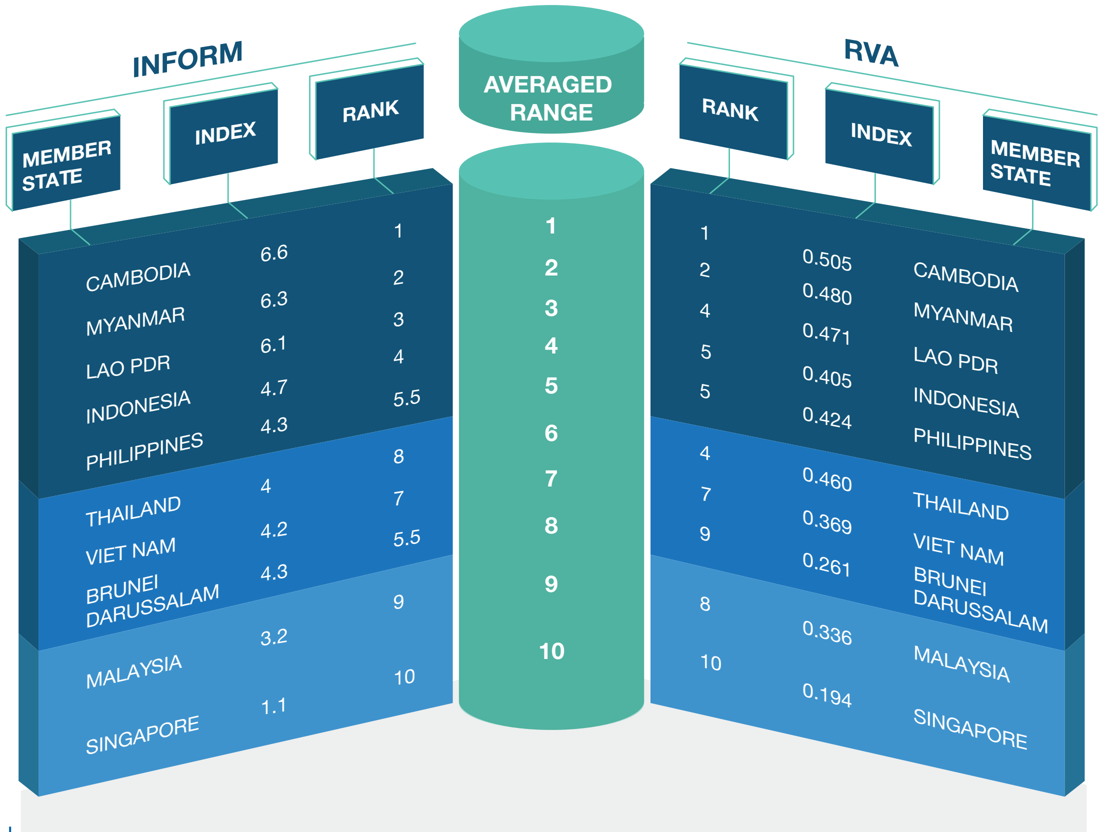
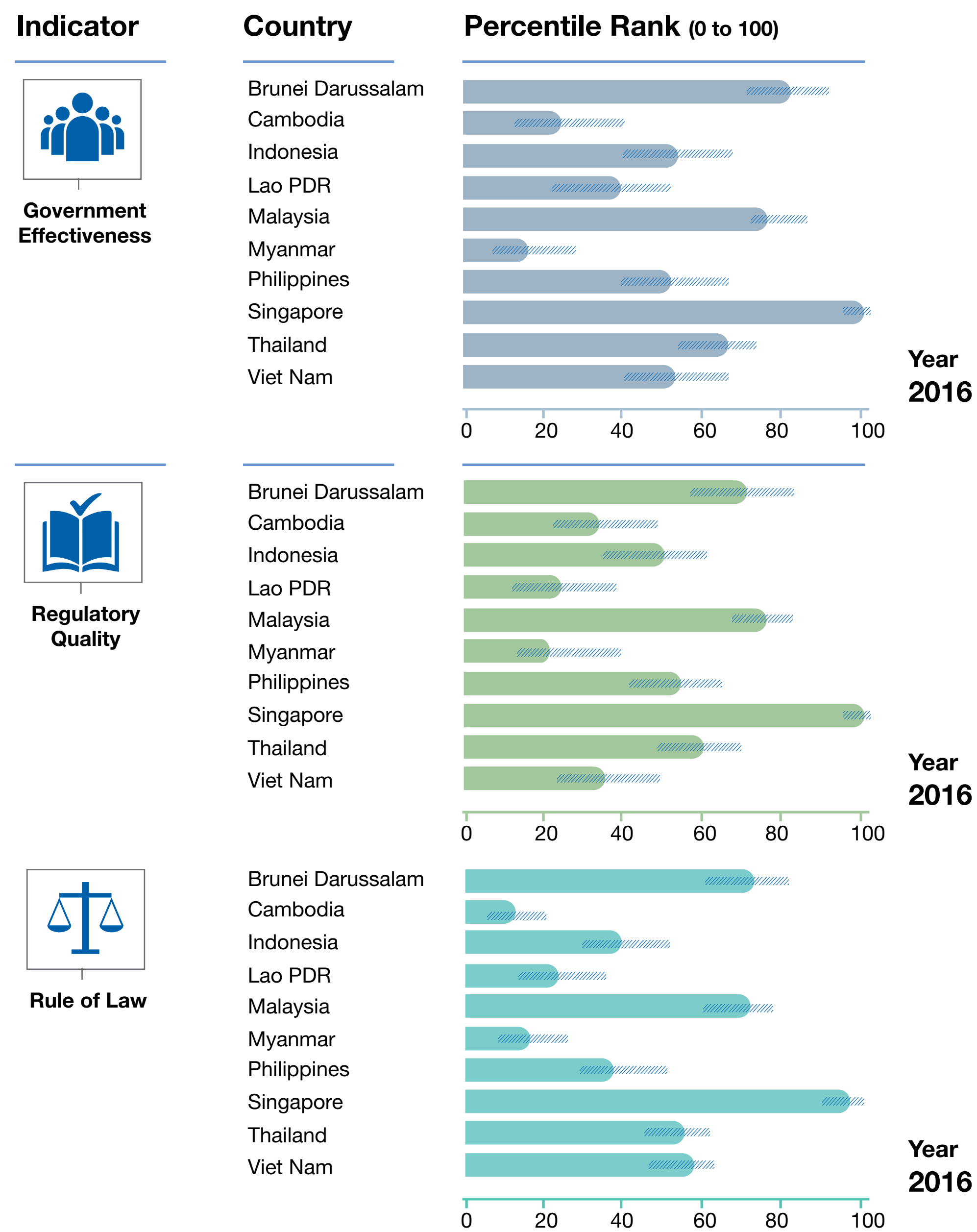


Figure 1.12 Coping Capacity Results (by country and ranking – higher ranking equals lower coping capacity) for both indexes identify the three ASEAN Member States with lowest coping capacity as Cambodia, Myanmar, and Lao PDR.



Source: *Source: Kaufmann D., A. Kraay, and M. Mastruzzi (2010)*

Figure 1.13 World Governance Indicators (2016) indicate that Cambodia, Myanmar, and Lao PDR will require significant effort to increase their Coping Capacity, while nations such as Singapore, Malaysia and Brunei darussalam are home to relatively strong Coping Capacity.

Combining the multi-hazard exposure, vulnerability, and coping capacity concepts forms the basis of the multi-hazard risk score. This score ranks the likelihood of disruption due to factors associated with a Member State's hazard exposure, as well as the ability to prepare, respond, and recover from the impact. The component scores are equally weighted (one third weightage for each component). As shown in Figures 1.14 and 1.16, the Philippines, Myanmar, and Indonesia have the highest risk index scores. The largest component contributing to the scores was multi-hazard exposure. However, due to their status as middle income countries, the Philippines and Indonesia hold sufficient mechanisms (Figure 1.15) to increase their resilience.

RISK SCORE

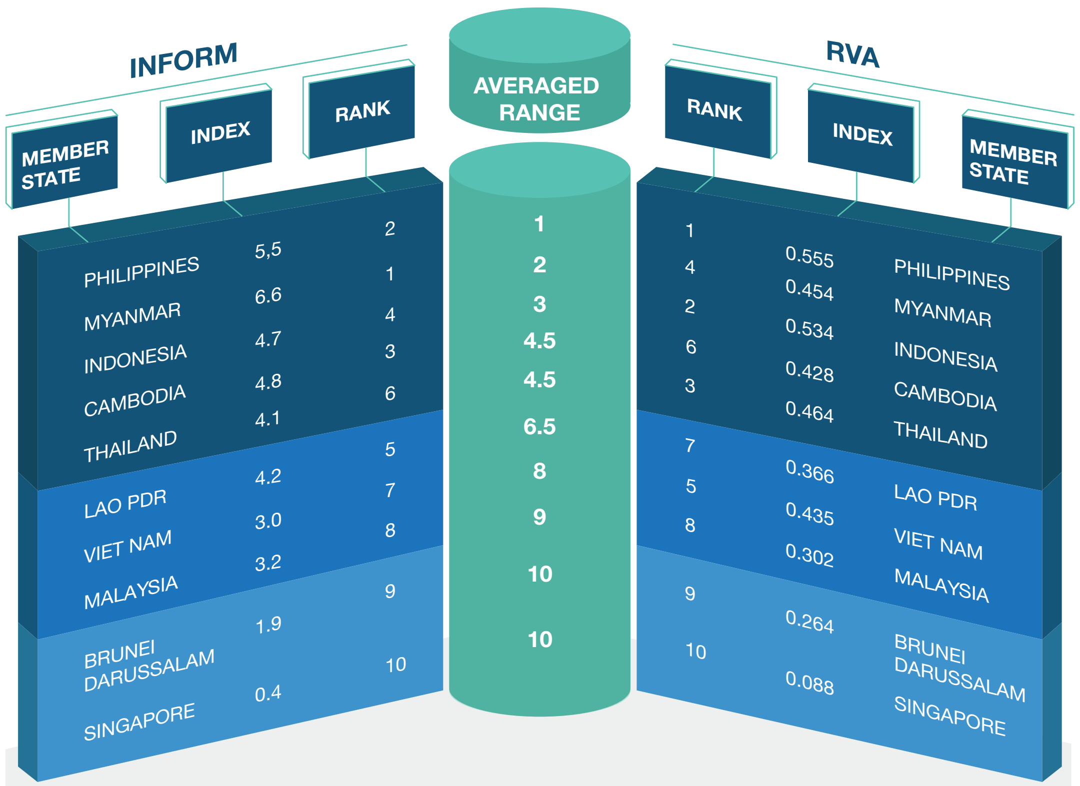


Figure 1.14 Risk Score ranks the Philippines, Myanmar, and Indonesia as the top three ASEAN Member States most at-risk to natural multi-hazards, with the Philippines and Myanmar scoring the top spot using RVA and INFORM respectively. This means that the Philippines has the highest risk from a long-term perspective, while the ongoing conflict in Myanmar ranks it highly on a year-by-year basis.

Singapore and Brunei Darussalam score the highest in relation to resilience. With a lower multi-hazard exposure scores, these nations are relatively shielded from a large number of natural hazards. However, both nations are not spared from flash floods – but governance and infrastructure mechanisms are highly-developed to counter such occurrences. Myanmar and Thailand were scored lowest in the resilience rankings. Myanmar's resilience level is largely hindered by its economic and infrastructure capacities, whereas Thailand is hindered primarily by its infrastructure capacity alone. Based on these results and context analysis, it can be seen that logistical access and healthcare systems in remote regions of these nations may be burdened heavily by shocks or disruptions following a natural disaster. Based on Singapore and Brunei Darussalam's smaller geographic size, access is generally greater. However, the risk of total devastation and collapse of infrastructure is high should a large-scale event occur for such smaller nations.

RESILIENCE

MEMBER STATE	INDEX	RANK
SINGAPORE	0.819	1
BRUNEI DARUSSALAM	0.581	2
MALAYSIA	0.518	3
PHILIPPINES	0.512	4
VIET NAM	0.481	5
INDONESIA	0.446	6
LAO PDR	0.381	7
CAMBODIA	0.335	8
THAILAND	0.295	9
MYANMAR	0.241	10

Figure 1.15 Consistently having the lowest exposure to natural hazards, lowest vulnerability, and highest coping capacity, Singapore and Brunei Darussalam rank the highest for resilience. While the Philippines and Indonesia, although entering three ASEAN Member States most at-risk to multi-hazards, they hold sufficient resilience, placing them in the middle. Meanwhile, Myanmar as the ASEAN Member State second most at-risk to multi-hazards, will require significant effort and support from the region to increase its resilience.

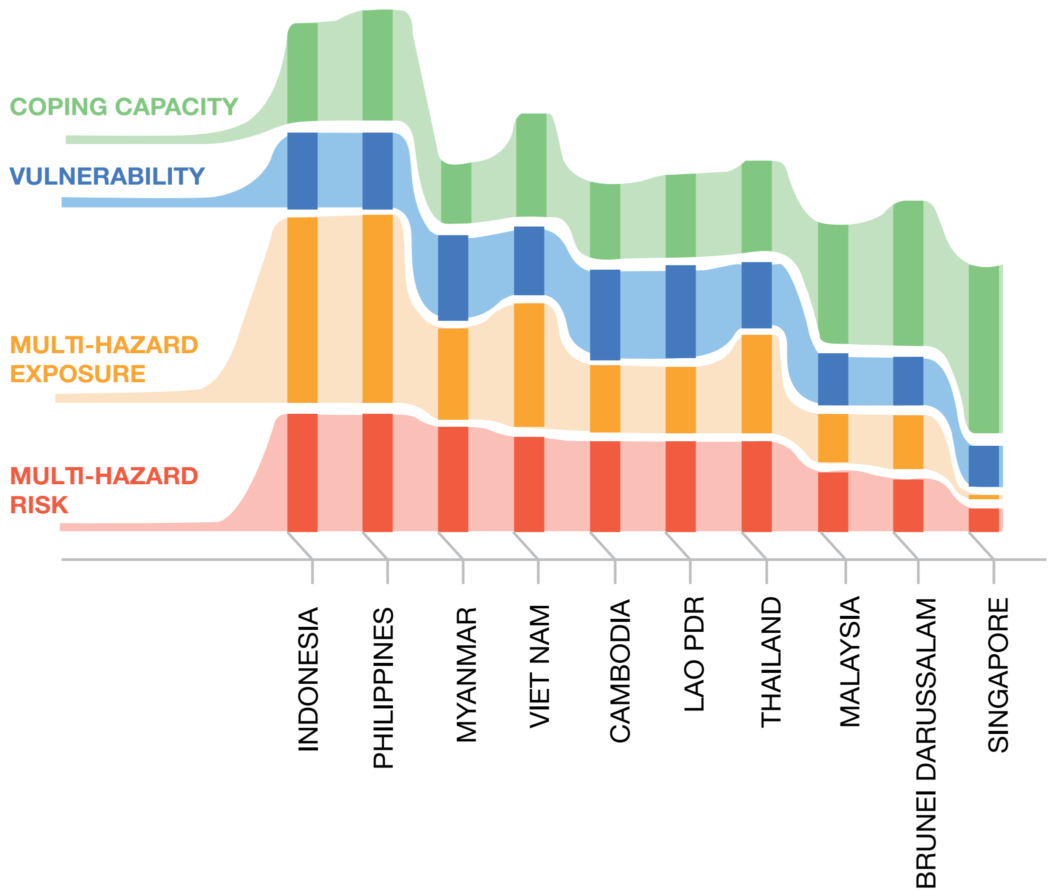


Figure 1.16 Multi-hazard Risk Results show that Singapore, Brunei Darussalam, and Malaysia have higher coping capacities yet lower multi-hazards risk, exposure, and vulnerability. This "surplus" of resilience is worthy of exploration to determine options to complement and improve other ASEAN Member States who generally rank lower.

Conclusion & Recommendation

Understanding the various components that constitute risk is important for decision-makers, policy-makers, and the general community when planning initiatives aimed at improving resilience. The risk score described is a simplistic and "big picture" view of the reality. Users of these scores should be aware of the method's limitations, and remember that real humanitarian risk is a complex and multi-dimensional issue, which may not be completely characterised by numbers or indicators alone.

While exposure to hazards are expected, countries could reduce their risk by taking steps to reduce vulnerability and increase their coping capacities. More detailed assessment is required in order to provide more in-depth analysis and recommendations for addressing the risk of each individual country.

Upon analysing 2018 GDPs and total capital stock exposed to hazards in the ASEAN region, there is a significant risk that disasters may influence economic growth, with potential disruption to overall ASEAN economic activity. Further study is required to understand potential impact of disaster risk to overall economic development, which includes the impact of investment in risk reduction in support of economic growth in the regional context.

While the study of the risks, hazards, vulnerability and coping capacity for individual countries of ASEAN has been conducted through the ASEAN Risk Evaluation report, further study is required to better understand the collective risk, hazard exposure, vulnerability and coping capacity of ASEAN as a whole. A study could measure the coping capacity of the ASEAN region as a whole, in order to further understand the resiliency of ASEAN nations to support each other within the context of One ASEAN One Response.

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CHAPTER

Most At-Risk Cities in ASEAN That Must be Watched

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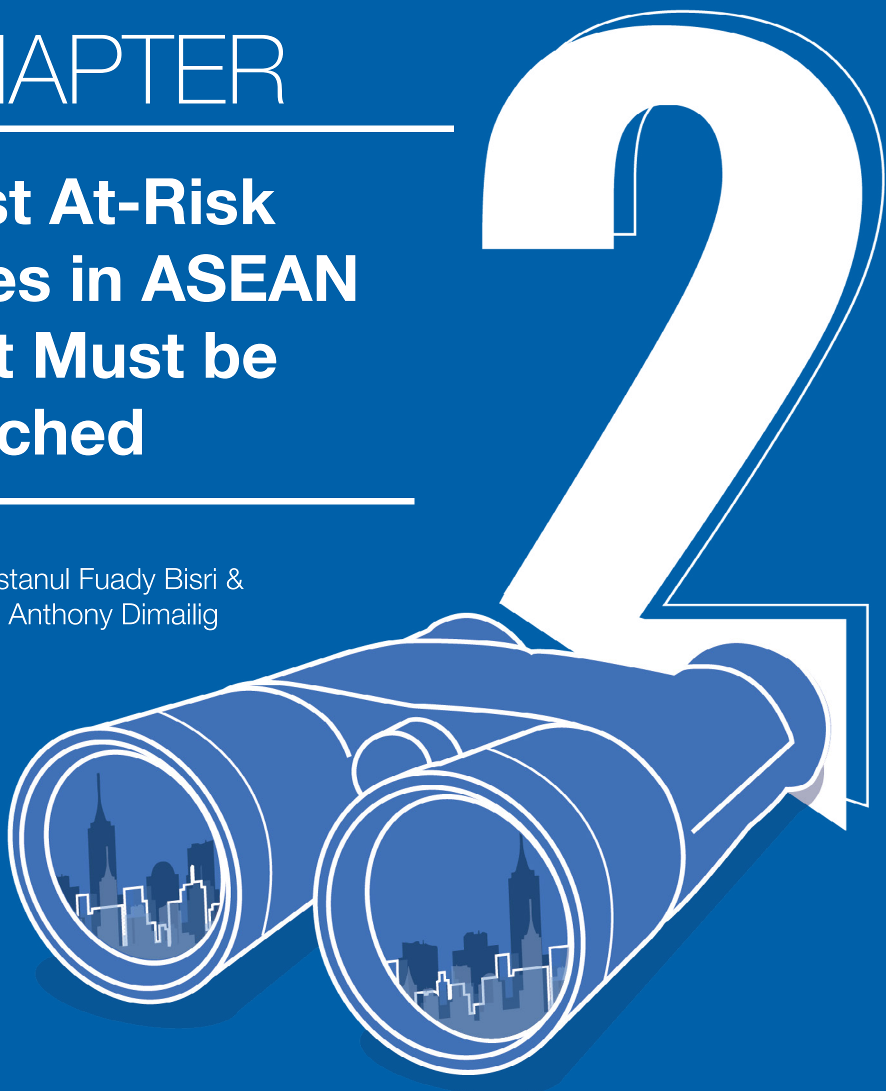


Abstract

The ASEAN Committee on Disaster Management (ACDM) formulated a concept note[1] that aims to develop an implementation framework to build the resilience of ASEAN cities to disaster and climate risks. The concept was realised through a project named "Building Disaster and Climate Resilient Cities in ASEAN". This paper focuses on the project's evaluation of candidate cities – in particular summarising the steps in the evaluation of said candidate cities, and exploring and analysing the resulting lists. This paper also outlines gaps for policy-action follow up, and recommends internalisation of candidate cities to various ASEAN disaster management platforms.

Keywords: risk profile, resilient cities, regional preparednes

2.1 Introduction

By 2050, 68% of the world's population will live in urban areas (UN-DESA, 2018). Accelerating urbanisation is defining our global reality, and will ultimately shape our future. Urbanisation intersects with climate change, natural disaster, conflict, and displacement. It therefore acts as a critical lens through which to review national and international efforts to prevent and mitigate, prepare for, and respond to crises, conflicts and disasters. Over 80% of the world's GDP originates from cities (McKinsey Global Institute, 2011), and consequently as they also constitute a central part of the global risk landscape, cities' vulnerability presents significant risk to national and global economic output. The urban population in lower-income and fragile countries has increased by 326 percent throughout the last 40 years, with urban poverty concentrated in fast-growing, at-risk, and mostly unplanned informal settlements (Boer, 2015). The increasing frequency of natural and human-induced emergencies in urban areas requires new efforts to address risk, prepare for unavoidable events, and mitigate the impact of crises. The provision of immediate humanitarian relief should be aligned with efforts to strengthen urban resilience and to build on opportunities for self-recovery in towns and cities.

Due to its geographical characteristics and climatic environment, disaster risk in ASEAN sits amongst the highest globally, with its cities constantly affected by disasters of varying levels. According to a study conducted by Swiss Re (2013), Asia's metropolitan cities are most at-risk from natural hazards. Based on their population exposure to five natural hazards of river flood, earthquake, tsunami, wind storm, and storm surge combined, the top five highest risk urban areas worldwide are all located in East and Southeast Asia (SwissRe, 2013).

[1] "Concept Note 18 (CN18): Building Disaster and Climate Resilient Cities in ASEAN" is included in the ASEAN Agreement on Disaster Management and Emergency Response Work Programme Phase 2 (2013-2015). In the overall scheme of CN18, a demonstration project on building resilient cities was implemented. As it is beyond the scope of this paper, interested readers should visit the project website: https://aurf.ahacentre.org

While at the same time, increasing numbers of people from rural areas move to and live in cities. By 2050, it is expected that 68 percent of the world's population will live in urban areas (UN-DESA, 2018). This unprecedented growth of cities, particularly in the ASEAN region, results in issues related to resource management and land use, and poses challenges to disaster risk management and sustainable development.

Against this background, a regional project "Building Disaster and Climate Resilient Cities in ASEAN" was jointly initiated and implemented by the ASEAN Committee on Disaster Management, ASEAN Member States (AMS), ASEAN Secretariat, AHA Centre, and Japan International Cooperation Agency and its Project Team. The project has three outputs – however this paper will focus only on one – namely Output 2: Evaluation of Candidate Cities, and Partnership and Commitment Building for Demonstration Project (JICA Project Team, 2015). More specifically, this paper summarises the steps in the evaluation of candidate cities, explores and analyses the resulting lists, outlines gaps for policy-action follow up, and recommends internalisation of candidate cities to various ASEAN disaster management platforms.

2.2 ASEAN Cities At-risk Identification Process

Within the evaluation process, a Preliminary Risk Assessment (PRA) was utilised for determining cities at 'most-risk' in the ASEAN region. From the considerable overall list of 817 cities at-risk, 56 cities were identified as at higher risk of natural disaster – referred to as the "middle list". Out of these 56 cities, the Project Team further shortlisted them into 16 cities that may become the potential project implementation sites – referred as the "potential project list". In the view of the AHA Centre, the methodology and resulting "middle list" and "potential pilot project list" from the initial lists of cities should be retained and captured for knowledge retention and consideration for future preparedness activities. The criteria utilised in the PRA ensures the initial and middle lists remain critical to be summarised and recognised by regional policy makers. These criteria include:

- **A** Representative of natural hazards in the region that have frequently impacted cities and considerably damaged socio-economic conditions. However, it should be noted that the considered types of natural hazards are limited to natural hazards that directly affect people and assets of cities, and excluded uncountable hazard damages, both physically and spatially (e.g. forest fire, drought, etc).
- **B** Replicability to apply pilot project to similar cities in ASEAN Member States (AMS), where cities with small and medium-sized population form a large percentage of urban areas.
- **C** Sustainability and preparedness for an effective demonstration of the project in terms of capacity and experience on disaster risk reduction and management, and the likelihood of the demonstration project to become good practice which might influence other cities.
- **D** Significance of economic exposure, such as clustered industrial areas in cities, to be protected from hazard risks (i.e. national and sub-national economic assets and activities that were historically subject to natural hazards).
- **E** Others, such as data availability of socio-economic status, hazards and records, development plans and land use plans, presence of hazard management organisations, and national and regional significance in conjunction with policies of respective AMS.

At the initial stage, based on the submitted information by AMS, there are 817 candidate cities. The term 'city' in this context is defined as an urbanised physical area administered by local government units according to each AMS definition. Nevertheless, as it did not apply any population threshold, there was a combination of small, medium, and large cities. Being the initial list, this collection of candidate cities became the 'long list'.

From the long list of 817 candidate cities, retaining knowledge of the process and results to determine the medium and shortlisted cities is of key interest. There were three steps undertaken in the PRA to shortlist the cities (Figure 2.1). In essence, the steps take into consideration the aspect of multi-hazard risk, exposure, and coping capacity of each candidate city. Here, it is imperative to emphasise the importance of the 1st and 2nd steps of PRA which may be utilised for understanding of key regional at-risk cities in ASEAN.

Three Steps and Assessment and Evaluation Process for the Selection of Candidates for the Demonstration Project

ASSESSMENT	PREPARATION	STEP 1 1st PRA for Middle List	STEP 2 2nd PRA for Short List	STEP 3 Evaluation for Candidate Cities	Selection
Hazard Risk Exposure Vulnerability Coping Capacity	Data Collection***	● ●	● ● ●	-- --	-- -- --
Project Principles Consistency		--	--	●	--
Major data source	--	GRDP/UNEP**/ Data Collection***	GRDP/UNEP Data Collection***/ Survey Data****	All available data	--
Each Member State's involvement		Recommendation	Recommendation	Discussion and Recommendation	--
Cities to be assessed		Long List Cities	Middle List Cities	Short List Cities	Candidates
Numbers of LGU	2.431*	817	56	(20~30)	(3-8)

Note: ** GRDP/UNEP: UNEP-GRID/Geneva, UNISDR, *** Data collection mainly through desktop (website documents, satellite imageries), *** the data gathering survey through sub-contract conducted by JICA Project Team, *The number of 2,431 includes all local governments (rural and urban) and 817 cities among local governments are covered for the preliminary risk assessment.
Source: JICA Project Team

Figure 2.1 Preliminary Risk Assessment Steps (JICA Project Team)

In the context of Step 1 (evaluation step to determine the middle-list), the hazard profile used in evaluating cities at risk is limited to those exposed to earthquake, tsunami, flood, and tropical cyclone (due to storm surge or wind). It is notable that drought, volcanic hazards, and wildfires are excluded. Drought is one of the most complex phenomena of natural hazard events, which often occurs long-term and results in a wide range of varying damage to local areas. As such, scientific research on assessment is not yet internationally established. Under this research, cities cannot be assessed based on events of which spatial data regarding exposure and vulnerability is not available. Hazards related to volcanic eruption are also excluded as they are present in a limited amount of countries. Wildfires are also not considered, as there are limited integrated data and sources at the city level in AMS.

Step 1 also considered regionally available exposure parameters such as population numbers, as well as physical and economic exposures. It is important to note that the populations parameter excludes national capital cities, and is only applied to cities with population of more than 10,000 inhabitants which were then identified within a 90% percentil. This saw the top 5% of cities with the largest population and bottom 5% cities with lowest population excluded in order to identify representative cities in AMS in terms of predominant population scale for the long list cities. Meanwhile, economic and physical exposures quantify the presence of major industrial areas, regional seaports and airports. This step narrowed down the 817 cities in the long list to 56 cities in the middle list.

Increased in-depth analysis was undertaken in Step 2, resulting in the short list of candidate cities. City-level data was analysed for all risk aspects, including hazard, exposure, and coping capacity. Hence, this step also included primary data collection. With regards to hazard analysis, city-level data of earthquake, tsunami, flood, and tropical cyclone were used. The exposure parameter further deepens the investigation on population, physical and economic exposure. For population exposure, numbers of affected populations, density, and growth rate are considered. The hazard information is also used to determine exposure of potentially affected regional infrastructures (roads, seaports, and airports), economic sectors, and industrial areas. At this stage, more robust coping capacity parameters were also analysed. The parameters included: urban planning and institutions; community resilience; capable disaster response systems; information and communication; urban utilities systems; logistics and transportation systems; medical care and rescue systems; evacuation and shelter systems; and quick recovery systems. After analysis, there was a discussion between stakeholders to finalise the list. This step narrowed down the 56 cities in the middle-list to 16 cities that would form the list for potential project sites.

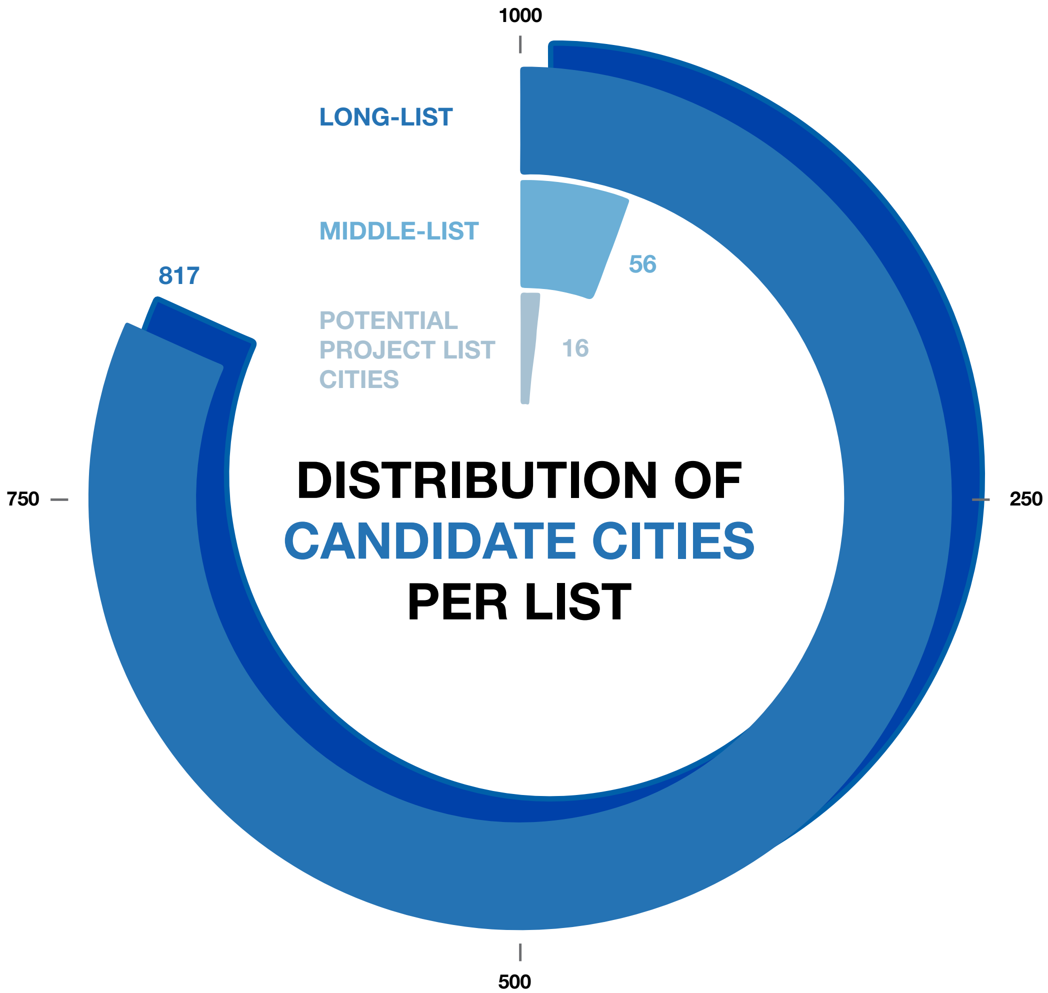


Figure 2.2 Distribution of Candidate Cities per list.

2.3 ASEAN Cities At-Risk

The ASEAN region, geographically located in Southeast Asia, belongs to tropical climate zone – except for the northern parts of Lao PDR, Myanmar, and Viet Nam, which are located in a temperate climate zone. The region generally experiences high amounts of precipitation throughout the year, with precipitation decreasing to significantly lower levels in regions where dry and wet seasons are apparent. In addition, typhoons or cyclones develop in the Pacific area east of the Philippines, as well as the Bay of Bengal to the west. This climate context forms a key cause of natural disasters such as floods, tropical cyclones and drought in the region.

From a geological point of view, the region is composed of three tectonic plates – the Eurasia Plate, the Philippine Ocean Plate, and the Australia Plate. The collision of these tectonic plates regularly causes earthquakes/tsunamis and volcanic eruptions. Furthermore, geological features that are susceptible to erosion and/or to high rates of rainfall often result in sediment disasters, particularly in Indonesia and the Philippines.

These natural conditions provide the background to natural disasters that have struck the region throughout history. Based on the Emergency Events Database (EM-DAT) and ASEAN Disaster Information Network (ADINet) record, the region primarily experiences seven types of hazards, based on numbers of occurrence between 1980-2011. These are earthquake (including resulting tsunami), flood, sediment disaster (dry), sediment disaster (wet), tropical cyclone, volcano, and drought.

2.3.1 Long-list of Cities at Risk

The 817 cities in the long list were identified and their data extracted by urban administrative local government units in each AMS. These cities include populous capital cities and secondary cities (e.g. Ho Chi Minh City with 5,880,000 people) to small population cities such as Injangyang township in Myanmar (1,732 people). Reflecting the different administration systems of AMS regarding data from cities, there are considerable gaps in population size between large population countries such as Indonesia, Myanmar, and the Philippines, and other, smaller AMS. Average numbers of city population range widely between populations of 20,000 to around 500,000, as shown in Table 2.1 and Figure 2.3.

COUNTRY	NUMBER OF CITIES	POPULATION INDICATORS (,000) MAX-MIN	AVERAGE	MEDIAN	ADMINISTRATION	AVAILABLE DATA YEAR
	4	21-13	19	21	Municipal Council (District Capital)	1991
	24	1,234-4	96	35	City	2008
	98	2,834-33	498	222	City	2010
	26	820-23	93	68	District	2015
	36	1,768-17	265	180	City Council/ Municipal Council	2010
	330	688-1	152	139	Township	2014
	145	2,761-6	254	151	City	2010
	49	293-0.01	79	48	Community Development Council	2015
	44	5,782-21	225	77	City Municipality	2014
	61	5,880-34	291	99	Provincial City/ Town	2009
TOTAL	871	5,880-0.01	222	130	--	--

Table 2.1 Profile of Long-listed Cities (JICA Project Team, 2015)

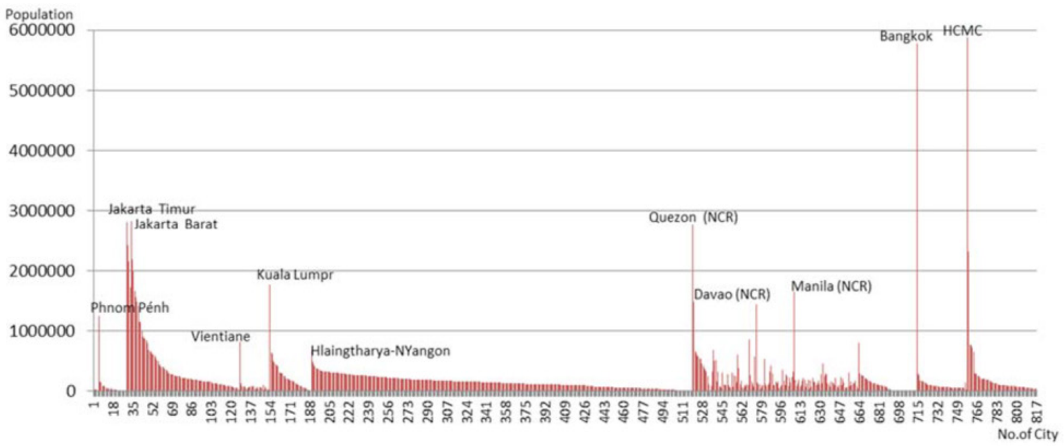


Figure 2.3 Population Distribution of Long-listed Cities (JICA Project Team)

Figure 2.4 indicates the location of long list cities at risk in the region. Of note is that the number of cities in Myanmar (330) outnumbered those in the Philippines (145) and Indonesia (98). These figures should be treated with caution, as there may be a concentration of urban areas in Indonesia and the Philippines, along with respective capital-intensive infrastructure and industries that may not be located inside a city. For example, industrial estates in the Bekasi Regency of Indonesia display the nature of a highly-urbanised area, but it was not identified in this context. Yet if it was to experience a large-scale disaster, the (economic) impact may be higher than an under-developed 'administrative city'.

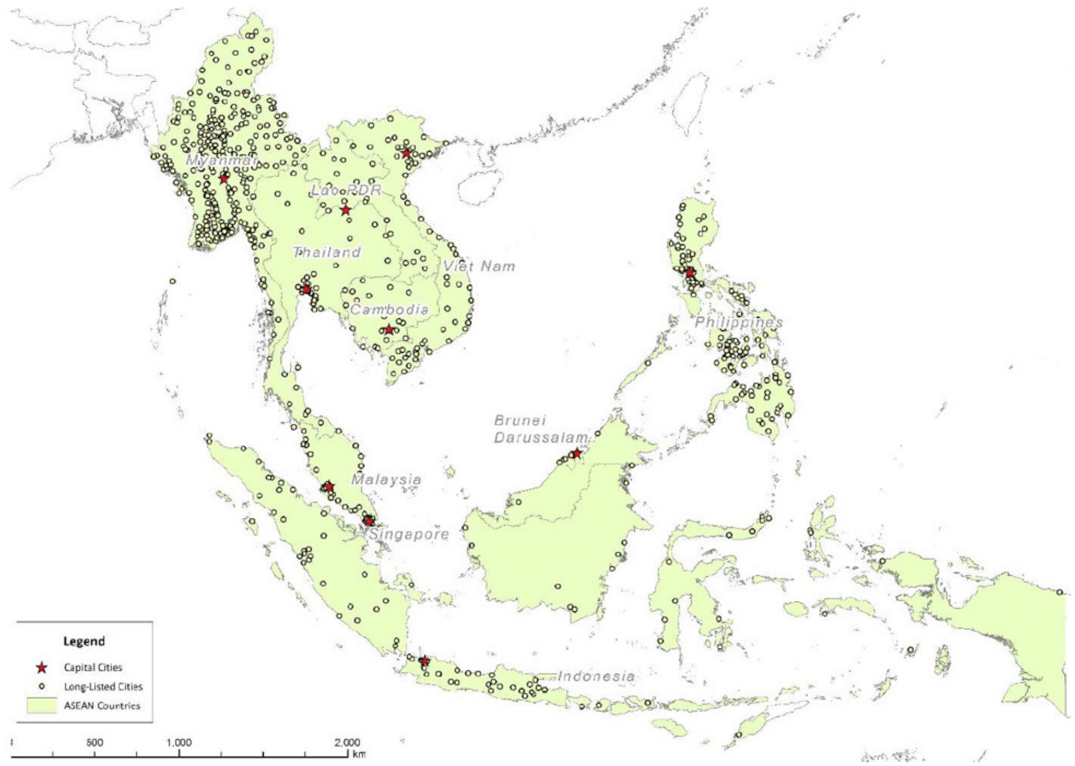


Figure 2.4 Locations of Long-listed Cities (JICA Project Team, 2015)

Aligned with economic alliance formulation through the establishment of the ASEAN Economic Community in 2015, connectivity through regional infrastructure in the region has become one of the key priority programmes to be enhanced by more efficient and effective logistics, and to be improved by resilient systems against natural hazards. In recent years, regional infrastructure has suffered from natural disasters, and brought enormous damages to regional economic activities. When cities were assessed in terms of vulnerability and exposure to potential natural disasters, regional infrastructure (represented by seaports and airports) were considered, and whether or not such infrastructure serves a city. Major regional seaports and airports transporting international passengers and regional goods were identified as shown in Figure 2.5.

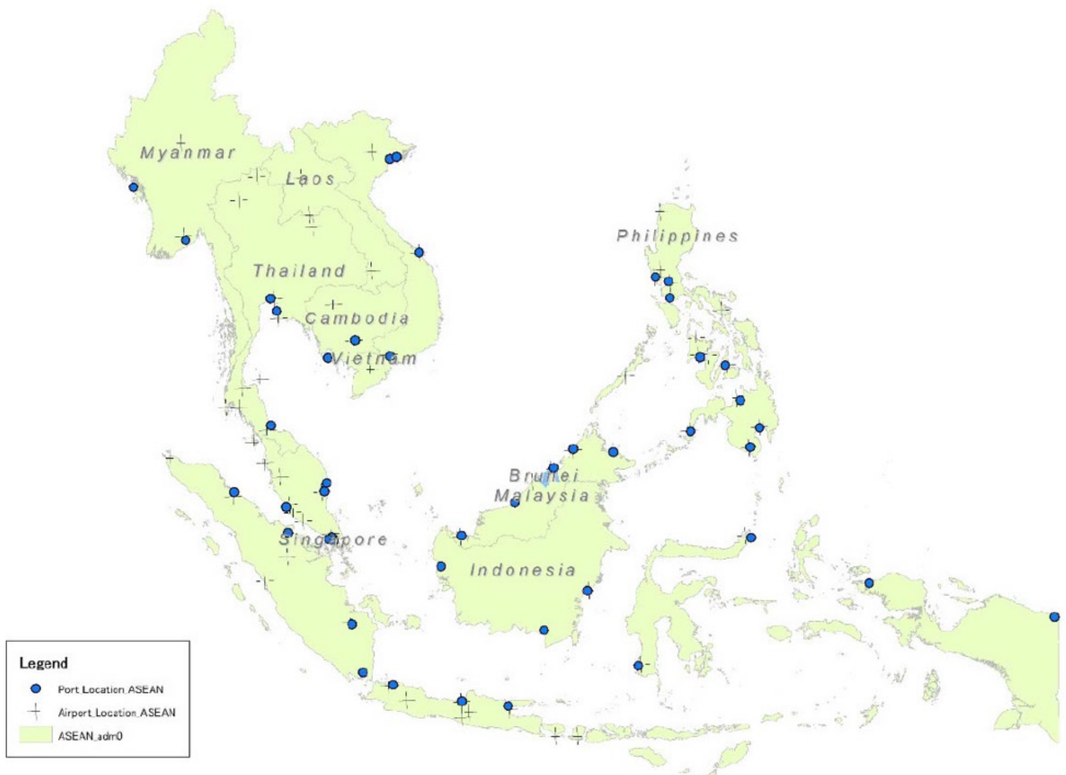
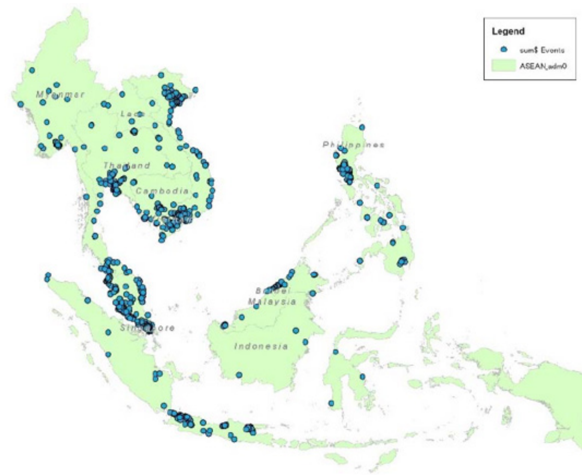


Figure 2.5 Location of Regional Seaports and Airports (JICA Project Team, 2015)

Finally, economic exposure was analysed using agglomerated industrial areas. This considers past lessons from disaster events that affected such industrial areas, resulting in the deterioration of the regional supply chain, causing further considerable damage to regional economic activities. Industrial areas were considered using the scale of property (more than 1-2 hectares) and modernity of the industry. Selection included reviews on industrial estate lists and visual analysis of satellite imagery. Figure 2.6 indicates the locations of approximately 1,100 industrial areas in the region. It is important to note that the 2018 ASEAN Regional Disaster Emergency Response Simulation Exercise (ARDEX-18) took place in one of these industrial areas – Cilegon City, Banten Province, Indonesia. Lessons learned on the complexity of managing response within such a setting included potential need for Hazardous Materials Management Teams, an outcome that should be considered in other industrial areas. At this stage, the generic information of industrial area locations in the region should be further explored to include the classification for type of industry and the associated risks.



COUNTRY	NUMBER OF INDUSTRIAL AREA
Brunei Darussalam	12
Cambodia	86
Indonesia	124
Lao PDR	23
Malaysia	252
Myanmar	44
Philippines	139
Singapore	72
Thailand	77
Viet Nam	271
TOTAL	1.100

Figure 2.6 Locations and Numbers of Considered Industrial Areas (JICA Project Team, 2015)

2.3.2 ASEAN's Top 56 Cities Most-at-Risk of Natural Disasters

More detailed and in-depth hazard assessments were undertaken during the process to determine the top 56 cities most at-risk of natural disasters – or "middle-list" of cities – under the context of risk from earthquake, tsunami, flood, and tropical cyclone (wind and storm surge) hazards. Earthquake and tsunami hazards were evaluated using data based on the Global Risk Data Platform (GRDP/UNEP) and other previous studies. Earthquake hazard data of GRDP/UNEP is based on the Global Seismic Hazard Assessment Programme (GSHAP) dataset. The index used represents expected Peak Ground Acceleration with

10% exceedance probability for the next 50 years. GSHAP data may not be detailed for the local level, however the regional level data was evaluated comprehensively. Nevertheless, it should be noted that as this is a study of the regional level, some advancements in localised earthquake hazard mapping in countries such as Indonesia and the Philippines could not be consolidated within the methodologies used.

Meanwhile, tsunami hazard data from the GRDP/UNEP is based on the data of the Global Assessment Report on Risk Reduction, designed by the International Centre for Geo-hazards. The index used represents a percentage of expected combined affected areas over a minimum period of 500 years. Based on this data, the hazard index value of each long-listed city was extracted from the maximum hazard index among identified areas within an approximately 10-km radius of city coordinates.

With regards to water-related hazards, the cities on the long list were assessed by their exposure to flood, tropical cyclones, monsoons, and typhoon (winds and storm surge), using open source data from UNEP/GRID. It should be noted that the database of UNEP/GRID is considered useful to evaluate and compare hazard assessment using the same assumptions, although data years are not completely up-to-date (latest being 2015/2016 data), and some evaluation process and methodology are not clearly stated.

The filtering process from long list to middle list further explored vulnerability and exposure analysis. It should still be noted that such analysis excluded AMS capital cities and small cities with populations under 10,000 inhabitants, regardless of their risk and exposure to various hazards. In addition, a more site-specific scoring analysis was undertaken with regards to regional seaports, airports, and industrial areas, as shown in Table 2.2.

Key Exposure		Scoring Grade by Conditions: 3 points	2 points	1 points	0 points
Key infrastructures	Regional airport (A) / Regional seaport (S)	Located within 10 km (A+S)	Within 10 km either A or S	Within 10-20 km range (A+S, A or S)	No faciliities
Agglomerate Industrial Area		Located within 10 km by multiple areas	Within 10 km by single area only	Within 10-20 km range by single or multiple	No faciliities

Table 2.2 Measurement Indicators and Scoring Grade for Key Infrastructures and Agglomerate Study Area (JICA Project Team, 2015)

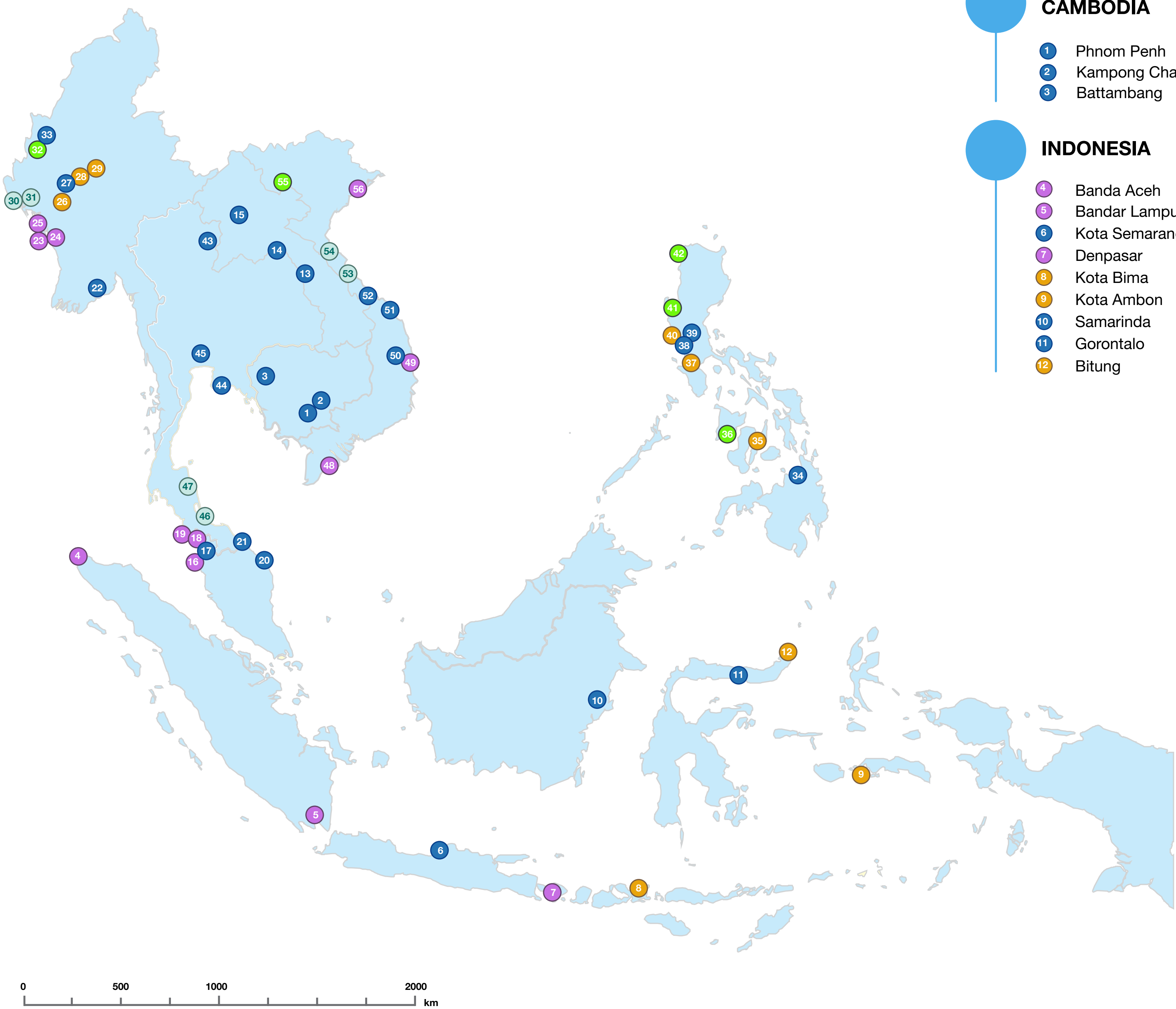
Based on the selected datasets, quantitative assessment for multi-hazards exposure was undertaken, including thorough normalisation of hazard parameters. The cities on the long list were assessed by a score by which each different value was provided based on 5km grid units. In other words, locations of cities identified by coordinates were automatically given by score on the grid of GRDP/UNEP through GIS spatial analysis. The assessment and index for the natural hazard and the exposure vulnerability (resulting from hazard-specific assessments) were evaluated in an integrated manner through a normalisation process utilising weight factor, which provides higher scores to factors of natural hazard points using a ten-point scale of score, while exposure and vulnerability are registered on a three-point scale.

After analysis was undertaken this step, 56 out of 817 cities (6.8%) were listed as part of the middle list. Selected cities are distributed primarily in Myanmar, followed by Indonesia, Malaysia, the Philippines and Viet Nam. It should be noted that numbers of cities with exposure to flood as its main hazard were the highest (34 cities – 60% of the total selected cities). Some cities home to multi-natural hazard potentials were not specified, in consideration of the principles regarding the demonstration project, and the associated difficulties in mitigation measures against multi-hazards and their probability. Therefore, cities with potential multi-natural hazards are listed only by a represented natural hazard. Lastly, as disaster risks in Brunei Darussalam and Singapore are lower than other AMS, the cities in these AMS do not appear in the middle list. Table 2.3 summarises the data for middle-listed cities, and Figure 2.7 indicates location of these cities and their corresponding primary hazard.

NUMBER OF CITIES WITH TYPICAL NATURAL HAZARD AND RISKS TYPE

COUNTRY	Earthquake	Tsunami	Flood	Tropical Cyclone Wind	Tropical Cyclone Surge	TOTAL
BRUNEI DARUSSALAM	-	-	-	-	-	0
CAMBODIA	-	-	3	-	-	3
INDONESIA	3	3	3	-	-	9
LAO PDR	-	-	3	-	-	3
MALAYSIA	-	2	4	-	-	6
MYANMAR	3	5	4	-	-	12
PHILIPPINES	1	1	4	3	-	9
SINGAPORE	-	-	-	-	-	0
THAILAND	-	-	5	-	-	5
VIET NAM	-	-	9	-	-	9
	7	11	35	3	0	56

Table 2.3 Distribution of ASEAN's Top 56 Cities Most At-Risk: per AMS and hazard type (JICA Project Team, 2015)



CAMBODIA

1. Phnom Penh
2. Kampong Cham
3. Battambang

INDONESIA

4. Banda Aceh
5. Bandar Lampung
6. Kota Semarang
7. Denpasar
8. Kota Bima
9. Kota Ambon
10. Samarinda
11. Gorontalo
12. Bitung

LAO PDR

13. Thakhek
14. Pakxane
15. Luang Prabang

MALAYSIA

16. Sungai Petani
17. George Town
18. Kota Setar
19. Langkawi Kedha
20. Kuala Terengganu
21. Kota Bharu

MYANMAR

22. Kyimyindaing
23. Manaung
24. Toungup
25. Kyaukpyu
26. Pwintbyu
27. Nyaung-U
28. Myingyan
29. Amarapura
30. Rathedaung
31. Mrauk-U
32. Hakha
33. Kale

PHILIPPINES

34. Butuan City
35. Mandaue City
36. Iloilo City
37. Batangas City
38. Cavite City
39. Meycauayan City
40. Olongapo City
41. Dagupan City
42. Laoag City

THAILAND

43. Nan
44. Wiang Sa
45. Pathum Thani
46. Ranot
47. Pak Phanang

VIET NAM

48. Bac Lieu
49. Qui Nhon
50. Anh Khe
51. Hoi An
52. Hue
53. Dong Hoi
54. Ha Tinh
55. Son La
56. Ha Long

Legend
Middle-Listed Cities
- Earthquake
- Tsunami
- Flood
- Cyclone Wind
- Cyclone Surge

Figure 2.7 Locations of ASEAN's Top 56 Cities Most-at-Risk (JICA Project Team, 2015)

Conclusion & Recommendation

The “Building Disaster and Climate Resilient Cities in ASEAN” project has provided a strong foundation for regional identification on cities at-risk in the ASEAN region, as well as highlighting a series of potential follow-up studies to understand the various risk profiles of the region. In fact, some of the cities already identified in Figure 2.7 were to form ‘ground zero’ for a number of notable disasters recorded in 2018 – including Kampong Chan in Cambodia during Tropical Storm Son-Thinh; Kuala Trengganu in Malaysia; Nakhon Si thammarat and Songkhla in Thailand; and various other cities in Indonesia, Myanmar, and Viet Nam (visit ASEAN Disaster Information Network at adinet.ahacentre.org for details). Nevertheless, further inquiries should be addressed as to the analytical steps that saw cities such as Palu City (Indonesia) and Tuguegarao City (Philippines) omitted through the process of filtering from long list to middle list. Both cities were heavily affected by disasters in 2018, with Palu experiencing an earthquake and tsunami, and Tuguegarao heavily impacted by Tropical Cyclone Mangkhut. Therefore, it is recommended to use ex-ante evaluation of disasters in 2018 and beyond for improving the secondary data of regional risk assessment at city level.

Beyond selecting cities for potential demonstration projects, the two-step Preliminary Risk Assessment (PRA) approach – including the middle and long lists of the cities, map layers and other attributes accumulated in the PRA process – could be considered for integration into the ASEAN Disaster Monitoring and Response System (DMRS), which forms the AHA Centre’s decision-making support system. This integration may further enrich the DMRS and support the prioritisation of regional response, in the event of disasters within the vicinity of such cities.

There is also a need for further study to investigate probabilistic scenario, and also consider non-traditional disaster scenarios. These may include considering a scenario similar to that utilised by ARDEX-18 (which focused on a combination of natural disaster and industrial accident), or the 2018 Sunda Strait Tsunami, in which a tsunami was triggered by a landslide of volcanic materials. As described in this chapter, there are more than a thousand industrial areas in ASEAN region. Therefore, recognising the rate of urbanisation and the development of new industrial areas, there may be a need for further research to assess industrial areas at-risk in the ASEAN region, and update the regional risk profile accordingly.

This chapter has covered the pressing issue of urban risk. However, questions remain on rural risks induced by failure of key infrastructures due to natural hazards. A case in point might be Kampong Cham in Cambodia and Xanamsay district in Lao PDR (both affected by Tropical Storm Son-tinh), as well as the exclusion of Pandeglang special economic zone and inclusion of Bandar Lampung City (see Figure 2.7). In following the processes of this assessment, both would have been excluded due to the number of population (less than 10,000). Hence, a dedicated study for understanding risks to ASEAN villages and rural areas with small cities/towns is integral. After events in 2018, future regional updates of risk profile may need to recognise the existence of key infrastructures (such as dams), as well as other types of special economic zones (tourism) for their calculations. In addition, with the exclusion of capital cities in this chapter, the authors suggest a need for a dedicated study for understanding the risks faced by ASEAN capital cities. Such a study should go beyond a generic risk assessment and government-driven contingency planning, and include elements such as business continuity planning across diverse stakeholders in capital cities.

Lastly, in this chapter we must recognise the limitation of preliminary regional risk assessment within the framework of “Building Disaster and Climate Resilient Cities in ASEAN” project – particularly the way it viewed and downscaled global datasets to a regional level, regardless of the fact that some local and country levels may hold more advanced relevant datasets. For instance, Indonesian earthquake hazard source maps or the Philippines tropical cyclone datasets are more advanced and robust than those used in the study reviewed in this chapter. Therefore, in account of the regional datasets gap, it is important to improve collectively so that datasets from other AMS can reach the level of more advanced countries, allowing regional risk analysis to be more precise, which can enable more calculated pre-disaster humanitarian pre-positions.

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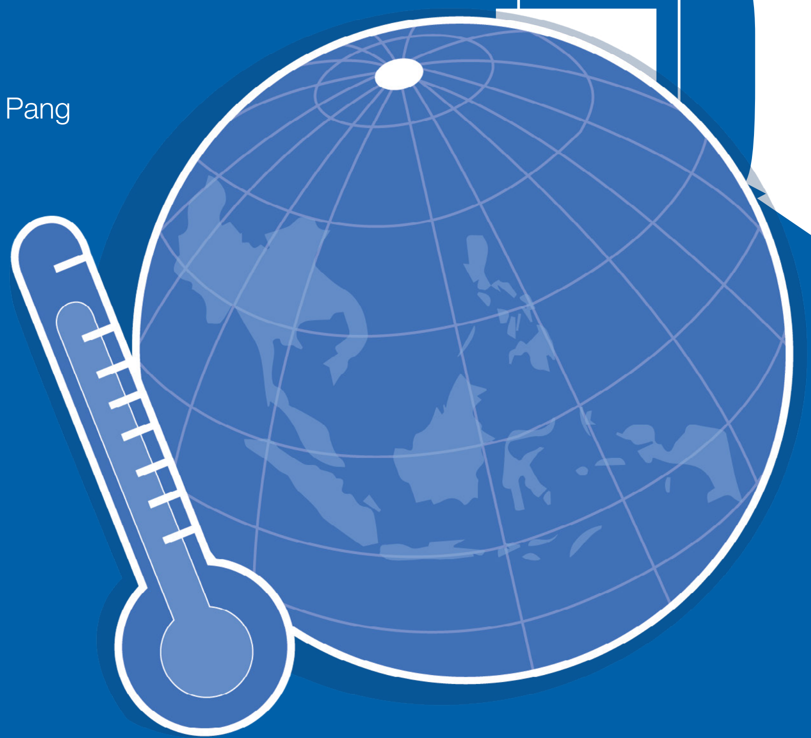
CHAPTER 3

Why Climate Change Matters for ASEAN



Author:
Qingyuan Pang

ARMOR

Abstract

Anthropogenic activities during the past century have resulted in increased pressure on the Earth and its atmosphere. These activities generate greenhouse gases, increasing global warming and hastening climate change. The impacts of climate change are profound and contain significant research area interests. Within ASEAN, the effects of climate change have been linked to extreme weather events, such as increased floods and severe droughts. These events impact water security, food security and yield, and the health and safety of the region.

This article seeks to briefly address how climate change is an overarching problem with serious impacts for ASEAN. We are at risk of driving ourselves toward increased insecurity. Therefore, this article appeals to policy makers, political office holders, disaster management professionals, and all other stakeholders and communities to adopt a holistic approach towards the impacts of climate change, and to acknowledge that the threat to our existence is not just regional, but global.

Keywords: climate risk, impact of climate change, adaptation

3.1 Anthropogenic Activities and Link to Climate Change

Anthropogenic activities during the past century have resulted in increased pressure on the Earth and its atmosphere. During the last few decades, the combined global average land and ocean temperatures experienced a linear increasing trend (range of 0.65-1.06°C) between 1880 and 2012 (Figure 3.1) (Bannaga, Anna, Daniel, Lorraine, & Trejos, 2016). Houghton et al., 2001 have projected global mean surface temperatures (GMT) will increase by 1.4°C to 5.8°C between 1990 and 2100.

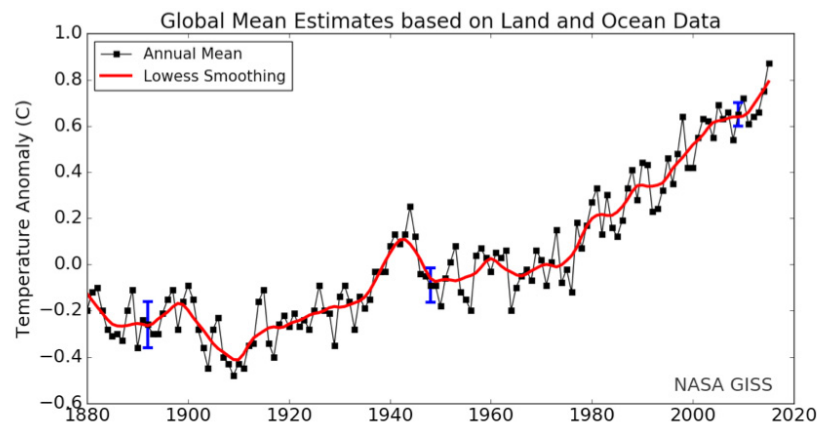


Figure 3.1 Global annual mean surface temperature change (NASA GISS, 2016)
(Image from http://data.giss.nasa.gov/gistemp/graphs/)

Increases in anthropogenic greenhouse gas (GHG) emissions were largely driven by industrialisation. Between 1750 and 2011, cumulative global anthropogenic carbon dioxide (GtCO2) totalled 2040 ± 310 (Figure 3.2) (IPCC, 2015). Findings from the Intergovernmental Panel on Climate Change (IPCC) 2014 report suggest that continued GHG emissions will cause further global warming and climate change. 30% of GtCO2 emitted was absorbed by the ocean, resulting in acidification (IPCC, 2015). To connect increasing GHG with natural disasters, however, it is not sufficient to show that the increase has led to increased temperatures or precipitation. A relationship between climate-related hazards and GHG is required, as research in this area can be controversial (Thomas, Ramon, Albert, & Perez, 2013). Even with the controversy surrounding climate change, there is still consensus in published research that human-induced climate change has taken place (Asian Development Bank, 2015b).

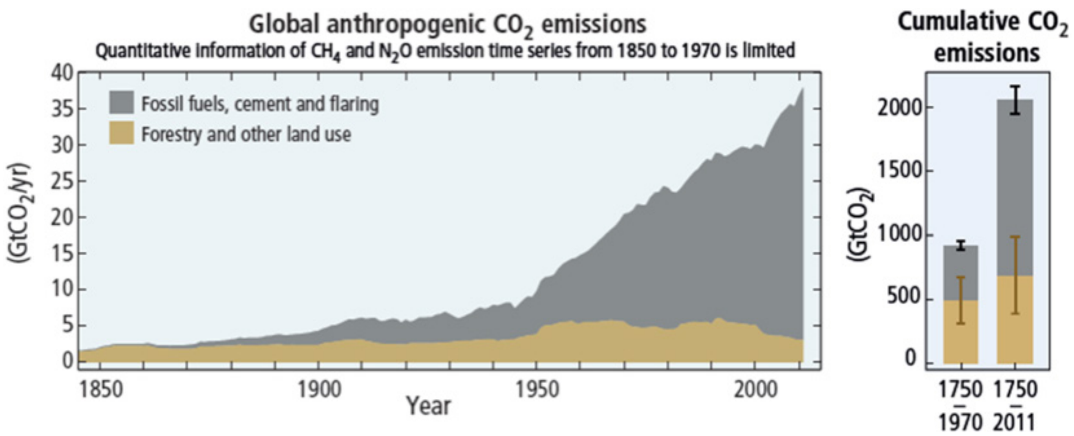


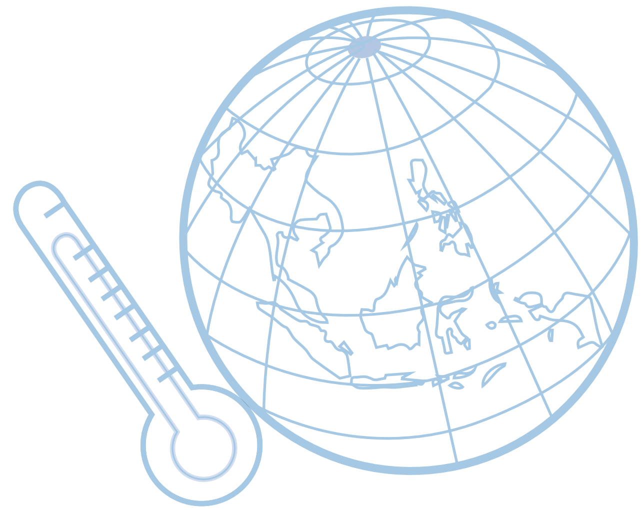
Figure 3.2 GtCO2 emissions between 1850 to 2012 (IPCC, 2015)
(Image from "Climate Change 2014: Synthesis Report")

As cities powered by energy progress, there is heavy reliance on fossil fuels and non-renewable energy sources to support transportation, power generation, industries and other activities. Anthropogenic activities continue to generate greenhouse gases which intensify the trend, driving global warming and hastening climate change. Figure 3.3 summarises examples of the impacts climate change may have on various sectors (water, ecosystems, food, coasts and health) with increasing annual global temperature. This paper does not seek to address all sectors, but seeks to expand the reader's understanding of the impacts on certain sectors.

3.2 Impacts of Climate Change on ASEAN

The impacts of climate change are profound with significant research area interests. ASEAN's population is approximately 634 million, making up 8.5% of the world's population. Collectively, it is the world's 6th largest economy, and the 3rd largest in Asia. The population has increased by 242% since ASEAN's inception in 1967 ("ASEANstats | ASEAN Statistics Web Portal," 2018). However, with increased population and rural-to-urban migration, the need for commercialisation and industrialisation increases, leading to a higher demand for fuel. This demand adds to the global warming phenomenon and contributes to climate change. The effects of climate change within ASEAN have been linked to extreme weather events, such as increased floods and severe droughts (Asian Development Bank, 2015b; Thomas et al., 2013). This has a profound impact on water security, food security and yield, and the health and safety of the region (Allen et al., 2014; Overland, 2017; Rebecca Shamasundari, 2017).

According to the Asian Development Bank, climate change coupled with economic and social progress has resulted in more than 75% of the Asian region facing water insecurity. This is also linked to the fact that more than 60% of the population rely on agriculture for their livelihoods. As climate change increases it is expected that by 2050, when the global population is projected to grow to 9 billion, an additional 2 billion people will need to survive with less water and less arable land under unstable climate conditions (Asian Development Bank, 2015c, 2015a). As recommended by Overland, 2017, there needs to be greater cooperation between ASEAN and IPCC in sharing research activities and data collection across ASEAN countries, to better mitigate the risks of maladaptation to climate change.



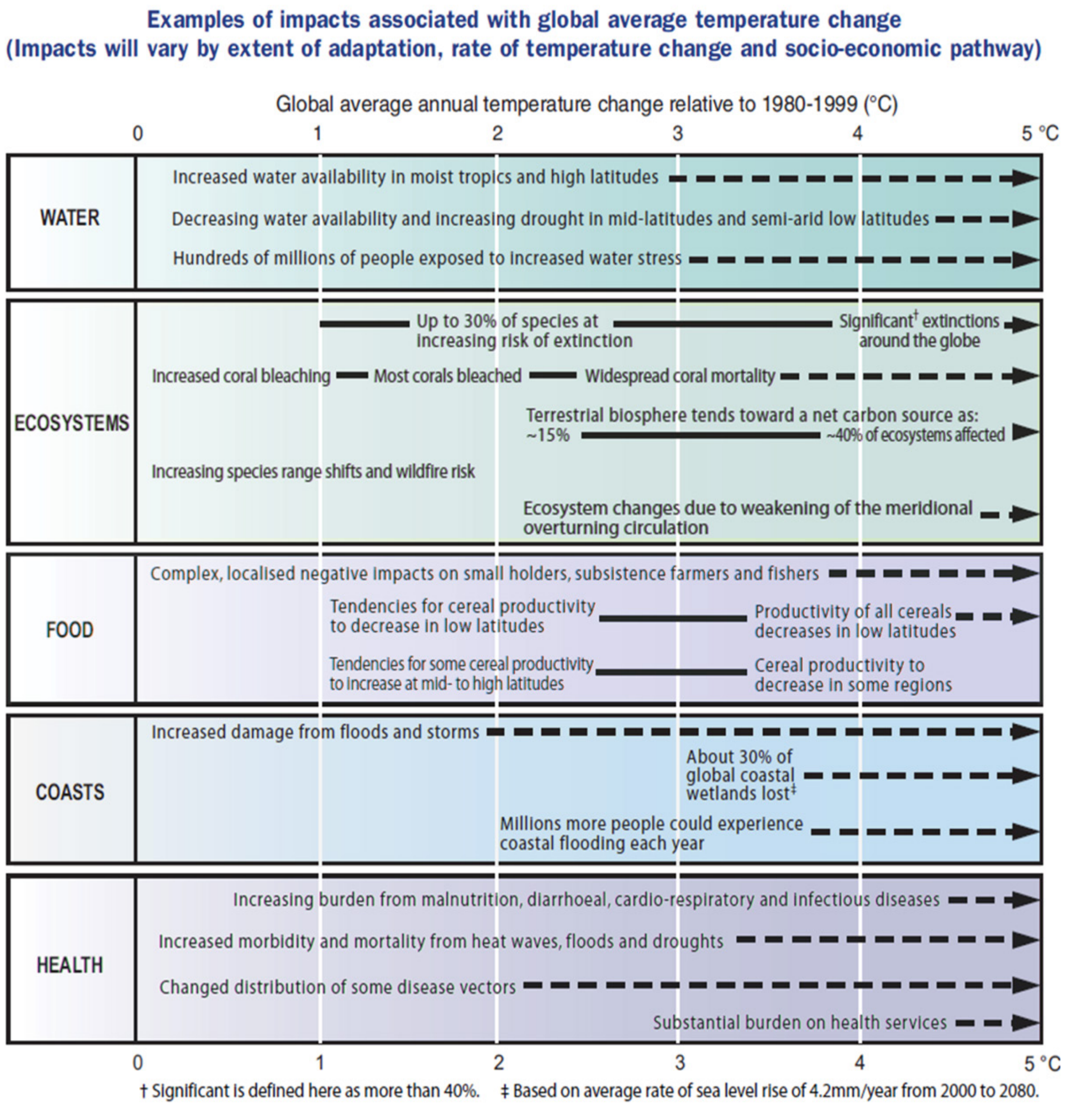


Figure 3.3 Examples of climate change impacts with global temperature change (Pachauri & Reisinger, 2007) (Image from "IPCC Fourth Assessment Report: Climate Change 2007")

3.3 Water (In)Security

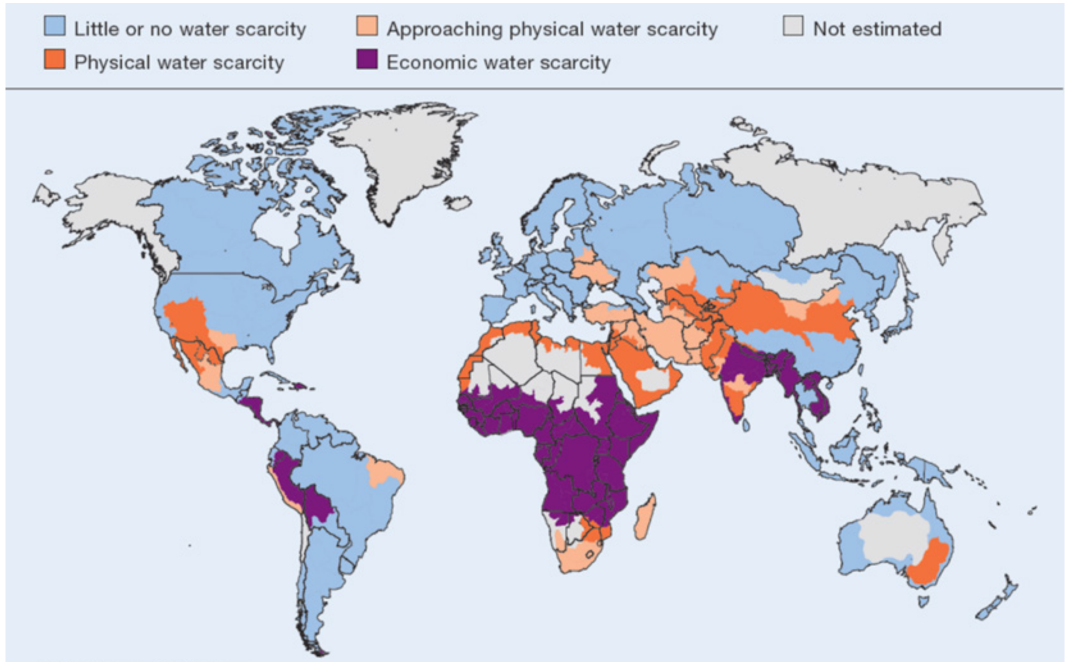
Climate change has the potential to place stress on hydrological patterns, water resources and management (Thomas et al., 2013). Using the hydrological model, Arnell, 1999 estimated that by 2025, around 5 billion people will be living in water-stressed countries. He described broad factors influencing the growth of future water use as 1) sustaining population growth; 2) adapting to industrial needs; 3) accommodating irrigation expansion; 4) managing water use efficiency and demand, and; 5) accommodating changing demands in environmental requirements. Climate variability, including changes in temperature, precipitation and evaporation will impact regional water resources. In a study conducted by Asian Development Bank in 2016, droughts and flooding are projected to increase in Southeast Asia (SEA), and regions that are already socioeconomically and geographically vulnerable (located in low-lying, high flood risk areas) will be impacted further by the underlying water and food insecurity (Asian Development Bank, 2016).

Increasingly, river and lake basins within Asia are being dammed, in an effort to reduce global greenhouse emissions by generating hydropower. This, however, creates a lot of friction and tension for water management issues within the SEA region (Ratner, 2003; Susanne, 2009; Weatherbee, 1997). However, when basins are transboundary with other countries controlling a stake upstream, the complexity of water management is exacerbated. Climate change adds another element of uncertainty to the water problem as authorities struggle to maintain the fine balance between drought and floods. The question remains regarding the approach ASEAN nations must adopt to tackle the issue of water insecurity.

A review by Hitz & Smith, 2004 distilled arguments that adverse impacts on water resource availability will likely increase with increasing magnitudes of climate anomaly. These arguments were based on considerations where future climate conditions may diverge from current conditions, for example, infrastructure and management systems may be inadequate to handle the frequency and severity of expected floods and droughts. In addition, while taking guidance from the Special Report on Emissions Scenarios (SRES), Arnell, 2004 concluded that the impact climate change would have on global water resources depends largely on the rate of emissions, assumed future changes in population, and the climate model used. Taking all this into consideration, water scarcity is a growing problem which needs to be urgently addressed.

As described in Earthscan's and International Water Management Institute (IWMI) publication, the problem of water scarcity is divided into physical and economic (Figure 3.4), where physical is characterised as a lack of abundant resources, and economic as a lack of infrastructure and investment to deliver these demands (Molden, 2013). As anthropogenic activities intensify, competition for water enters a new age, where demand for withdrawals from the supply must meet agricultural, industrial and population needs. Molden, 2013 states that factors underlying water scarcity will multiply and increase in complexity. Careful management, storage and control are the only sustainable measures to circumvent this issue.

Increasingly, river and lake basins within Asia are being dammed, in an effort to reduce global greenhouse emissions by generating hydropower. This, however, creates a lot of friction and tension for water management issues within the SEA region (Ratner, 2003; Susanne, 2009; Weatherbee, 1997). However, when basins are transboundary with other countries controlling a stake upstream, the complexity of water management is exacerbated. Climate change adds another element of uncertainty to the water problem as authorities struggle to maintain the fine balance between drought and floods. The question remains regarding the approach ASEAN nations must adopt to tackle the issue of water insecurity.



Definitions and indicators

- *Little or no water scarcity.* Abundant water resources relative to use, with less than 25% of water from rivers withdrawn for human purposes.
- *Physical water scarcity (water resources development is approaching or has exceeded sustainable limits).* More than 75% of river flows are withdrawn for agriculture, industry, and domestic purposes (accounting for recycling of return flows). This definition—relating water availability to water demand—implies that dry areas are not necessarily water scarce.
- *Approaching physical water scarcity.* More than 60% of river flows are withdrawn. These basins will experience physical water scarcity in the near future.
- *Economic water scarcity (human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands).* Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.

Source: International Water Management Institute analysis done for the Comprehensive Assessment of Water Management in Agriculture using the Watersim model; chapter 2.

Figure 3.4 Areas of physical and economic water scarcity (Image from Molden, 2013)

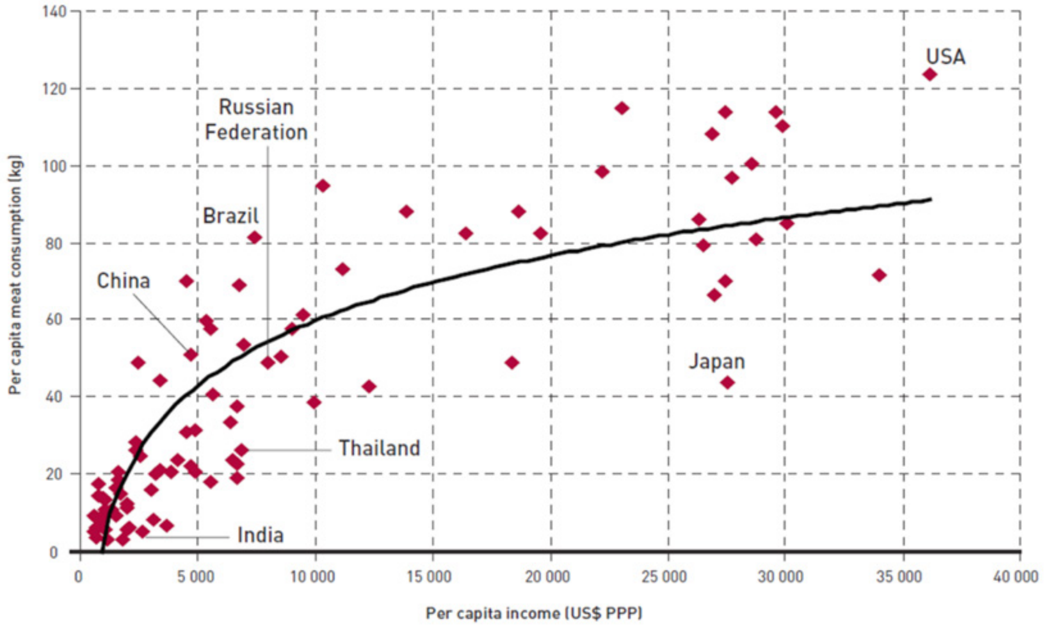
3.4 Water Resource and Linkage to Food (In)Security

At present, agriculture utilises 70% of freshwater withdrawals globally, amounting to 2,700km^3 out of 3,800 km^3 (Raskin, Gleick, Kirshen, Pontius, & Strzepek, 1997). Within SEA, irrigation water withdrawal for agriculture was an estimated 287 km^3 in 2006, which accounts for 84% of the total water withdrawal for that year. As irrigation is crucial in this region, the largest water withdrawals are expected to be at an annual rate of 1.25 km^3 to 342 km^3 per year (19.2% increase). This potentially adds up to 5% pressure on the water resources due to irrigation (Food and Agriculture Organization; Earthscan, 2011).

Increasing water demand has led to water quality deterioration resulting from changes in water flow, land clearing, and increased withdrawals by cities and industries. In order to fulfil demand irrigation areas will reduce, combining with other environmental events, while will impact future food security. Climate change potentially affects agricultural and food security as a result of altered evaporation, precipitation and water runoff patterns (Arnell, 1999; Hanjra & Qureshi, 2010).

To meet humanity's needs by 2050 on a 3000 kcal per person per day basis (assumption used by "Water for food, water for life"), a water gap of 3300 km^3 per year to sustain agricultural needs must be filled, which is a significant barrier to meeting future food demands. Changes in weather patterns will affect food availability, accessibility and agricultural yields adversely impacting food security (Hanjra & Qureshi, 2010; Molden, 2013).

Babinszky et al., 2011 and Thornton et al., 2009 examined the impact climate change has on animal husbandry. They described biological changes resulting from temperature changes and their potential effects on the food chain, from quality of feed, to quality and nutritional value of meat, eggs, and dairy products. However, the root of this problem is cyclical, where, with increasing per capita income, demand for and consumption of meat increases (Figure 3.5). To fulfil this demand, livestock production (accounting for nearly 80% of agricultural sector GHG emissions) is projected to double from 229,000,000 tonnes in 1999-2001 to 465,000,000 tonnes in 2050, exacerbating the problem. In addition, increased demand for water and grazing land to sustain the production will follow, adding stress to water scarcity and deforestation activities (Babinszky et al., 2011; McMichael, Powles, Butler, & Uauy, 2007; Steinfeld et al., 2006).



Note: National per capita based on purchasing power parity (PPP).
Source: World Bank (2006) and FAO (2006b).

Figure 3.5 The relationship between meat consumption and per capita income in 2002 (Steinfeld et al., 2006)

Besides terrestrial agriculture, potential impacts on aquaculture could exacerbate food insecurity. Major factors affecting aquaculture are summarised as 1) sea level rise resulting in saline water intrusion, potentially impacting freshwater fish and shrimp culture practices; 2) global acidification potentially affecting mollusc species growth; 3) increased ocean temperature affecting metabolism and reproductive efficacy; 4) increased susceptibility to diseases; and 5) loss of aquatic habitats. Figure 3.6 provides a clear summary of the elements of climate change impacting aquaculture and potential adaptive measures (De Silva & Soto, 2009; Khoshnevis Yazdi & Shakouri, 2010).

AQ./ OTHER ACTIVITY	IMPACT(S) +/-	IMPACT(S) TYPE/FORM	ADAPTIVE MEASURES
All: cage, pond; fin fish	-	Raise above optimal range of tolerance	Better feeds; selective breeding for higher temperature tolerance Increase feed input
FW; all	+	Increase in growth; higher production	Better planning; sitting; conform to cc; regulate monitoring
FW; cage	-	Eutrophication & upwelling; mortality of stock	None; monitoring to prevent health risks
M/FW; mollusc	-	Increase virulence of dormant pathogens	Fishmeal & fish oil replacement; new forms of feed management; shift to non-carnivorous commodities
Carnivorous fin fish/ shrimp*	-	Limitations on fishmeal & fish oil supplies/ price	None; but aquaculture will impact positively by reducing an external driver contributing to destruction and help conserve biodiversity
Artificial propagation of species for the "luxurious" LFRT*	(+)	Coral reef destruction	
SEA LEVEL RISE AND OTHER CIRCULATION CHANGES			
All; primarily in deltaic regions	+/-	Salt water intrusion	Shift upstream stenohaline species – costly; new euryhaline species in old facilities
	+/-	Loss of agricultural land	Provide alternative livelihoods – aquaculture: capacity building and infrastructure
Marine carnivorous fin fish *	-/+	Reduced catches from artisanal coastal fisheries; loss of income to fishers	Reduced feed supply; but encourages use of pellet feeds – higher cost/ environmentally less degrading
Shell fish	-	Increase of harmful algal blooms- HABs	Mortality and increased human health risks by eating cultured molluscs
Habitat changes/ loss	-	Indirect influence on estuarine aquaculture; some seed availability	None
ACIDIFICATION			
Mollusc/ seaweed culture	-	Impact on calcareous shell formation/ deposition	None
WATER STRESS (_ DROUGHT CONDITIONS, ETC)			
Pond culture	-	Limitations for abstraction	Improve efficacy of water usage; encourage non-consumptive water use aquaculture, e.g. CBF
Culture-based fisheries	-	Water retention period reduced	Use of fast growing fish species; increase efficacy of water sharing with primary users e.g. irrigation of rice paddy
Riverine cage culture	-	Availability of wild seed stocks reduced/ period changed	Shift to artificially propagated seed; ectra cost

EXTREME CLIMATIC EVENTS			
All forms; predominantly coastal areas	-	Destruction of facilities; loss of stock; loss of business; mass scale escapement with the potential to impacts on biodiversity	Encourage uptake of individual/ cluster insurance; improve design to minimise mass escapement; encourage use of indigenous species to minimise impacts on biodiversity

Temp. temperate; Tr.- tropical; LFRT - live fish restaurant trade; CBF- Culture based fisheries . * instances where more than one climatic change element will be responsible for the change.

Table 3.1 Impact of elements of climate change on aquaculture and potential adaptive measures (Image from De Silva & Soto, 2009)

3.5 Human Health and Diseases

Variations in weather patterns and conditions resulting from climate change can influence disease transmission patterns and impact human health (Figure 3.6). Climate variables such as temperature, precipitation, sunlight and wind affect survival, reproduction, habitat distribution and transmission environments (Epstein, 2001; Wu, Lu, Zhou, Chen, & Xu, 2016). Global climate change impacts on human health are dependent on, 1) host immune defences and living space; 2) pathogen characteristics and transmission modes; 3) vector distribution and breeding patterns; and 4) environmental factors (Figure 3.7).

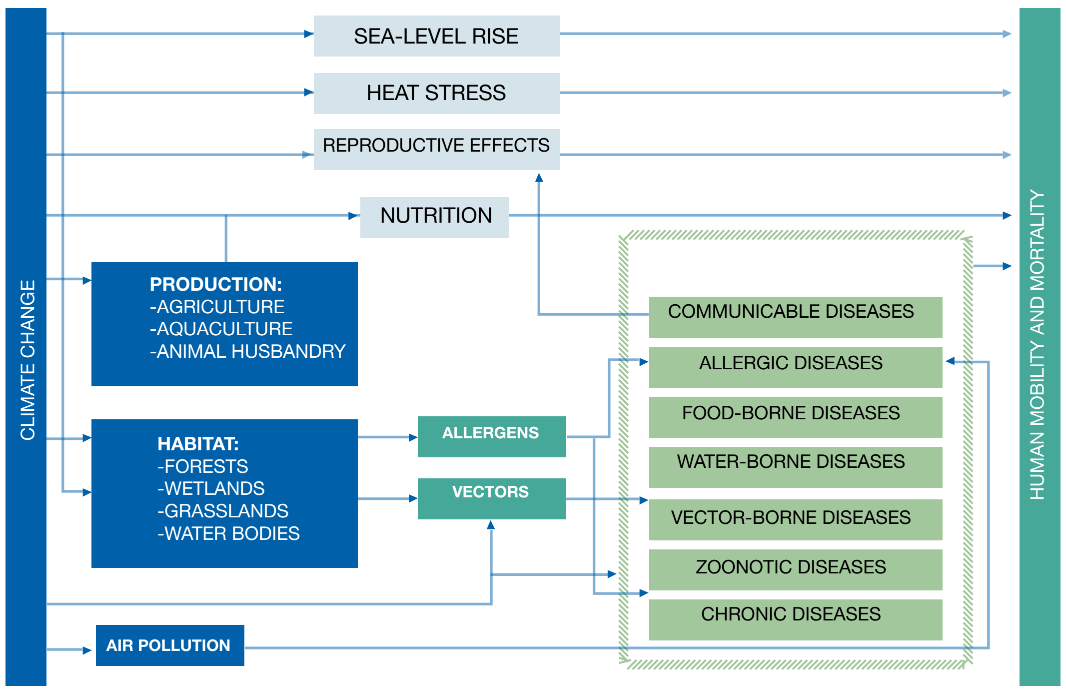


Figure 3.6 Effects of climate change on human health (adapted from Fig 10.1 of Hardy, 2003)

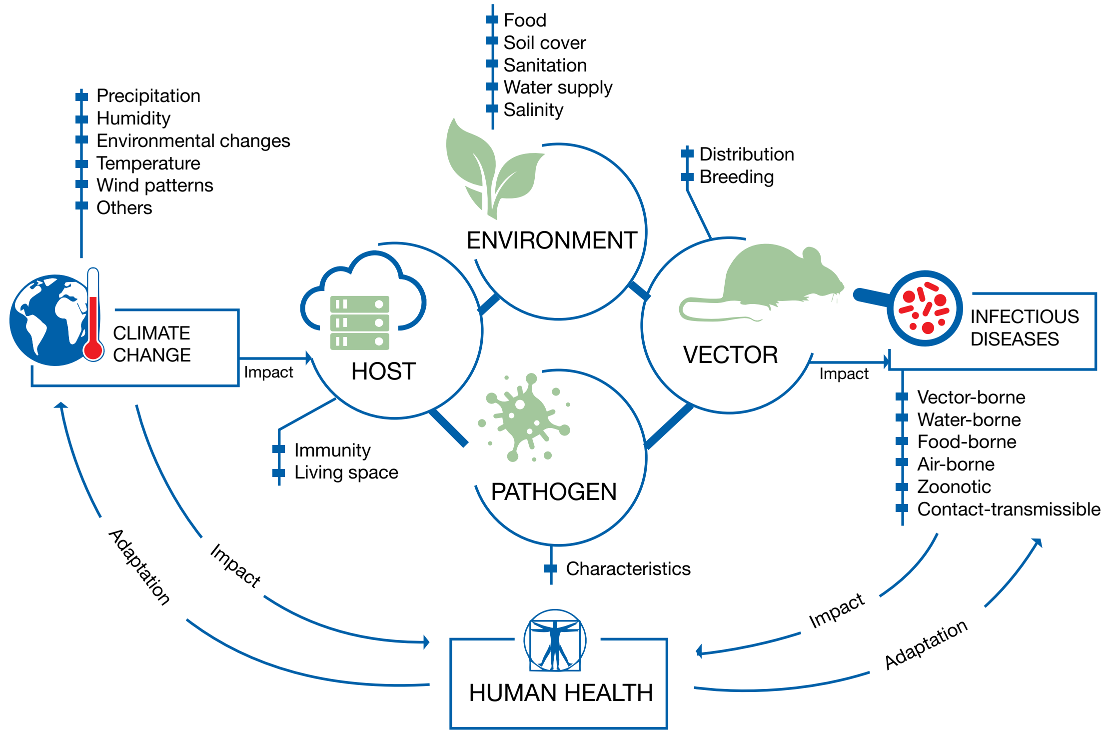


Figure 3.7 Schematic of impact of climate change on epidemiological pyramid, infectious diseases, and human health (adapted from Wu, Lu, Zhou, Chen, & Xu, 2016)

Climate change will affect disease prevalence and incidence, seasonal transmission and geographic distribution of vector-borne (VBD) and waterborne diseases. With increased temperature, pathogens and vectors breed faster, increasing infection efficacy and probability of transmission (Epstein, 2001; McMichael et al., 2007; McMichael, Woodruff, & Hales, 2006; Wu et al., 2016). Worrying trends include the potential range expansion of mosquitoes' distribution; increased incidence of water and soilborne diseases; and increased infection rates due to faster reproduction and maturation times (Epstein, 2001).

Compiling occurrence records of Aedes aegypti (2108) and Aedes albopictus (8040), Campbell et al., 2015 modelled a potential Aedes distribution pattern under Special Report on Emissions Scenarios (SRES) A1B conditions (see Annex A for SRES scenarios). Being efficient vectors of dengue, chikungunya and Zika virus, regions previously unaffected (Figure 3.8 lower map) are at risk of disease introduction by 2100 based on the model.

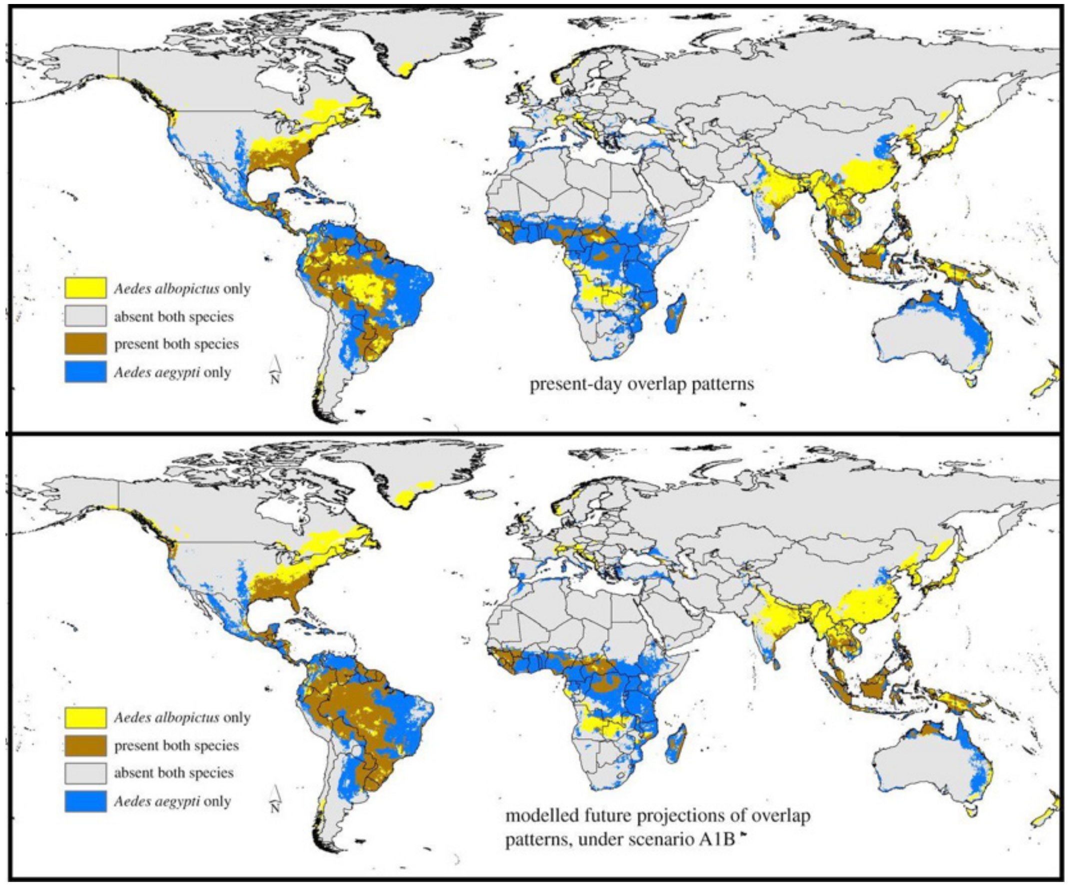


Figure 3.8 Potential vector distribution patterns derived from ecological niche models of A.aegypti and A.albopictus worldwide (image from Campbell et al., 2015)

Malaria is also another concern where warmer climates shorten the reproduction and incubation times of malarial parasites, increasing infection efficacy of Anopheline mosquitoes (carriers of malaria). Plasmodium falciparum takes 26 days to mature at 20°C, while an increase in 5°C decreases maturation to 13 days. Given the short lifespan of the vector (3-4 weeks), increased temperatures enable parasites to mature faster, raising the probability of transmission (Epstein, 2001; McMichael et al., 2006; Zell, 2004). Furthermore, sea-level rise contributing to saline water intrusion affects the breeding habitats of these vectors (brackish waters), meaning it will expand inland, raising the risk to human health (Griffitts, 1921; Zell, 2004).

Extreme weather events caused by climate variability have resulted in periods of torrential rain, floods, droughts, and storms. These hydrological and meteorological events potentially lead to greater risk of food and waterborne disease transmission, such as salmonellosis and cholera. As populations are affected and displaced due to such extreme events, overcrowding in relief shelters will be commonplace. Such overcrowding and unsanitary conditions present conducive environments for outbreaks of diarrheal illness such as cholera and cryptosporidiosis (McMichael et al., 2006).

As rural-to-urban migration increases around the region, the risk of water supply contamination increases as infrastructure is unable to support the growing population in these densely populated cities (Coker, Hunter, Rudge, Liverani, & Hanvoravongchai, 2011; World Health Organization, 2016). According to the World Health Organization, additional deaths from diarrhoeal disease in children below 15 years which are attributable to climate change within Southeast Asia are expected to increase to 1,105 by 2030 (Bowen & Ebi, 2017). Therefore, water, sanitation and hygiene (WASH) interventions to keep up with the growing demands of the population are critical in keeping diarrhoeal disease incidence low as society progresses (Chakravarty, Bhattacharya, & Das, 2017; Coker et al., 2011).

Increasing eco-tourism and anthropogenic activities in ASEAN (extensive land-clearing for economic activities or to support displaced communities, industrialisation etc.) may drive communities towards unchartered habitats, increasing the risk of zoonotic disease transmission. Illegal animal trade, animals being driven from shrinking habitats and gradually moving towards human settlements in search of food, may also contribute to the increased risk of emerging infectious diseases (Coker et al., 2011). This is also in parallel with the mass migration or displacement of communities as water basins shrink, driving them towards populated areas to resettle (Weatherbee, 1997). These communities may introduce pathogens native to their area into these areas, whose populations have naive immunity to the pathogens. Such diseases may spread rapidly, creating stigmatisation and driving social segregation. All these factors may contribute to intra and intercommunity conflicts, creating a basis for complex emergencies to emerge.

3.6 Coastal Erosion, Biodiversity and Greenery Loss

With rising sea levels projected to reach between 3 and 6 metres by 2030 (Figure 3.9) (Marzin et al., 2015), coastal areas face the threat of erosion. This impacts the efforts to preserve mangrove swamps, biodiversity and coral reefs. Coastal erosion in the region is also detrimental to SEA's aquaculture and agricultural output.

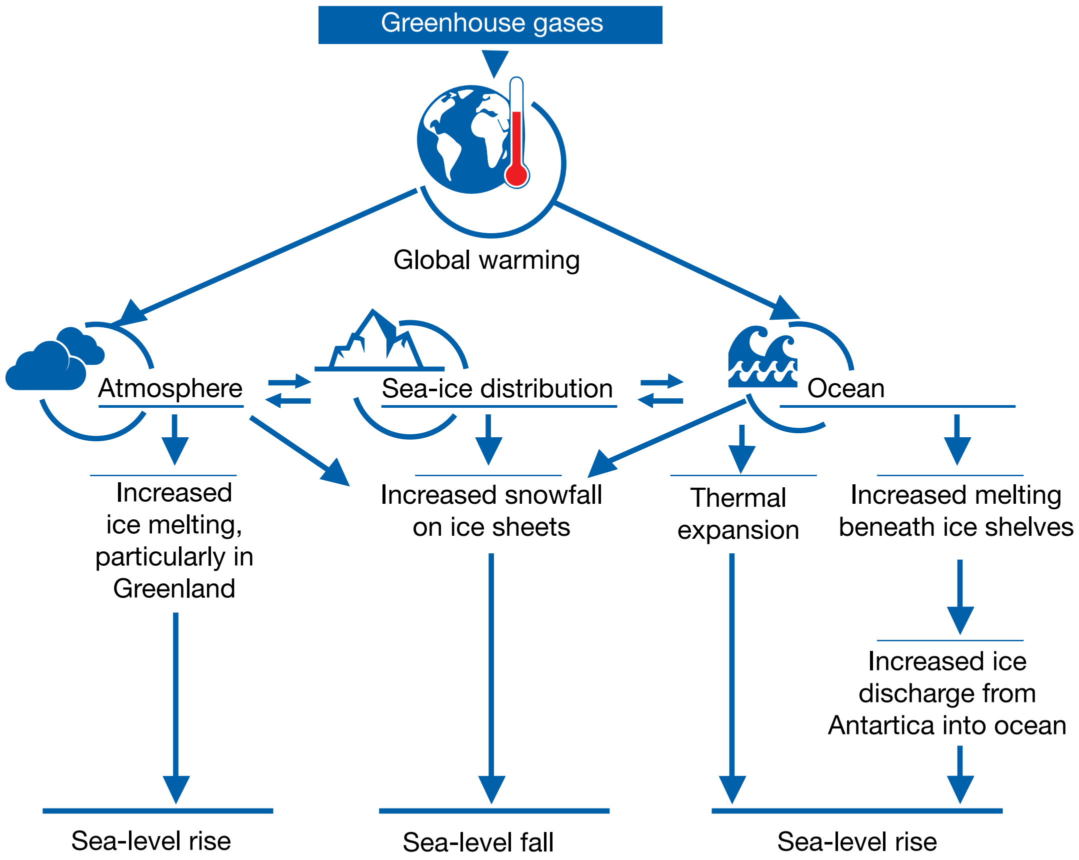


Figure 3.9 Processes related to global warming and sea level impact (image from: Titus, 1986)

Fish and seafood are major sources of protein and income within ASEAN. Four of the world's top ten largest fish producers are in ASEAN, namely Indonesia, Thailand, Viet Nam, and the Philippines. Overall production volume was recorded at nearly 22 million tonnes in 2010, with Myanmar adding a significant 4% ("Fisheries | ASEAN Investment," n.d.). This production accounts for a significant percentage in global trade of agricultural commodities.

Urban and economic developments, climate change and ocean acidification pose increasing threats to production and yields, which could severely impact food and economic security. Coastal and agricultural communities are highly vulnerable to such impacts as their main sources of livelihood will be adversely affected. As described by van Wesenbeeck et al., 2015, there is an increasing need to adopt long-term sustainable solutions and improve governance frameworks to mitigate and guide coastal infrastructure designs, including ground water extraction.

In addition to coastal erosion, biodiversity decline and loss in the region is increasing at an alarming rate. Deforestation rates are estimated to be around 14.5% of the regional forest cover lost within the last 15 years, at an average 1% rate of loss annually (Hughes, 2017; Stibig, Achard, Carboni, Raši, & Miettinen, 2014). Such an estimate is conservative as it is difficult to distinguish certain plantations from actual forest foliage (Sajise, 2015; Suneetha M., Alexandros, Ademola K., & Wendy, 2011). Sajise, 2015 stated the major causes of biodiversity decline (Figure 3.10) and how it threatens the region across several sectors.

The major causes of biodiversity decline in the region include the following (Sajise, 2011)

- rapid modernisation of agriculture that strongly favours monoculture and high-yielding varieties vis-a-vis traditional varieties and landraces;
- changing consumer tastes that tend tolessen biodiveristy in favour of just a few crops, breeds of animals, and other biological entities;
- rapid urban population increase partly as a result of migration from rural areas which results in the youth leaving farming, causing discontinuities in the practice of traditional agriculture that favours biodiversity;
- infrastructure development, pollution, and rapid land conversion resulting in the loss of agricultural land, natural forest, and aquatic areas; and
- poverty and lack of livelihood options resulting in human activities that destroy habitats.

Figure 3.10 Causes of biodiversity loss within ASEAN (Sajise, 2015)

Conclusion & Recommendation

Raising awareness of the impacts of climate change and how human activities contribute to it has always been a challenge. The effects of climate change are not always immediately apparent or even visible, as changes occur over extended periods. A thorough understanding of climate change requires significant investment in scientific research, which is not always accessible for those outside the scientific community. In the disaster management sector, few are convinced that climate change should be considered a slow-onset disaster. This is not only due to the fact that observed effects are difficult to identify, associate or even correlate, but also because mitigation strategies surrounding climate change involve broad, encompassing policies or actions that extend beyond the traditional understanding of the disaster management cycle.

The extent of climate change, its implications and complex relation to human activities are hardly conceivable unless one realises the situation is intricately linked with other sectors in ASEAN. It is therefore necessary to adopt a holistic approach and understand that the topics addressed in this article should also be linked back to the initial points on water, food insecurity and health issues. Biodiversity loss and poor land clearing practices pave the way for increased risk of landslides and floods (accounting for up to 71% of recorded disasters within ASEAN between 2012 and 2017) (ASEAN Coordinating Centre for Humanitarian Assistance, 2018), which eventually lead towards a destructive cycle where fertile topsoil is washed off, contributing biodiversity loss and adding further pressure to the biosphere and ecosystems within the region.

We are at risk of driving ourselves towards increased insecurity within the region. Therefore, it is crucial for policy makers, political office holders, disaster management professionals, and all other stakeholders and communities to adopt a holistic approach towards the impacts of climate change, while acknowledging that the threat to our existence is not just regional, but global. Climate change does not adhere to geopolitical boundaries; it must be tackled transnationally. Close cooperation between ASEAN countries is required, as ASEAN's interlinked geographies and economies are highly exposed to the effects of climate change. Should member nations not commit to working together to tackle climate change, ASEAN's future could be hanging in the balance (Arief & Shira, 2017).

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CHAPTER 4

State of Early Warning Systems in ASEAN

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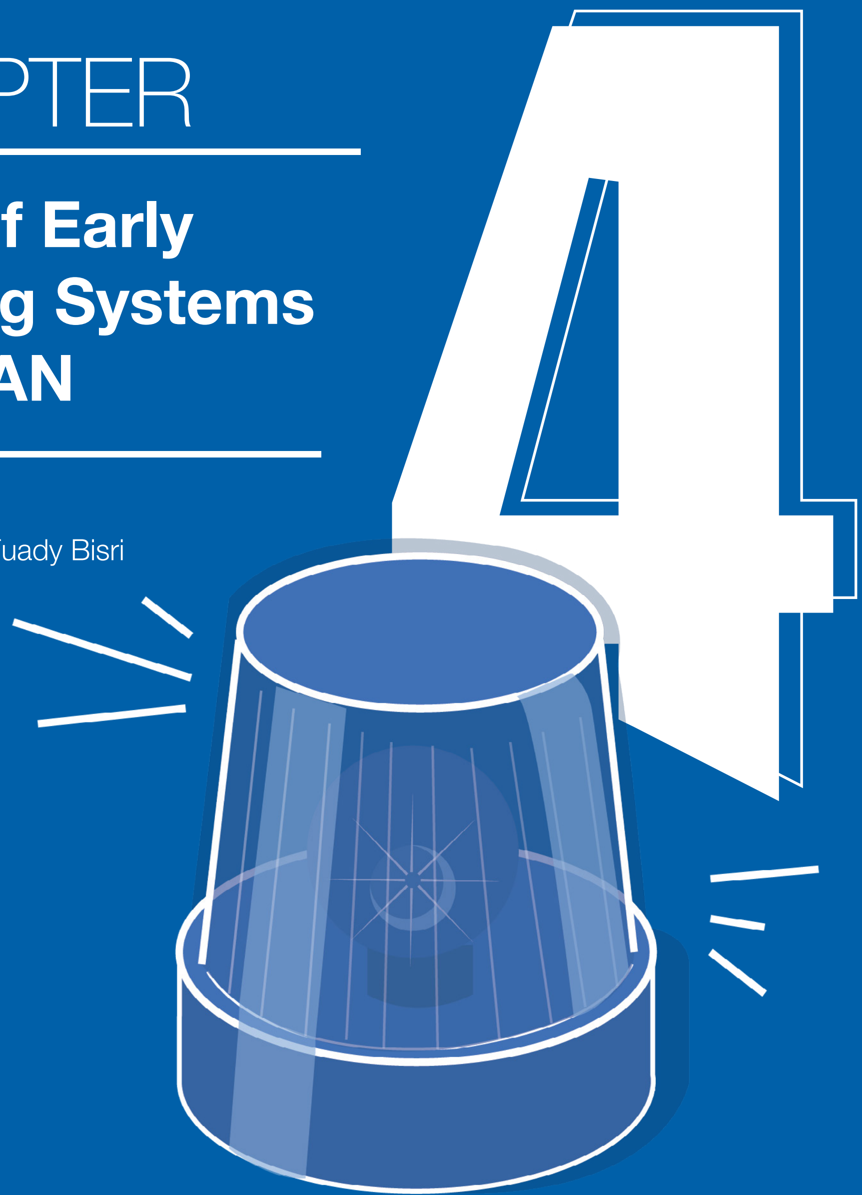


Abstract

This chapter provides a brief systematic review of operational Early Warning Systems (EWS) in each ASEAN Member State. Content analysis of four elements of end-to-end EWS was conducted, to understand the current condition of multi-hazard early warning systems in each country. The elements are risk knowledge, monitoring and warning, warning dissemination, and linkage to emergency response system. Social Network Analysis (SNA) was then conducted to model the structure of institutional arrangements for hazard and disaster data sharing, and inter-organisational dissemination of early warnings.

The review will address the current existence (or absence) of each EWS' operational connection with regional disaster monitoring and response systems, i.e. the ASEAN Disaster Monitoring and Response System (DMRS). It will also investigate seven types of hazards that the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management focuses on, and will elaborate on the new and emerging risks that the region should incorporate into its regional monitoring efforts. The disasters that prompted an ASEAN regional response in 2018 demonstrated gaps, limitations, and the need for improvement in national and regional level EWS, for example, the Xe-Pian Xe-Namnoy Dam Collapse following Tropical Storm Son-Tinh in Lao PDR, and the Central Sulawesi Earthquake and Tsunami, and Sunda Strait Tsunami in Indonesia. A strategic recommendation for improving national and regional EWS is also provided.

Keywords: disaster alert, early warning system, social network analysis

4.1 Introduction

The severe destruction of coastal cities in several ASEAN countries caused by the 26 December 2004 Indian Ocean Tsunami (IOT), is a devastating example of what can occur when there is a complete absence of an Early Warning System (EWS) as part of an overall disaster management system. Following the 2004 IOT, various initiatives were implemented to improve capabilities in reducing the risk of tsunami, and disaster risks in general, both at international and state levels. The IOT is said to have expedited the adoption of the Hyogo Framework for Action on Disaster Risk Reduction (DRR) during the 2005 United Nations World Conference on Disaster Risk Reduction in Kobe, Japan (Lovholt, et al., 2014). At the regional level, the decision to implement the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) was also accelerated by the effects of the 2004 IOT.

Triggered by the development of tsunami EWS after the 2004 IOT, the United Nations Educational, Scientific, and Cultural Organisation (UNESCO)'s Intergovernmental Oceanographic Commission (IOC) was requested to establish an Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS), which was formally established in June 2005 through Resolution IOC-XXIII-12. Its mandate is to promote the exchange of seismic and sea level data for rapid tsunami detection and analysis, to provide warnings for such events, and to coordinate mitigation efforts among its 24 member states (IOC, 2016). It was also tasked to align itself with the Pacific Tsunami Warning Center (PTWC), which was established in 1965 and anchored by the US, Japan and Chile, for servicing its member states in the Pacific Ocean. At the national level the Indonesian Tsunami Early Warning System (InaTEWS) is in place (BMKG, 2012). According to the ICG/IOTWMS' terms, it has two components: an upstream and a downstream channel of early warning. In the upstream, the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG) assumes the dual role as one of the Tsunami Service Providers (TSP), and as the National Tsunami Warning Centre (NTWC). It is expected to disseminate earthquake information and tsunami early warnings to all other organisations in the downstream channel to ensure effective response, e.g. to the Indonesian National Disaster Management Authority (BNPB), and the Provincial Disaster Management Agency (BPBD). Similarly, other earth observation and EWS are continuously developed in each of the ASEAN Member States, such as volcano monitoring, earthquake alerts, and EWS for floods and landslides. These will be examined in this chapter.

Amid the continuous progress of risk assessment and investment in EWS at the sub-national and national levels of ASEAN Member States, the ASEAN Disaster Monitoring and Response System (DMRS) continues to operate as the official regional tool for providing early disaster information. Continuous updates at the regional level, which leverage the advances made among the Member States are crucial. Therefore, this article will provide a review of the operational EWS in each ASEAN Member State. Gaps and levels of system integration, as well as hardware and software conditions, will be identified.

This paper will investigate the current state of geophysical and meteorological hazard warnings provided in each Member State, which are often operated by non-National Disaster Management Organisations (NDMOs). It also addresses what kind of information is provided, and the method of delivery. It also attempts to identify whether all Member State's sub-systems are linked to the DMRS. Recommendations for further integration into DMRS are made, to improve the inter-operability of EWS, and to improve the response time (speed), scale, and solidarity of ASEAN's collective response. This chapter also serves as a summary of the day-to-day process of hazard, risk, and disaster monitoring and analysis conducted by the AHA Centre Emergency Operations Centre.

4.2 Components of Early Warning Systems and Methodology

The United Nations International Strategy for Disaster Reduction (UNISDR) defines the term 'early warning system' as "the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organisations threatened by a hazard to prepare and act appropriately and in sufficient time to reduce the possibility of harm or loss" (2009). The architecture of each country's EWS is subject to the institutional arrangement within its entire disaster management system, and the level of development of each country's disaster management system varies. In a background paper prepared for the 2015 Global Assessment Report on Disaster Risk Reduction, the World Meteorological Organization (WMO) synthesised the status and trends of global EWS development. The WMO (2015) identified four elements of an effective 'people-centered' EWS, namely risk knowledge, monitoring and warning service, dissemination, and emergency response capacities. These elements maintain the components that originated from the 2006 checklist of the 3rd Early Warning Conference (UNISDR, 2006).

However, the WMO highlighted global trends revealing that the effectiveness of those four elements are subject to whether they are "underpinned to appropriate legislative, legal frameworks and policies, organisational coordination and cooperation mechanisms, feedback mechanisms to improve the system over time and appropriate allocation of resources, as well as inter-linkages of coordination and communications among elements" (WMO, 2015, p. 11). Accordingly, the first step of this paper is to use content and description analysis to gauge to what extent these four EWS elements – and in the Indonesian context, their necessary legal and policy aspects – have been fulfilled at the local level. The working definition of these EWS elements and their key indicators for assessment in ASEAN can be found in Table 4.1. For each of the criteria and its indicator, a qualitative five-level of valuation is applied:

- Very strong
- Strong
- Moderate
- Weak
- Very weak

and thus to achieve maximum point the system at national level should fulfil three levels of an EWS presence, i.e. availability, functionality and access to each component of EWS elements.

Elements	Working definition	Availability of …' AND 'Functionality of …'AND 'Access to …
1 Risk knowledge	Risks are analysed and this information is incorporated into the warning messages	(1A) Hazards document/map/platform (1B) Risk document/map (1C) Disaster record and database
2 Monitoring and warning service	Hazards are detected, monitored, and forecasts and hazard warnings are developed	(2A) Device for source of hazards monitoring (2B) Presence-of specialised agency (e.g. geological/meteorological) (2C) Open access to hazards monitoring
3 Warning Dissemination	Warnings are issued (by one national designated authority) and disseminated in a timely manner to authorities and public at-risk	(3A) Public sirens (3B) Variety communication devices (3C) Use of social media (3D) Dedicated EWS platform for disaster responders
4 Linkage to emergency response	Community-based emergency plans are activated in response to warnings, to reduce potential impacts on lives and livelihoods	(4A) Emergency Operation Centre (EOC) (4B) Evacuation plan/map (4C) Evacuation facilities and equipment, e.g. escape buildings (4D) Disaster drills and exercises
5 Legal and policy aspect	Legal and policy aspect enables strong inter-linkages between all EWS elements	(5A) Laws and regulation on early warning system (5B) Contingency Plan (multi or single hazard) (5C) Standard Operating Procedures for early warning dissemination

Source: Modified from WMO (2015)

Table 4.1 Components of Early Warning System

EWS activation varies in accordance with the nature of the risk itself. For example, in terms of tsunami EWS, the frequency of activation is generally lower as tsunamis are infrequent, and yet have the power to cause massive loss of life, significant economic losses and cascading effects such destruction of critical facilities (Lovholt, et al., 2014). A more frequent natural phenomenon is earthquakes which usually precede tsunamis; nevertheless, the reoccurrence level is also lower compared to other 'routine emergencies' such as fire or flood. Therefore, two of the challenges of tsunami preparedness is how to keep the preparedness of public offices and communities maintained, and how to track inter-governmental agencies' ability to effectively receive and activate EWS in between these infrequent disasters.

This research follows the approach of Choi and Brower (2006), who illustrated that a "simplified (social) network analysis process can be used to assist policy makers in creating more effective network structures for emergency management activities", i.e. by identifying gaps between inter-organisational networks of emergency responders. Huggins and Cui (2011) concluded that during the 2009 West Sumatra Earthquake response, there were differences between disaster management networks outlined in Indonesian Law 24/2007, and their actual activation. The research above used SNA to identify these gaps. SNA unravels the network structure of relationships among actors, and how these networks create social impacts (Scott, 2000). Further, as emphasised by Bisri (2016, 2017), there is a great need to continuously monitor the ability of bonding and bridging among organisations involved in Indonesian disaster management. SNA is critical for identifying the condition of early warning and emergency response, as has been shown in various countries with more advanced disaster management.

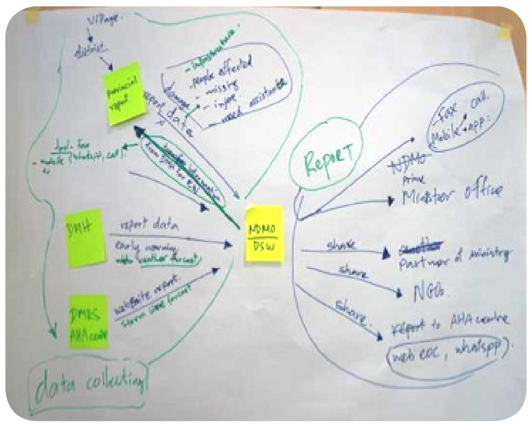
This chapter employs qualitative descriptive analysis and SNA to model the state of EWS in ASEAN countries. First, content analysis of four elements of end-to-end multi-hazard EWS was conducted to understand their current state in each country; i.e. risk knowledge, monitoring and warning service, warning dissemination, and linkage to emergency response system. In the Indonesian context, the legal and policy aspect was also examined. Second, it applies SNA to model and understand the structure of institutional arrangements for hazard and disaster data sharing and inter-dissemination of early warnings. In this paper, nodes depicted in the SNA model are government (or non-government) agencies that provide or receive hazards data and disaster early warning alerts, meanwhile the ties are reflecting operational linkages in terms of hazards data and early warning alert information sharing; the SNA model was generated using Ucinet Version 6.

The data collection for this article included analysing text from disaster-related secondary sources, such as early warning policy documents, technical manuals, and related websites in each ASEAN Member State. As part of data collection and verification, a mini workshop was organised by the author with participants of the AHA Centre Executive (ACE) Programme in November 2018. Due to professional profile of ACE participants as mid-level career officers of NDMOs, it was believed that they could enrich the discussion of investigating the current state of EWS in their respective countries. During the workshop, the ACE participants from each Member State were asked to illustrate the early warning information collection and dissemination process as indicated in Figure 4.1 below. In the context of this paper, input from ACE participants were used to verify secondary information on EWS in each ASEAN Member State.

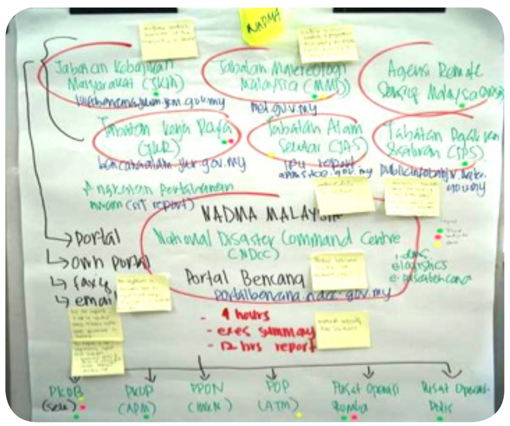
CAMBODIA

INDONESIA

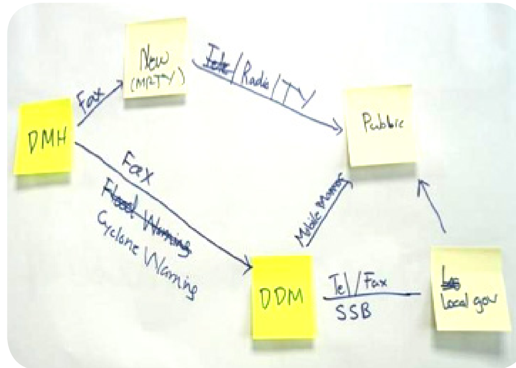
LAO PDR



MALAYSIA

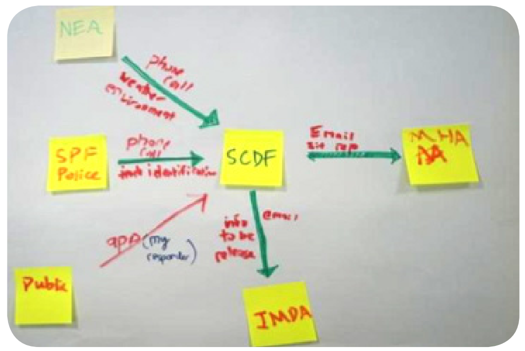


MYANMAR

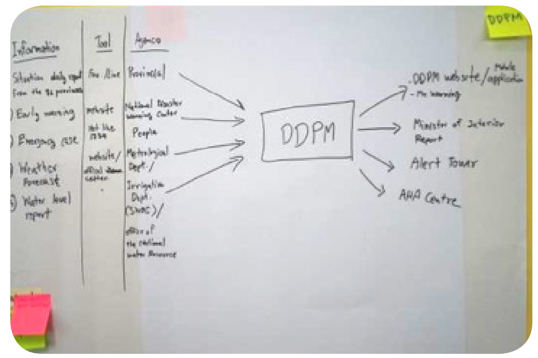


PHILIPPINES

SINGAPORE



THAILAND



VIET NAM

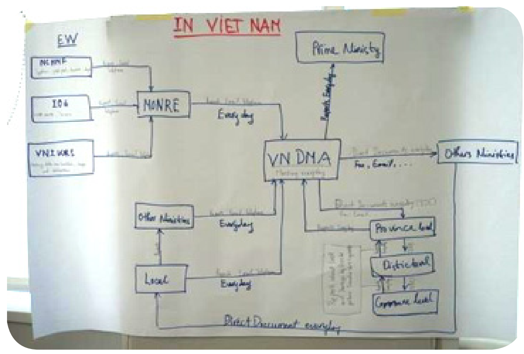


Figure 4.1

Illustration of Output from Workshop with ACE Participants on Early Warning Systems in ASEAN, November 2018

[1]See more on ACE Programme here: https://ahacentre.org/capacity-building/

4.3 Functional Early Warning System in ASEAN

This sub-chapter examines the state of functional EWS in ASEAN for seven core hazards: drought, earthquake, flood, landslide, tropical cyclone, tsunami, and volcanic eruptions. This is followed by preliminary assessment of the four elements of EWS in each Member State. Lastly, a network of EWS in ASEAN is presented.

Drought is an extended period characterised by deficiencies in a region's water supply, as a result of constantly below average precipitation. A drought can lead to agricultural losses, affect inland transportation and hydropower plants, and cause a lack of drinking water and famine. Early warnings for drought are difficult, as drought is not only influenced by atmospheric factors (e.g. precipitation), but also long-term geological conditions (e.g. soil characteristics or water volume or land use change), therefore differentiating between crisis from drought and crisis from water shortage may be misleading. In some countries such as Indonesia, a regular drought notification is issued by BMKG (Sari, 1st ARMOR).

To date, earthquakes in the ASEAN region are unable to be predicted. However, earthquake monitoring, and database and earth observation (e.g. changes in the earth's surface caused by tectonic activity) is available. Therefore, the locations of potential sources of earthquake, the level of vulnerability, and the history of earthquakes in each ASEAN Member State should be understood. Some Member States routinely update their earthquake hazard map (and its peak ground acceleration probability), and provide information regarding macro, mezzo, and micro-zonation of the earthquake hazard. For example, among other micro-zonation maps, Indonesia has released its updated 2017 Indonesian Earthquake Source and Hazard Map (Pusgen, 2017), and the Philippines has provided a micro-zonation for Metro Manila in the Valley Fault System Atlas and the Philippines Earthquake Model, a probabilistic seismic hazard assessment for the Metro Manila. Indonesia, Malaysia, Myanmar, the Philippines, Thailand, and Viet Nam have a dedicated programme for earthquake monitoring and alert system.

In the context of Southeast Asian region, flood is 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, e.g. dam or drainage channels. It can include riverine flooding, urban flooding, and coastal flooding, with details of the types and causes of floods displayed in Table 4.2 below. Due to the various types, the nature of flood early warning is not as straightforward as other risks, and the 'subjective' parameters in one Member State may not be applicable in another. For example, some floods in Singapore in 2018 (see ADINet for detail) may not be perceived as floods in Indonesia or Thailand. In most Member States a flood early warning system is in place for most major river systems in ASEAN, as well as in transnational rivers, such as the Mekong River (see detail in Mekong Flood Forecasting). In Singapore, the Public Utility Board installed CCTV across the city for alerting flood risks, while some Indonesian cities have also incorporated citizen reporting as part of flood EWS, e.g. as can be seen in petabencana.id.

TYPES OF FLOODING	CAUSES: NATURALLY OCCURRING	CAUSES: HUMAN-INDUCED	ONSET TIME	DURATION
Urban flood	Fluvial (river), coastal, flash, pluvial (overland), groundwater	Saturation of drainage and sewage capacity, Lack of permeability due to increased concretisation, faulty drainage system, and lack of management	Varies depending on the cause	From few hours to days
Pluvial and overland flood	Convective thunderstorms; severe rainfall; breakage of ice jam; glacial lake burst; earthquakes resulting in landslides	Land use changes, urbanisation, increase in surface runoff	Varies	Varies depending upon prior conditions
Coastal flood	Earthquake, submarine volcanic eruptions, subsidence, coastal erosion	Development of coastal zones; Destruction of coastal natural flora (e.g. mangroves)	Varies but usually rapid	Usually a short time, sometimes takes a long time to recede
Groundwater	High water table level combined with heavy rainfall, embedded effect	Development in low-lying areas; interference with natural aquifers	Usually slow	Longer duration
Flash flood	Can be caused by river, pluvial or coastal systems; convective thunderstorms; GLOFs	Catastrophic failure of water retaining structures, inadequate drainage infrastructure	Rapid	Usually short often just a few hours
Semi-permanent flooding	Sea level rise, land subsidence	Drainage overload; failure of systems; inappropriate urban development; Poor groundwater management	Usually slow	Long duration or permanent

Source: Jha et al., 2012, pp. 56-57

Table 4.2 Type and Cause of Floods

Landslide is the movement of soil or rock and other materials due to slope failure, heavy rains or earthquake or anthropogenic activities such as deforestation, blasting, etc. These conditions increase landslide risk and the need for EWS is very site-specific. In Brunei Darussalam, Indonesia, Malaysia, and Thailand, landslide may be triggered when slope failure occurs due to heavy rainfall inducing soil saturation. Meanwhile, in the Philippines and Viet Nam, landslides are also treated as collateral risks due to tropical cyclone, and thus landslide warnings are part of tropical cyclone warnings. Indonesia pioneered the ISO 22327 guidelines for a community-based landslide early warning system, which has been implemented in 140 sites in various countries.

Tropical cyclone and wind-associated hazards may include a non-frontal storm system characterised by a low-pressure center, spiral rain bands and strong winds. Usually it originates over tropical or sub-tropical waters and rotates clockwise in the southern hemisphere and counter-clockwise in the northern hemisphere (southern Pacific/Indian Ocean). A typhoon is large-scale closed circulation system in the atmosphere above the western Pacific with low barometric pressure and strong winds that rotate clockwise in the southern hemisphere and counter-clockwise in the northern hemisphere. On average in the ASEAN region, particularly the Philippines, there are 20 cyclones per year, with around half also travelling across the South China Sea, threatening Viet Nam and other Mekong River countries. ASEAN DMRS follows the Saffir-Simpson Scale for tropical cyclone monitoring and early warning. The scale was also adapted by the Malaysian Meteorological Service, Indonesian BMKG, and the Philippines' PAGASA. Viet Nam's NCHMF, on the other hand, has its own tropical cyclone and alert levels.

"Tsunami is a series of travelling waves of extremely long length and period usually generated by disturbances associated with earthquakes occurring below or near ocean floors" (IOC, 2016, p. 12). Aside from earthquake, tsunami may occur due to disruption of the ocean column due to activities of volcanoes (e.g. eruptions or collapsed flank), submarine landslides, coastal rock falls, and large meteorite impact.

The ASEAN region is covered by two tsunami warning systems: Indian-Ocean Tsunami Warning System (IOTWS) and Pacific Tsunami Warning System (PTWS), coordinated through the Intergovernmental Oceanographic Commission (IOC). For each system, TSPs have been assigned and are responsible for delivering tsunami warnings to each NTWC, within the first eight minutes after detection. The TSPs of the IOTWS are: Indonesian Tsunami Early Warning System (InaTEWS) operated by BMKG; Joint Australia Warning Centre (JATWC); Indian Tsunami Early Warning Centre (ITWEC) operated by the Indian National Center for Ocean Information Services (INCOIS). The end-users of these TSPs are Indonesia, Malaysia, Thailand, and Myanmar. The TSPs of the PTWS are North West Pacific Tsunami Advisory Centre (NWPTAC) conducted by Japan Meteorological Agency (JMA), and USA Pacific Tsunami Warning Centre (PTWC), of which Indonesia and the Philippines are end-users.

Volcanic eruption may result in harmful effects such as rock fall, ash fall, lava streams, and noxious gases. Volcanic activity describes both the transport of magma and/or gases to the earth's surface, which can be accompanied by tremors and eruptions, and the interaction of magma and water (e.g. groundwater, crater lakes) underneath the earth's surface, which can result in phreatic eruptions (a steam eruption with no lava ejection). Another risk is potential disruption to the aviation sector. Hence, aviation stakeholder refers to the Volcano Observatory Notice for Aviation (VONA) that is globally recognised containing updates on volcanic activities and its potential impact to aviation sector.

Indonesia and the Philippines are home to active volcanoes. In Indonesia, PVMBG-Ministry of Energy and Mineral Resources (PVMBG) is responsible for volcano monitoring, and producing and disseminating alerts and early warning information. PVMBG provides a daily 'geological-disaster monitoring report' and operates web-based geological hazard occurrence monitoring, the MAGMA). Indonesia has four levels of volcano alert, as displayed in Table 4.3. When a volcano in Indonesia has reached Alert Level III (Siaga/ Standby) or IV (Awas/Warning), risks are imminent. In the Philippines, the PHIVOLCS is responsible for volcano monitoring, and producing and disseminating alerts and early warning information. The Philippines adopts five levels of volcano alert.

Table 4.3 summarizes the functional early warning systems in ASEAN Member States for seven principal hazards. In addition to ASEAN's DMRS, Indonesia operates InaAWARE and the nationally-developed Multi-Hazard Early Warning System (MHEWS) platform, Viet Nam operates VinAWARE, and Myanmar is in the process of establishing its own similar platform with the Pacific Disaster Centre.

For the analysis above, the author employs qualitative justification based on the criteria contained in Table 4.1 for all functional early warning system in ASEAN Member States. The results are contained in Table 4.2 and should be viewed as the latest available information as at the time of writing. As can be seen, in general, none of the Member States can be classified as having a very strong performance in all EWS components, with all ranging from moderate to strong. Attention should be given to the Member States which received a weak and very-weak assessment in some components. For example, in Lao PDR, all components are classified as very weak. Although in the past there have been working systems for flood modelling and forecasting, such capabilities were inactive towards the end of 2018. On the other hand, in Brunei Darussalam and Cambodia, in principle early warning information needs to be channelled into preparedness.

Hazard	Drought	Earthquake[2]	Flood	Landslide	Tropical cyclone	Tsunami	Volcano eruptions
ASEAN Member State							
Brunei Darussalam	N/A	N/A	Weather forecast website (BDMD)	N/A	Weather forecast website (BDMD)	N/A	N/A
Cambodia	N/A	N/A	EWS1294 (Dept. of Met)	EWS1294 (Dept. of Met)	EWS1294 (Dept. of Met)	N/A	N/A
Indonesia	Periodi-cal drought maps (BMKG)	InfoBMKG (BMKG); Magma (PVMBG)	Through web-based EWS in each major-river agency	Land movement hazard daily report (PVMBG)	Tropical Cyclone Centre (BMKG)	InaTEWS (BMKG)	Magma & Daily Report of (PVMBG)
Lao PDR	National Early Warning Centre DMH	N/A	National Early Warning Centre DMH	N/A	N/A	N/A	N/A
Malaysia	N/A	Website of MetMalaysia	InfoBanjir website (Dept. of Irrigation)	N/A	Website of MetMalaysia	N/A	N/A
Myanmar	N/A	DMH Website	DMH Website	N/A	DMH Website DAN app	DMH Website	N/A
Philippines	N/A	PHIVOLCS	PAGASA Flood alert	N/A	PAGASA TC alert	PHIVOLCS	Volcanoes daily report (PHIVOLCS)
Singapore	N/A	MSS Website	MSS Website PUB Website	N/A	MSS Website	MSS Website	MSS Website
Thailand	Thai-Water (HAII)	Earthquake TMD website & app (TMD)	ThaiWater website & app (HAII)	N/A	Metalarm (TMD) Weather Warning (TMD)	N/A	N/A
Viet Nam	N/A	N/A	NCHMF website	Landslide warning website (VN Institute of Geosciences & Mineral	NCHMF website	N/A	N/A

Source: various sources - consolidated by author

Table 4.3 Matrix of Functional Early Warning Systems in ASEAN[3]

[2]In ASEAN, this should be understood as 'earthquake notification' capabilities, which provide information of earthquake occurrence and potential collateral hazards following the main tremor, e.g. tsunami. As of 2018, none of the ASEAN Member States have the capability to provide public warning prior to the mainshock of an earthquake. This should be differentiated with the Japanese Earthquake Early Warning System (Kinkyu Jishin Sokuho), which provides warning before the strong tremor starts (3-5 seconds before mainshock, applicable for magnitude 6 and above). To the best of the author's knowledge, in the past 10 years there were formal G-to-G communications between Japan-Indonesia, Japan-The Philippines, Japan-Thailand, as well as through ASEAN/UN/donor channels, exploring the possibility of technical cooperation on such technology, however, this is yet to result in a prototype/pilot study/project or operational implementation as of 2018.

[3]The table consists of name of the system (provider and operator).

For the analysis above, the author employs qualitative justification based on the criteria contained in Table 4.1 for all functional early warning system in ASEAN Member States. The results are contained in Table 4.2 and should be viewed as the latest available information as at the time of writing. As can be seen, in general, none of the Member States can be classified as having a very strong performance in all EWS components, with all ranging from moderate to strong. Attention should be given to the Member States which received a weak and very-weak assessment in some components. For example, in Lao PDR, all components are classified as very weak. Although in the past there have been working systems for flood modelling and forecasting, such capabilities were inactive towards the end of 2018. On the other hand, in Brunei Darussalam and Cambodia, in principle early warning information needs to be channelled into preparedness.

EWS Component	1 Risk Knowledge	2 Monitoring and warning service	3 Warning dissemination	4 Linkage to emergency response	5 Legal & policy aspect
COUNTRY					
Brunei Darussalam	4.44	5.56	4.17	3.33	3.33
Cambodia	4.44	6.67	5.00	3.33	3.33
Indonesia	7.78	8.89	8.33	7.50	6.67
Lao PDR	3.33	5.56	3.33	3.33	3.33
Malaysia	6.67	7.78	5.00	5.00	5.56
Myanmar	5.56	5.56	5.00	4.17	4.44
Philippines	7.78	8.89	8.33	8.33	6.67
Singapore	7.78	7.78	7.50	7.50	6.67
Thailand	7.78	7.78	6.67	5.00	6.67
Viet Nam	7.78	7.78	6.67	5.00	6.67

Source: Calculated by authors based on fulfilment to criteria and indicators in Table 4.1. Range of value is 0-10 (value expressed is normalized).

Table 4.4 Classification of Early Warning Components in ASEAN Member States

Before analysis of the linkages between national hazard and early warning systems and ASEAN DMRS (managed by the AHA Centre with the support of Pacific Disaster Centre) commences, this section of the chapter briefly reviews other relevant regional bodies and mechanisms in the ASEAN region. They include the ASEAN Earthquake Information Centre (AEIC), ASEAN Specialised Meteorological Centre (ASMC), Mekong River Commission, and Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES). These bodies are mentioned here not because of their status (two of them are ASEAN entities), but because they are directly or indirectly concerned with regional hazards and disaster early warning systems. The author wishes to note that earth observation, hazards and risk assessment, and early warning for ASEAN is also conducted by entities outside the region. The point of this section is to highlight the fact that untapped resources for capacity building of early warning systems exist.

Discussion about the establishment of the ASEAN Earthquake Information Centre (AEIC)[4] dates from 1990, and was first put forward by directors of the meteorological services of ASEAN Member States. It was then formally inaugurated in October 2000 in the 40th Meeting of the Committee on Science and Technology, and then housed at BMKG. The AEIC facilitates exchange of earthquake data in the ASEAN region, and provides notification of earthquake and potential tsunami threats. Based on its operations during 2017-2018, AHA Centre's DMRS received earthquake data from BMKG, but as it also houses AEIC, this data is essentially the same. An examination of the operations during this period reveals that the threshold of AEIC alerts was set at M 6.5 and above. However, an earthquake with the potential to require a regional response could be triggered at a weaker magnitude, for example, at M 6.0, as in the case of the 2018 Lombok Earthquake. Furthermore, there were no periodic strategic discussions between the AHA Centre and the AEIC on disaster monitoring and analysis, such as agreeing to a list of regional stakeholders who will receive AEIC alerts, which would ensure critical consistency of their observations.

The ASEAN Specialised Meteorological Centre (ASMC) was established in January 1993 as a regional collaboration programme among the National Meteorological Services (NMSs) of ASEAN Member States. ASMC is hosted under Meteorological Service Singapore, in the National Environment Agency of Singapore. ASMC has two main roles: i) monitor and assess land and forest fires, as well as the occurrence of transboundary smoke haze for the ASEAN region; ii) conduct seasonal and climate predictions for the ASEAN region. The AHA Centre has been consistently present in the ASMC-led regular ASEAN Climate Outlook Forum, as its up-to-date regional weather reporting and sub-seasonal weather outlook are relevant to the AHA Centre's disaster monitoring and analysis processes. However, due to the absence of a mandate, there was no exchange of learning processes for improving collective regional early warning efforts for climatic disasters, e.g. on tropical cyclone monitoring. Tropical cyclone alert levels were also unsynchronised. Although the AHA Centre found information on trans-boundary smoke haze useful during 2017-2018, the end-user and response mechanism for this hazard did not lie with the AHA Centre.

In the Southeast Asian region, two other non-ASEAN bodies that provide hazard monitoring and disaster warnings to several Member States are the Mekong River Commission (MRC) and RIMES. The MRC is an inter-governmental organisation working with the governments of Cambodia, Lao PDR, Thailand, and Viet Nam to jointly manage Mekong River resources. China and Myanmar are also dialogue partners of MRC. MRC provides a shared tool for hydrology and river monitoring, flood monitoring and forecasting, and drought monitoring. At this stage there is no operational linkage between MRC and ASEAN DMRS, meaning information is manually collected if any potential hazards are detected by the AHA Centre.

The Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) is another intergovernmental institution owned and managed by its member states that operates inside Southeast Asia region. According to its official history account, RIMES evolved from the efforts of countries in Africa and Asia, in the aftermath of the 2004 Indian Ocean Tsunami, to establish a regional early warning system within a multi-hazard framework for the generation and communication of early warning information, and capacity building for preparedness and response to trans-boundary hazards". It was initially proposed by the Government of Thailand to the Special ASEAN Leaders' Meeting on January 2005. As the tsunami affected two continents, however, it was pushed beyond ASEAN.[5] Its members are mainly the national meteorological and hydrological services of the member states. ASEAN Member States that also participate in RIMES are Cambodia, Lao PDR, Myanmar, the Philippines, Thailand, and Viet Nam. For earthquake and tsunami warnings, RIMES provides information on the Indian Ocean in adherence with UNESCO/ICG protocols. For flood and drought, RIMES provides a closed decision-support-system for Cambodia, Myanmar, and the Philippines. There is no automated operational linkage between RIMES, the AHA Centre, DMRS, AEIC, or ASMC.

[4]http://aeic.bmkg.go.id/aeic/history.html

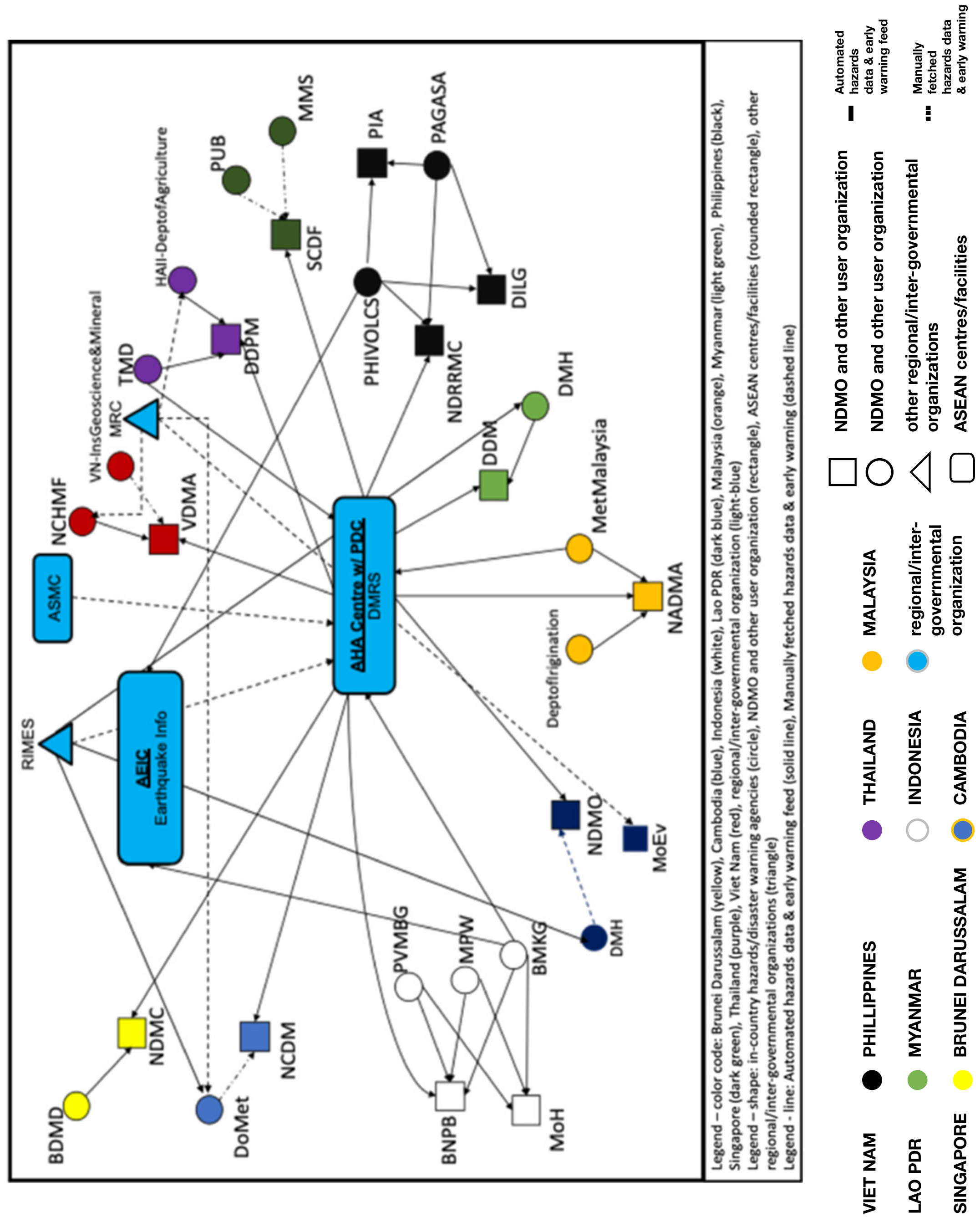
[5]As stated here http://www.rimes.int/?q=history and confirmed with an officer from RIMES.

Hazard	Drought	Earthquake	Flood	Landslide	Tropical cyclone	Tsunami	Volcano eruptions
Regional body/ mechanism							
AEIC	N/A	Yes, mailing list	N/A	N/A	N/A	Yes, mailing list	N/A
ASMC	Partially through regional sub-seasonal weather and climate outlook	N/A	N/A	N/A	Partially through regional sub-seasonal weather and climate outlook	N/A	N/A
MRC	Yes, for several AMS through website	N/A	Yes, for several AMS through website	N/A	N/A	N/A	N/A
RIMES	Yes, for several AMS through website & a closed system	Yes, open for public through website	Yes, for several AMS through website & a closed system	N/A	N/A	N/A	N/A

Table 4.5 Functional Regional Early Warning Systems

In this section of the chapter, simple network analysis is conducted to gauge the presence or absence of operational linkage between EWS in each Member State and various ASEAN-level platforms. For the Member States, a particular focus is also given to whether operational linkages exist, through various channels, between warning service agencies and their respective NDMOs. Two of the parameters for this are whether an NDMO's website refers to the other NDMOs' websites, and the formal warning advisory messages of other NDMOs. Furthermore, ASEAN DMRS linkages are identified through the presence/absence of data/information flow, either through 'push' or 'pull' actions by either system.

As can be seen in Figure 4.2, NDMOs in Indonesia, the Philippines, Malaysia, Thailand, and Viet Nam receive both hazards monitoring and disaster warning from the DMRS and in-country meteorological and/or geological agencies. Some of the meteorological agencies also receive data extracted by DMRS, e.g. Thailand Meteorological Department (TMD) and BMKG, but not others, e.g. NCHMF or PAGASA. It should be noted that the AHA Centre is also responsible for manually monitoring valuable data and information from in-country meteorological services that do not link with DMRS and/or the AEIC platform, e.g. data from PAGASA or Meteorological Service Singapore (MSS).



(Created by author based on secondary data and ACE Workshop)

Figure 4.2 ASEAN Early Warning System Networks

4.4 Notable Disasters in 2018 and Limitations of Current Network of Early Warning Systems

This sub-chapter will discuss three disasters in 2018 which highlight the current limitations of ASEAN EWS:[6] Tropical Storm Son-Tinh and the subsequent dam collapse in Xanamsay district, Lao PDR, and the Central Sulawesi Earthquake and Tsunami and Sunda Strait Tsunami in Indonesia.

For Tropical Storm Son-Tinh and the subsequent dam break, regional monitoring and early warning was effective, as demonstrated by provision of punctual flash updates as the storm moved from the Philippines to Viet Nam, and eventually affected weather systems across Cambodia and Lao PDR (AHA Centre, 2018). However, during its movement, Lao PDR's National Warning Centre website[7] was not functional, and even if it was functional, there was no data feed to the DMRS. Furthermore, there was no linkage between the data stream from dam monitoring through Mekong River Commissions mechanisms with ASEAN DMRS. The current system sent alerts by sending fax between the ministries. The AHA Centre EOC did receive advance notice between three to four hours before the dam break on 24 July 2018. This shows the absence of a linkage between mainstream hazards, and early warning of collateral hazards.

The Central Sulawesi Earthquake and Tsunami highlights the time-lag of early warning communication, and the impact of technical difficulties on reporting due to near-field tsunami. A powerful M 7.4 earthquake occurred on 28 September 2018 at 1702 UTC+7 in Central Sulawesi, Indonesia. The earthquake's epicentre was at 0.18 South and 119.85 East, 26 km north of the Donggala Regency, at a depth of 10 km (BMKG). Based on the location of its epicenter, depth of its hypocentre (the point of origin of an earthquake), and observed fault movement, it was triggered due to deformation of the strike-slip mechanism in the Palu Koro fault (BMKG). The earthquake affected more than 310,000 people in Donggala Regency (felt at VII-VIII MMI), and more than 350,000 people in Palu and Mapaga (felt at VI-VII MMI), and Gorontalo and Poso (III-IV MMI).

Following the earthquake, BMKG activated the tsunami early warning with Warning/Siaga alert status (anticipated tsunami height 0.5 3 metres) for the western part of Donggala Regency, and Advisory/Waspada (anticipated tsunami height 0-0.5 meters) for the northern part of Donggala Regency, Mamuju Regency and Palu City, with anticipated tsunami arrival time at 1722 UTC+7. Based on tide gauge observation at Mamuju station, the tsunami was confirmed at 17.27 UTC +7 and BMKG elevated the tsunami warning at 1736 UTC+7. Based on photos and videos in the media originating from Palu City, it seemed the tsunami height was higher than anticipated. Therefore, it is possible the shoreline shape of Palu Gulf may have amplified the wave resulting in increased height. Figure 4.3 shows the tsunami warning generated by the Indonesian Tsunami Early Warning System (BMKG-InaTEWS).

[6]See relevant AHA Centre information product here: https://ahacentre.org/flash-updates/
[7]It is currently working and available at www.newcdmh.com/newc/. However, even the current system is only equipped with 14 hydrologic stations for two watersheds, Sebangfai and Sebanghiang.

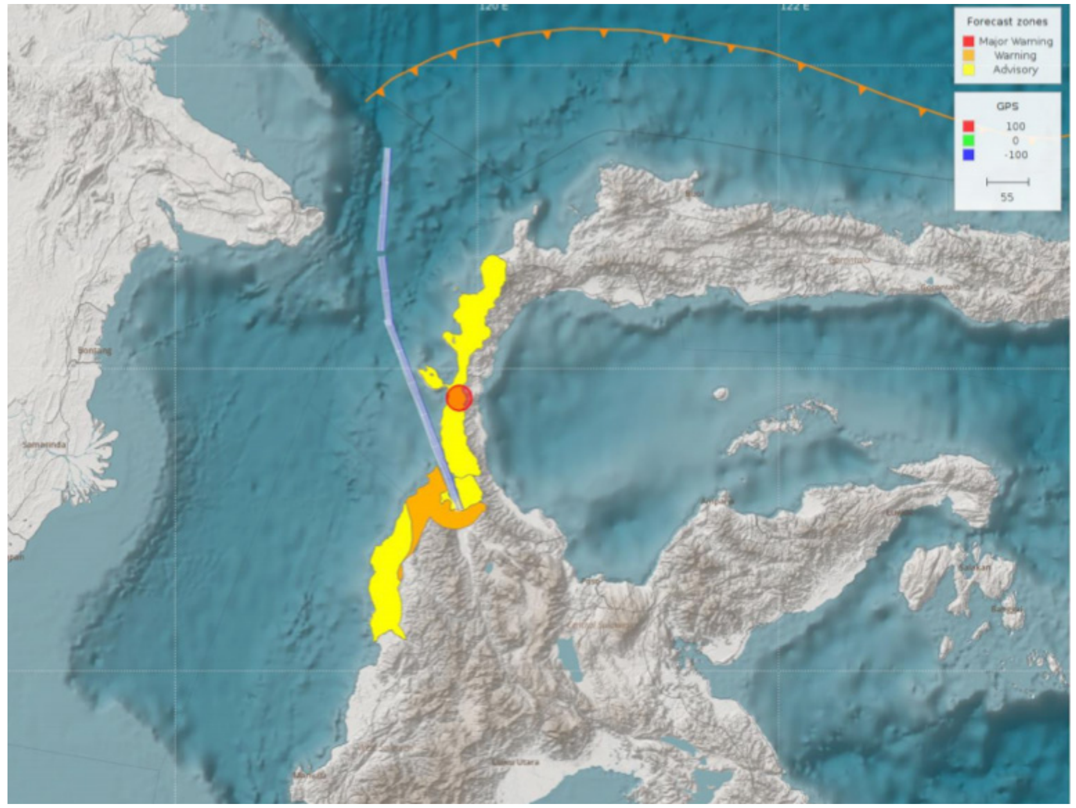


Figure 4.3 Tsunami warning generated in Indonesian Tsunami Early warning System (BMKG)

Based on the assessment of the Bandung Institute of Technology (ITB), the Indonesian Institute of Sciences (LIPI), and the Agency for the Assessment and Application of Technology (BPPT), as cited by BNPB, the tsunami was triggered by a combination and amplification of water displacement generated by both the M 7.4 earthquake and a sea-slide (landslide on the ocean floor at around 200-300 metres below the surface). The sea-slide occurred as sediment from rivers across Palu Bay had solidified, and collapsed when the earthquake occurred. Based on the various video observations, the first wave of the tsunami was significantly muddy as it was composed of water from Palu Bay, while the second wave was composed of clearer water from the outer Makassar Strait.

Based on the record in Indonesian Tsunami Early Warning System, BMKG produced an infographic of the timeline of the earthquake and tsunami events. The timeline reveals the extremely limited window during which people were able to evacuate, resulting in a high number of casualties. Despite the functional early warning system, the alerts were not successfully received by local stakeholder and the people, potentially due to damaged local infrastructure by the earthquake and the early arrival of the tsunami, which in some cases only 3 minutes after the earthquake (Weniza, et al., 2018).

Timeline of Tsunami Early Warning System

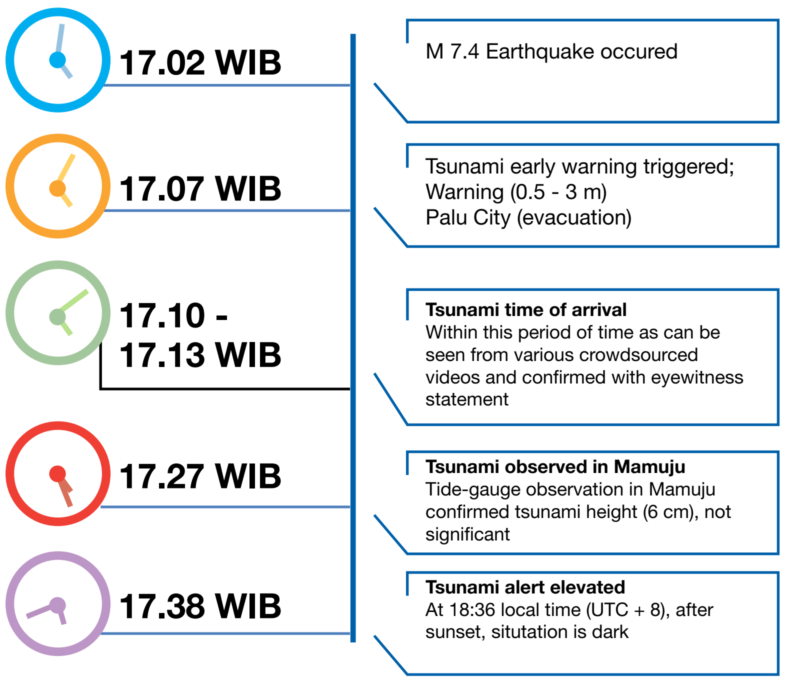


Figure 4.4 Timeline of Tsunami Early Warning System – Sulawesi Earthquake and Tsunami 28 September 2018 (Source: BMKG)

Finally, the Sunda Strait Tsunami on 22 December 2018 revealed InaTEWS' limitations in cross-hazard monitoring.[8] The case shows that although Anak Krakatau Volcano only received an Alert Level-2 warning, its relatively moderate volcanic activities still triggered landslide and flank collapse capable of generating a tsunami. Despite being very rare, this type of hazard has occurred before, for example in the Philippines due to Mount Taal, and in Nagasaki, Japan.

Preliminary reports from PVMBG indicate that the eruption tremors (the largest since June 2018) did not trigger the tsunami waves. It was, however, caused by the materials that fell around the volcano's body after the eruption, that were loose after being dislodged during the eruption in June 2018. To cause such a large tsunami there must have been a massive collapse which entered the sea water column, and this was later discovered to be the case (see Figure 4.5). However, the significance of this is that the loss of part of the volcano's flank resulting in landslide into the sea required considerable energy, which was not detected by the seismograph at the volcano observation post. Consequently, there was no follow-up tsunami warning from BMKG. The presence of tsunami sirens in Teluk Labuhan, Labuhan Subdistrict, and Pandeglang Regency had very limited effectiveness in providing warning to their populations.

[8]Full media statement of the author's perspective on this event can be found on the following link: https://www.facebook.com/watch/?v=516045068895833

Figure 4.5 Satellite Imagery indicating Flank Collapse of Mount Anak Krakatau triggering Tsunami (Source: GFZ Postdam)

The two tsunamis in 2018 also prompted public discussion on the effectiveness of InaTEWS compared to global tsunami EWS, with arguments citing lack of funds and maintenance, as well as security for its infrastructure, for example tsunami buoys.[9] Despite these arguments, it should be understood that by design, InaTEWS and global tsunami EWS were initially focused on international cooperation to reduce the risk of distant tsunami, e.g. the 2004 Indian Ocean Tsunami or 1960 Chile Tsunami, which affected the Philippines and Japan. Even if all tsunami buoys had been operational, the two tsunamis in Central Sulawesi were triggered by seaslide (near-field), and triggered by volcanic activity.

Regardless of the presence of scientific devices that could have detected the tsunami triggered by the Mount Anak Krakatau activity (Giachetti, Kelfoun, Ontowirjo, 2012), without policy to formally recognise the device, investment, and resource mobilisation, the benefit would still have been limited. One point often made during post-tsunami public debate is that according to Indonesian Law 31/2009, geophysical and meteorological phenomena and their warnings are within the jurisdiction of BMKG. However, volcano monitoring and warnings are within PVMBG under the Ministry of Energy and Mineral Resources. Therefore, data sharing is very limited and even in the Volcano Risk Map produced by PVMBG, formal recognition of potential tsunami threat due to volcanic activities is not available. Nevertheless, this matter is not limited to EWS technicalities, but should be addressed as part of the overall disaster risk governance.

Considering the trigger for the Sunda Strait Tsunami, ASEAN must be aware that there are other volcanoes in the region that have the potential to cause tsunamis, and some of them have triggered tsunamis in the past. According to a review by Paris et al., 2013, at least 17 different volcanoes in Southeast Asia generated tsunamis during the last four centuries. Collectively, there are 23 volcanoes in Indonesia, the Philippines, and Viet Nam that have the potential to trigger tsunami either due to earthquake (mainshock or aftershock), underwater explosion, caldera subsidence, pyroclastic flow, or flank failure).

There are also four volcanoes in Papua New Guinea that could potentially trigger a tsunami, which could travel (albeit with minor risk) to the ASEAN region. Paris et al. introduced three criteria to gauge a volcano's potential to trigger tsunami: the dimension of the volcano's flank, the location of the volcano in relation to the coastal area or its partially submerged complex, and its submarine structure. Based on these criteria, they identified 10 locations that have potentially tsunamigenic volcanoes in Southeast Asia. These locations include Mount Anak Krakatau. The other locations are the Maluku Islands, Sangihe Islands, the Banda Sea, and Lesser Sunda Islands (Indonesia); Taal caldera lake (the Philippines) (this region experienced volcanic events in 1965, 1911, 1754, and 1749); Babuyan Archipelago (northern Philippines); and Bismarck Sea and Rabaul (PNG). The location of these volcanoes is displayed in Figure 4.6.

[9]See for example: https://theconversation.com/reviewing-indonesias-tsunami-early-warning-strategy-reflections-from-sulawesi-island-104257

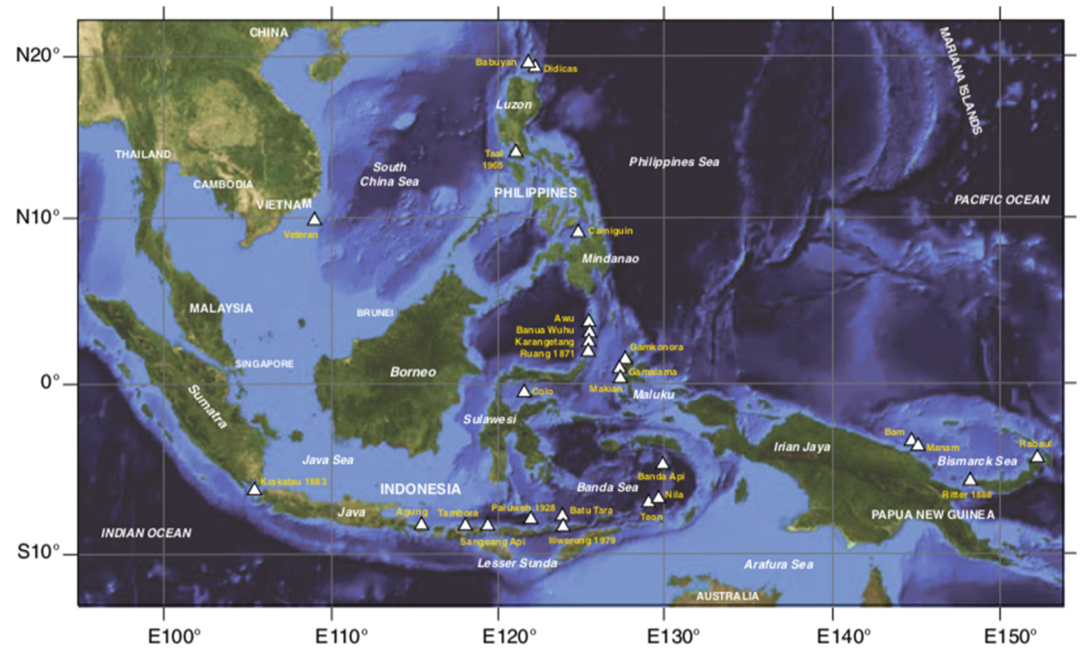


Figure 4.6 Map of volcanoes potentially triggering tsunami events and year of past tsunamis in Southeast Asian region (Paris et al., 2013)

Conclusion & Recommendation

The author would like to clarify the role of EWS networks in ASEAN. EWS at the regional level operate to enable regional EWS to save lives through early action in emergency response and humanitarian operations, such as through DMRS. This chapter has investigated the current state of functional EWS as well as current limitations. It also addressed the key components that need to be linked among EWS.

Some of the cases illustrated in this chapter indicate the importance of better linkages with in-country or ASEAN entities and mechanisms. Figure 4.1 and 4.2 reveal that not all key data and information ties exist between each Member State's early warning alert providers and their respective NDMOs, nor between NDMOs and respective ASEAN entities, e.g. AEIC and the AHA Centre through the DMRS. To strengthen the capabilities of DMRS, the author suggests a frequent regional audit and familiarisation with each EWS, coordinated by the AHA Centre, the AEIC and the ASMC.

This is crucial for improving regional knowledge of EWS. Regular regional EWS updates for ensuring its operational linkages, e.g. annually, through SNA modelling of data and information exchange is also crucial to find missing links in the system as also stipulated in the AADMER Work Progamme 2016-2020 (ASEAN, 2016).

While the ASMC conducts a regular regional-level forum and updates a regional sub-seasonal forecast, regional surveillance and warning systems for tropical cyclone events can be strengthened. For geological observation, better coordination and information sharing is needed between AEIC's platform and the AHA Centre's DMRS. Based on the records of destructive earthquakes during the past five years, it is recommended that the regional earthquake notification threshold set by AEIC at > M 6.5 is lowered to > M 5.0, with additional earthquake intensity at IV MMI and above. In addition, it is clear that the AEIC and the AHA Centre need to coordinate the list of alert recipients for both systems.

Sharing activation ability, and linkages between disaster and key infrastructure failure warning systems, is crucial, e.g. dams or radioactive facilities or power plants. In addition, the author wishes to highlight that during a visit to the ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM) and nuclear regulatory agencies of ASEAN Member States, it became clear that some ASEAN countries with radiological facilities do not yet have data and information sharing mechanisms for emergency situations induced by natural disasters or other causes. A similar situation applies with these risks resulting in the need for an EWS for potential hazardous material, should disasters occur in industrial areas (see corresponding chapter in ARMOR).

The author emphasises tthe importance of the Pacific Disaster Centre in upgrading the DMRS in 2019. It can do this by implementing a new command post feature and externally-sourced hazards and disasters model, and by improving the links between new data sources from ASEAN Member States and the public through big data and 'internet-of-things' approaches. Further improvements in the ASEAN EWS can be made in two ways. First, better linkage of data and information sharing related to hazards, vulnerability and imminent risk. Second, legal and policy improvement for early warning messaging and disaster reporting. Disaster data sharing and reporting, as well as early warning improvement, cannot be attained without robust governance.

Finally, considering the limitations of EWS hardware and software, preparedness strategies are still important as EWS have the potential to collapse. Consequently, NDMOs, LEMAs (Local Emergency Management Authorities), and the general public should continue various DRR initiatives and must ensure business continuity plans and contingency plans are in place. Regular exercises to ensure awareness of local risk and safe place for evacuation in local community or school/workplace are still essentials in Southeast Asian countries.

Acknowledgement

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CHAPTER 5

NATECH: The Silent and Potentially Deadly Threat in ASEAN

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Abstract

Technological accidents triggered by natural hazards, known as Natech, are typically more devastating in terms of human casualties, economic loss, and environmental damage than either a natural or technological disaster on its own. The cascading nature, as well as growing potential risk of Natech occurrence, increases the need for a better understanding of the phenomenon. This chapter presents an overview of Natech risks on a global scale, as well as its emergence as a key concern in the ASEAN region. This paper proposes several policy recommendations for Natech risk reduction in ASEAN and within ASEAN Member States' government institutions. Recommendations include raising risk awareness and risk knowledge, conducting risk assessment, and mitigating risk through the adoption of chemical risk management regulatory frameworks and programmes, in order to ensure improved safety performance within industrial facilities.

Keywords: Natech, Risk management, Risk reduction, hazmat, ASEAN

5.1 Introduction

Natural disasters have been an emerging topic among researchers, government institutions, and international organisations around the world. Seismic disasters have accounted for 1.3 million fatalities and USD 2.908 billion of economic losses during the past 20 years (UNISDR, 2018). Alongside this, hydro-meteorological disasters are just as destructive, and predicted to escalate in coming years due to climate change. Moreover, secondary hazards such as explosions, toxic chemical releases and oil spills can also occur in following such natural disasters, most often there is a presence of hazardous materials nearby the disaster site.

When a natural hazard occurs in an industrial area where hazardous materials (hazmat) are used, handled, generated, or stored, there is a high risk of the release of contained hazmats. Hazmats include certain liquids, gases, and pressurized gases with hazardous properties, such as toxic, flammable, and/or explosive materials (Cameron & Raman, 2005, pp.26). Hazmat releases – depending on their properties, processes, and confinement – can result in contamination, toxic vapor, fire, or explosion, that can impact surrounding communities and industries (Cameron & Raman, 2005; Cozzani, et al., 2010). These joint NAtural and TECHnological hazards, later referred to as Natechs, must be increasingly studied and understood, as the risk of such events is predicted to increase in the future (Krausmann, Cruz, Salzano, 2017).

Even though scientists have observed Natech hazards for more than half a century, they are now more broadly recognised as a result of the 2011 Japan Earthquake and Tsunami and resulting meltdown at the Fukushima nuclear plant. Several studies investigating the frequency of Natechs (Sengul et al. 2012; Santella et al. 2012; Krausmann, et al. 2011b) reported that 2 to 5% of industrial accidents recorded in main European and US databases were Natechs — as they were triggered by the onset of natural disasters. Besides industrial facilities, numerous other critical infrastructure such as wastewater treatment plants, landfills and waste handling facilities, also display a potential risk of Natech disaster (Arrighi, et al., 2018). Natech accidents can be costlier, cause more casualties, and have broader environmental impacts than a natural disasters alone – therefore awareness raising, understanding of risk, risk reduction actions are more important than ever.

This chapter aims to provide a general overview on Natech, including Natech incidents, past research, and options for risk management. The paper discusses the main Natech related threats in ASEAN, and proposes several policy recommendations for ASEAN nations.

5.2 Natech Incidents

Natech accidents represent about 3-7% of releases of hazardous materials reported to databases in the United States, Europe and Japan (Krausmann, et al., 2011b). Sengul et al. (2012) reported an increasing trend in the number of Natech events in the United States between 1982-2008. Recent work by the author indicates that this trend has continued up to sa recently as 2017 (Ashino, 2018).

Although Natech-specific data is not available for ASEAN Member States, there are strong reasons to conclude that a similar trend is occurring. Asia has experienced the highest rate of chemical industry growth across the past 25 years, and it is predicted that Indonesia, Thailand, Viet Nam and the Philippines will continue to experience the highest growth in the coming years (ASEAN, 2014). Concurrently, Asian countries have also registered the highest number of natural disasters and disaster losses worldwide throughout the past 25 years (EM-DAT 2015). The 2011 floods in Thailand serves as an example, causing significant economic losses to industrial estates in Thailand, and resulting in large amounts of chemical releases and pollution from the affected industrial facilities. Nevertheless, such incidents have not been well documented and reported in most developing countries, including within the ASEAN region.

Natechs may pose a severe threat to people, property and the environment, with several case studies evidencing the devastating impacts of Natech accidents. The 2011 Great East Japan earthquake and tsunami, for example, triggered radioactive substance releases from the Fukushima nuclear power plant. The tsunami disabled the emergency generators that would have provided power to control and operate the pumps necessary to cool the nuclear reactors. The insufficient cooling led to three nuclear meltdowns, hydrogen-air explosions, and the release of radioactive material from 3 plant units across a number of days, as the Fukushima nuclear power plant emitted approximately 900PBq of radioactive substances overall (The National Diet of Japan, 2012). Although the Japanese Government reported no deaths caused by radiation exposure, the radioactive substance release from the power plant spread through a range of modes such as air, rain, dust, water circulation, wildlife, garbage and disposal. Its spread affected soils, waters, plants, animals, infrastructure, and food supply chains in many areas. It not only caused immediate and short-term impact, but also has had a long-term effect. As of 2013, JANIC (Japan NGO Center for International Cooperation) reported that 154,148 Fukushima residents are still displaced, with 57,135 outside the prefecture and 97,013 within. The disaster also affected supply chains and the agriculture industry in the prefecture. Due to genuine or perceived health risks, many Japanese consumers stop buying agricultural, fishery and food products that originated from the affected regions (Bachev and Ito, 2013).

Aside from the extreme case in Fukushima, a different perspective of Natech is presented through the case of Hurricane Katrina. Hurricane Katrina occurred in 2005, causing catastrophic damage along the Gulf of Mexico in the United States. Katrina had a severe impact on the Southeast Louisiana/Mississippi oil and gas industry, which accounts for nearly 30 percent of total domestic crude oil production, as well as 20 percent of domestic natural gas supply (NOAA, 2006). Sengul et al. (2012) reported over 800 hazardous material releases in 2005, from both onshore and offshore oil and gas installations. Oil spills had a significant impact on surrounding ecosystems, and also entered residential areas. A spill at the Murphy Oil refinery, for example, released approximately 3,100,243 litres of crude oil into a highly populated area of St. Bernard Parish, affecting approximately 1,700 homes in an adjacent residential neighbourhood (Pine, 2006). Cruz and Krausmann (2009) identified that offshore infrastructure – including platforms and pipelines – that were exposed to storm forces such as hurricane winds, waves, and currents, experienced significant damage resulting in oil spills that affected wildlife and fisheries.

In ASEAN, in aside from the previously-described events during the Thailand floods, Natech occurrences are relatively unknown, however, Natech events were documented during the Indian Ocean tsunami in December 2004. A report from United Nation Environment Programme (UNEP) showed that about 8,000,000 litres of oil leaked from a facility at Banda Aceh after the 2004 Tsunami. Three key industrial sites were confirmed damaged by the UNDAC assessment – namely the Pertamina oil depot in Kreung Raya Bay/Banda Aceh, the Pertamina oil depot in Meulaboh, and the Semen Andalas Indonesia cement factory in Banda Aceh. Oil storage prior to the disaster was confirmed at 40,000 kilolitres of oil in eight tanks in Banda Aceh, and 5,000 kilolitres of oil in one tank in Meulaboh (UNEP, 2018).

The above examples show the potentially devastating consequences of Natechs, and evidence the urgent need to improve disaster prevention and preparedness for such types of events. The next section discusses the modernisation of Natech research, displaying increasing efforts dedicated to the development of Natech risk assessment and management for earthquake, flood, and weather-related events.

5.3 Natech Research

A systematic literature review and a qualitative meta-analysis of over 160 documents, including scientific papers and official documents suggested by experts on Natech risk management, was recently conducted at Kyoto University. The research aims to identify existing gaps, provide a clear overview of current Natech Risk Management practices, and propose future research contributing to closing such existing gaps. This study classified publications into different categories according to: (i) natural hazard addressed; (ii) approach of the methodology (e.g. qualitative, semi-quantitative and quantitative); and (iii) type of analysis developed (according to the risk management process ISO 31000 and the disaster management cycle) (Suarez-Paba et al. 2018).

Findings from the above study show that although the impact of natural hazards on industry has been studied since the early 1960's, Natechs have only captured the wider interest of researchers since the 1990s following earthquake events in California, USA. Therefore, for the last 40 years, there has been an increasing amount of scientific publications developed about Natech issues. To this point, most of the research has been developed for earthquakes, floods and weather-related events, but other natural hazards such as lightning, volcanic eruptions and tsunami have begun receiving attention from researchers, governments and industry. Landslides and extreme temperatures are also hazards of major concern, but are yet to be fully studied; thus more contributions on the impacts of such events are required. Furthermore, the study showed that due to an increase in awareness concerning the interdisciplinary nature of Natechs, alongside a greater knowledge of Natech scenario characteristics, multi-hazard and crosscutting studies have been undertaken in the last decade.

Suarez-Paba et al. (2018) conclude that Natech research has thus far focused on risk assessment methodologies from a quantitative perspective, and on accident analysis and return of experiences from a qualitative point of view, both accounting for more than 60% of the retrieved publications. The number of semi-quantitative methodologies proposed for Natechs is limited, which provides ample opportunity to develop new research studies.

Interestingly, some researchers have begun to study the impacts of Natech events on human health, nevertheless this is still a new topic that needs further development. In addition, a limited number of the studies have focused on Business Continuity Planning and Reconstruction, Recovery and Restoration (BCP+R3), yet none of them have addressed Natech scenarios from an area-wide impact perspective. Thus, in order to view consequences beyond industrial facility fence-lines, and with the aim of strengthening BCP+R3, more research addressing these issues is required.

In general, the trend in the number of publications on Natech risk management issues has been on the rise for the last 40 years. Interest has expanded over time, shifting from earthquakes to hydro-meteorological hazards, and incorporating multi-hazard and cross-cutting approaches. In addition, long-term impacts of Natechs have begun to enter consideration as important factors of Natech risk management.

This section has summarised Natech research based on a systematic literature review carried out by Suarez-Paba et al. (2018). Other important work published as books (Kato et al. 2017), Handbooks (Earthquake Engineering Handbook, Chen and Scawthorn, 2003), national and international guidelines (INERIS, OECD, 2015), and other similar publications were not included. The importance of Natech research is nevertheless highlighted by the increasing number of publications, and growing interest in the topic by the international community (e.g., OECD Chemical Accident Working Group, 2nd Natech Project; and the United Nations' Science and Technology Advisory Group (STAG), subgroup on Natechs). The adoption of Natech risk management programmes by industry and governments is imperative for Natech risk reduction in ASEAN, and thus should be promoted thoroughly by and to all related stakeholders.

5.4 Natech Risk Management

Risk management of Natech presents particular challenges due to their complexity (deriving from the interaction of different hazards within short time frames), as well as the heterogeneous competencies and diverse stakeholders required to deal with Natechs (OECD 2012). Knock-on effects and cascades of failures are also common because of the inter-dependence of infrastructural systems. Because natural disasters impact large areas, the risk management of Natechs requires a comprehensive risk management approach that considers not only individual facilities, but also neighbouring industries, common infrastructure and services, and communities within the vicinity. Risk management entails risk assessment, risk treatment (through the adoption of risk reduction measures including prevention and mitigation), disaster preparedness and response, risk communication, and monitoring and control.

As explained in the previous section, both qualitative and quantitative risk assessment methodologies have been proposed (Antonioni, et al., 2009; Busini, et al., 2011; Antonioni, et al., 2015). Following risk assessment, risk reduction approaches should be introduced. Furthermore, providing and communicating scientific risk information between scientists, government, industries, and communities is critically important, to increase awareness and promote disaster risk reduction measures in high-risk areas (Krausmann, Cruz, Salzano, 2017).

Restricting hazardous installations within natural hazard-prone areas through land-use planning should be a priority for reducing future Natech risk. However, structural measures also need to be taken for facilities that already exist in high-risk areas. Actions such as the adoption of building and safety codes, retrofitting, and installation of strong-motion detectors on equipment and pipelines in earthquake-prone areas may serve to prevent accidents. This also includes implementing state-of-the-art design standards and codes of practice, and considering exposure to natural hazards during the design and construction stage as well as day-to-day operations. In higher-risk areas, protection measures and systems should already be considered during the design stage of any facility. Law enforcement and control from governments on the practice of good hazmat management for industry forms one step in mitigating Natech risk, particularly as most of the mitigation requirements overlap (Sengul, et al., 2012).

In the pre-emergency or emergency stage, early warning may help to reduce losses and save lives. Early warning for Natechs is not always available and practical, depending on the underlying natural hazard (Krausmann, Cruz, Salzano, 2017; Krausmann et al., 2011a). However, developing an early warning for Natech disaster is possible only when quantitative risk assessment information is available. For example, Salzano, et al. (2009) proposed an early warning system for earthquake triggered Natech using a threshold value obtained from prior Natech risk assessment. Threshold was calculated based on the estimated equipment fragility, and depending on the peak ground acceleration (PGA).

Emergency response for Natech requires further consideration on damages caused by the natural hazard, and interrupted mitigation measures and lifelines (Krausmann, et al., 2011a; Sengul, et al., 2012; Cruz and Okada, 2008). During the 1999 Kocaeli Earthquake in Turkey, several Natech accidents were reported. The emergency response to the Natechs was problematic, as industry and government were not prepared for such a big earthquake – let alone the hazmat releases that followed. The key problems identified were the lack of trained personnel, damage to lifelines, and loss of communications (Steinberg & Cruz, 2004). Similarly, road blocks, loss of power, and insufficient fuel for emergency response were also reported during the emergency response of Hurricane Katrina and Rita (Cruz and Krausmann, 2008).

Accordingly, facility emergency plans should also prepare for the cascading nature of Natech accidents, and not rely solely on government emergency response agencies (Krausmann et al., 2011a). Some of the measures which can be taken include having adequate backup power to operate critical equipment, plans for alternative water supply, and plans for alternative communication methods (e.g. short-wave radio, but also bicycles, boats).

Reflecting on Natech events during 17 past flood disasters in China (Liu, et al., 2017), and during Hurricane Katrina and the Tohoku tsunami (Miller, 2015), governments, NGOs, and media also hold critical roles during a Natech emergency response and relief. Governments need to make informed decisions and transmit accurate information to relief agencies, thus, it is very important to hold prior knowledge or risk assessment on the Natech risks in the area. Good communication and data transmission should be established between government and local NGOs, as these local NGOs have stronger direct engagement with communities (Liu, et al., 2017). Meanwhile, media can cause a greater impact on people's risk perception (which may cause outrage in extreme cases), and therefore media information reliability must be controlled (Miller, 2015).

Natech risk is a product of the presence of hazmat processing facilities where population and natural hazard co-exist (Sengul, et al., 2012). Therefore, Natech risk management can be challenging as it requires multidisciplinary approaches and involves varying stakeholders. The entire risk management process, starting from risk assessment, risk treatment, and including emergency response, requires good coordination among all the involved stakeholders, including government, industry, scientists, and communities.

5.5 Natech Characteristics by Natural Hazard Classification in ASEAN

ASEAN has a complete collection of natural hazards, from earthquake, tsunami, volcanic eruptions, forest fire, and hydro-meteorological hazards – such as floods, storms, and landslides. Located between several tectonic plates and between two great oceans, ASEAN's unique geographic and climatic characteristics makes it one of the most vulnerable regions to natural hazards and climate change impact (UNISDR, 2010).

Natural hazard risks can be classified into seismic and hydro-meteorological hazards. Seismic hazards include earthquake and tsunami, which are particular threats for Indonesia and Philippines, as well as for Malaysia, Brunei Darussalam, and Thailand. On the other hand, hydro-meteorological hazards, including storms, form the dominant risk for Philippines, Myanmar, Thailand, Viet Nam, Lao PDR, and Cambodia, as well as flood which is a dominant risk for Malaysia and Thailand (UNISDR, 2010; PDC, 2017).

5.5.1 Earthquake and Tsunamis

Strong earthquakes have caused some of the most disastrous Natech accidents in other parts of the world, including the Fukushima nuclear power plant accident and industrial fires following the Great East Japan Earthquake and Tsunami in 2011, the Turkey Earthquake in 1999, and Wenchuan Earthquake in 2008. Based on the analysis of 48 historical cases reviewed, the most recurrent consequences triggered by earthquakes were fire and hazmat release (Krausmann, et al., 2011b). In some cases, explosion, toxic vapor, and water contamination were also observed. Earthquakes can be very powerful, but the potential sources can be well predicted. Thus, the best measure to be taken for earthquake-triggered Natech is prevention through land-use planning. Building codes and design standard for industrial facilities should be in place for areas with higher earthquake risk.

Indonesia and Philippines also have a long history of strong earthquakes and tsunami, however, there are limited reports of Natechs in these two countries. Several instances of oil spills were found after the Indian Ocean Tsunami in 2004, including in a Pertamina oil transfer facility in Kreung Raya, and a cement factory in Lhoknga (Borrero, 2005, and Goto, 2008).

5.5.2 Floods

A database review on historic flood-triggered Natech accidents found storage tanks (74%) and pipelines (17%) to be the most frequently damaged equipment during floods (Cozzani, et al., 2010). Such damage to industrial facilities caused by floods often occurs due to water buoyancy and drag forces (Krausmann, Cruz, Salzano, 2017). Water contamination is the most frequent result of flood-induced Natech, and the spread of floodwater can also contribute to the contamination of wider areas, including groundwater. Although most accidents occurring during floods primarily result in water contamination, flame ignition and toxic vapor release also form possible occurrences (Cozzani, et al., 2010; Krausmann, et al., 2011b).

5.5.3 Cyclonic Storms

In terms of human casualties, cyclonic storms form the most threatening natural hazard in the ASEAN region (UNISDR, 2010). Floods caused by storms and heavy rain can lead to Natech, with similar types of damage as river floods (Krausmann, Cruz, Salzano, 2017). However, most damage occurs from storm surges on storage tanks, pipelines, and vulnerable processing equipment. Such damage can result in release of hazardous materials, oil spills, as well as facility shut-down for an extended period (Santella, et al., 2010). Possible measures for storm triggered Natech might include the enforcement on design standard and retrofitting of existing facilities, as most of the damaged platforms during Hurricane Katrina and Rita occurred on platforms aged over 30 years, which were built before design standards were implemented in 1977 (Cruz and Krausmann, 2008). On the other hand, early warning systems for floods and cyclonic storms have been developed, and should be extended to emergency responses for industrial facilities exposed to these hazards.

5.6 Growing Need for Natech Risk Management in ASEAN

Krausmann, Cruz, and Salzano (2017) consider the factors which contribute to increasing Natech risk in the future, including: (a) climate change, with regards to affecting severity and frequency of hydrometeorological hazards; (b) growth of the industrial sector; and (c) proximity of developing industrial areas and residential areas in high-risk natural hazard locations. Related to these factors, Natech risk can be considered as increasing in ASEAN Member States.

As described, the ASEAN region experiences some of the highest risk of natural hazards, including both seismic and hydrometeorological disasters. In addition, the majority of ASEAN Member States also experience high risk of hydrometeorological events (UNISDR, 2010). Although not completely at consensus, most scientists agree that climate change has affected the frequency and intensity of hydrometeorological events such as storm, typhoon, hurricane and flood. The Thomas, et al. (2013) review on historical data shows that the intensity of damage, as well as the frequency of hydrometeorological hazards in Asia-Pacific increased throughout 1971-2010. This includes the increasing intensity of typhoons in the Philippines, which sits on the typhoon belt. These factors increase the importance for ASEAN nations to prevent industrial facilities being developed in areas with hydrometeorological risk, while equipping existing facilities with strong mitigation measures.

The number of facilities handling hazardous materials has also increased in ASEAN. According to data summarised by Towney (2010), there are approximately 1,732 offshore installations in the Asia-Pacific region, with 1,237 of them in ASEAN countries. This number has increased from an estimated 950 in the year 2000, to almost a double that number by 2010. In 2010, 48.1% of said installations were over 20 years old, with 11.8% were more than 30 years of age. Considering the increasing energy demands within ASEAN and East Asia, the number of offshore oil and gas platforms and refineries, as well as traffic transporting oil and gas are expected continue increasing. The ASEAN Centre for Energy (2017) forecasted that the total primary energy supply in ASEAN will increase by at least 1.8 times by 2040 compared to 2015 levels. Additionally, population growth and the increasing rate of urbanisation might also increase the exposure of these hazardous facilities to the general community, which could be deadly and costly should a natural hazard occur. Lack of risk knowledge and awareness may mean consideration of risk exposure, caused by proximity of industrial and residential areas, to be neglected in some regions.

5.7 Policy Recommendations for ASEAN Region and Member States

Prevention is the best possible measure to reduce Natech risks in the ASEAN region. It is not too late for ASEAN and its nations to adopt land-use plans and regulations that force facilities handling hazmats outside of hazard-prone areas. If not yet in place, each ASEAN Member State should prioritise the development of a policy framework for chemical-accident prevention and mitigation. In addition, Natech risk should be evaluated in industrial areas that are already developed. Local governments in areas home to industries that handle hazardous materials should focus on improving the performance and safety of these existing facilities.

Mitigation through law enforcement and contingency planning at a regional level might also be necessary, as trans-boundary Natech risks are present among several ASEAN nations. For instance, Kajitani, et al. (2013) developed a prototype risk assessment for a disruption caused by an oil refinery explosion and fire in the Malacca straits and Singapore. Other examples were mentioned such as undersea natural gas pipelines between Natuna Island, Indonesia and Jurong Island, Singapore (Kajitani, et al., 2013), and potential releases from offshore petroleum platforms between bordering states (Lyons, 2013).

Some legal documents found in ASEAN Member States related to Natech risk reduction and emergency response include the ASEAN Joint Declaration on Hazardous Chemical and Waste Management, and the Oil Spill Preparedness and Response (ASEAN-OSPAR). Through the ASEAN Joint Declaration on Hazardous Chemical and Waste Management, ASEAN Member States highlighted their commitment to implement the Strategic Approach to International Chemical Management (SAICM) through decisions made at ASEAN Summits, ASEAN Ministerial Meetings on Environment, the Basel Convention (on the ban of transfer of hazardous waste from developed to less developed countries), the Rotterdam Convention (on transparency for some hazardous chemical exports), the Stockholm Convention (on ban and restrictions for usage of persistent organic pollution), and the Minamata Convention (on limit of mercury-added products and usages). However, these agreements are rarely mentioned within national law making in ASEAN Member States, especially in nations with significantly low risk awareness (IFRC, 2017). Meanwhile, providing a general guideline for oil spill contingency planning, ASEAN-OSPAR calls for Regional Oil Spill Contingency Plans in countries and sub-regions where it is considered necessary. However, there has been limited follow-up to ensure these contingency plans are prepared and practiced, as it was also not supported by a region-wide risk assessment.

The ASEAN Joint Disaster Response Plan (AJDRP) serves as the primary contingency plan for emergency response after a catastrophic disaster in ASEAN countries. The AJDRP aims to ensure better emergency response and more efficient asset and capacity distribution in emergency responses throughout ASEAN. The plan is operationalised through the Standard Operating Procedure for Regional Standby Arrangements and Coordination of Joint Disaster Relief and Emergency Response Operations (SASOP), and practiced biannually through the ASEAN Regional Disaster Emergency Response Simulation Exercise (ARDEX). The implementation of ARDEX in 2018 highlighted Natech risk in ASEAN countries, and was an important step towards further introducing this type of risk to the region. The exercise brought together decision makers and related stakeholders under the presence of Natech risk in future emergencies. It also increased awareness both for the region as a whole as well as each Member State to the potential risk of Natech in their territories.

Integration of policies is also pivotal in order to avoid double regulation or other administrative burdens. As an example, the Seveso III Directive, which regulates industrial establishments that handle hazardous materials in the European Union, applies to more than 12,000 industrial establishments. The Seveso III Directive specifically calls for the assessment and management of Natech risks. Furthermore, it includes several policy elements related to classification, labelling and packaging of chemicals, the Union's Civil Protection Mechanism, The Security Union Agenda (including CBRNE and protection of critical infrastructure), a policy on environmental liability and the protection of the environment through criminal law, and policy regarding safety of offshore oil and gas operations. ASEAN countries must develop their own regulatory framework, building on initiatives such as the Seveso and others that are already established I other regions.

Conclusion & Recommendation

This chapter has introduced Natechs, their risk management, and the importance of addressing Natech risk in ASEAN. We identified that the main natural hazard threats in ASEAN are earthquake, tsunami, storm and flood. ASEAN, as one of the most vulnerable regions for hydro-meteorological hazards, will be facing an increase in frequency and intensity of these events as a result of climate change. Alongside this, the number of industries handling hazardous materials in ASEAN is also expected to increase as the region continues to develop. These factors, along with population growth and urbanisation, all contribute to the increasing risk of Natech in ASEAN. Finally, some policy recommendations for ASEAN and ASEAN Member States were presented. These recommendations include increasing risk awareness and risk knowledge, conducting risk assessment, and mitigating risk through law enforcement for industrial facility performance and safety. Integrated policy at a regional level is also necessary to avoid double regulation or other administrative burdens.

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CHAPTER

Application of Breaks For Additive Season and Trend (BFAST) for Drought Monitoring

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Abstract

There is a likelihood of under-reporting on drought information collected by ASEAN Disaster Information Network (ADINet), EM-DAT database (international disaster database), and Indonesian Meteorological, Climatological, and Geophysical Agency (BMKG), due to their acquisition of information from people, stakeholders, and ground weather stations (bottom-up approach). This system aimed to complement the bottom-up approach by using Breaks for Additive Season and Trend (BFAST), that utilises satellite data to detect drought occurrence. BFAST is a package that is installed in R software, a software environment for computing and graphics. This method used the satellite data (MOD13Q1- Normalised Difference Vegetation Index) to provide potential drought estimations. Three different ASEAN regions – Cilacap (Indonesia), Chiang Rai (Thailand), and Dak Lak (Viet Nam) – were observed to detect potential drought using BFAST. Potential moderate drought was detected in the three areas based on BFAST analysis, but this finding was not confirmed by the Standard Precipitation-Evapotranspiration Index (SPEI) or Standardised Precipitation Index (SPI). This paper explores the possibilities of connecting the use of BFAST to an application that can be used by relevant end-users, such as farmers and companies. Future studies could be focused on the effect of drought on crop price fluctuations, tailor detection to the vegetation type and field size in improving accuracy, or a comparison study of the use of quantitative data versus experiential, data and how it impacts decision-making for crop harvesting.

Keywords: drought, BFAST, satellite data, crops

6.1 Introduction: The Current Practice to Detect Drought Occurrence

The key to a plant's survival is the transpiration process that transports water from the roots to the leaves via the circulatory system comprised of the xylem and phloem. Plant cells require sufficient water to maintain the plant's turgidity, and inability to maintain turgor pressure will result in the plant becoming flaccid. Water plays an important role for plant growth and production, and thus limited availability of water would result in inhibited or stunted growth leading to reduced yield. A change in the ecosystem comprises of three classes: (1) seasonal change, caused by the fixed fluctuation in temperature and rainfall annually that influences plant phenology with different vegetation types; (2) gradual change, a change of mean annual rainfall or land cover, and; (3) abrupt trend change, a change driven by human activities or natural disaster (Verbesselt, Hyndman, Newnham, & Culvenor, 2010; Vogelmann, Xian, Homer, & Tolk, 2012). A natural disaster like a long-term drought is classified as gradual change, as it results in changes throughout numerous years.

* this chapter represents a contribution from a young ASEAN researcher.

Based on the data consolidated from the ADINet and EM-DAT databases between July 2012 and February 2018, from 1250 total disasters reported, 19 were classified as drought. This accounts for 1.52% of the total, which stands as the lowest-recorded among all disaster types throughout those 5 ½ years. There is a likelihood of under-reporting in terms of drought monitoring as the current “bottom-up approach” drought reports rely on information provided by ADINet users and stakeholders. The AHA Centre recognises four different stakeholders as sources of disaster information, which are (1) Government agencies of ASEAN Member States; (2) ASEAN entities and related organisations; (3) Higher Education, Research and Development Institutions based in ASEAN; and (4) relevant regional, international and research institutions.

Current Drought Alert on BMKG Website

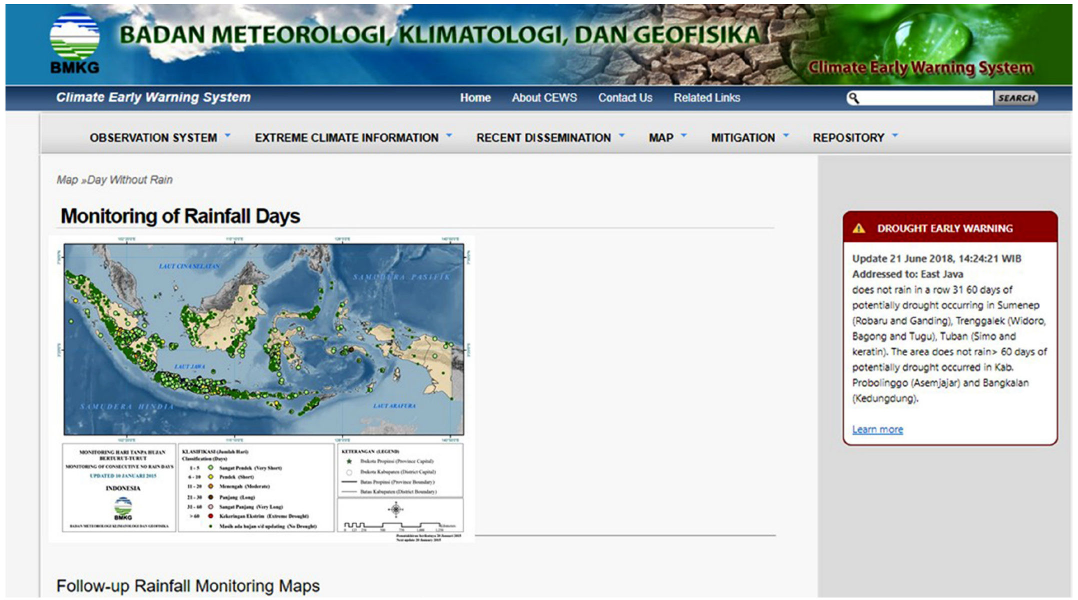

Image 6.1 Current Drought Alert on BMKG Website

In addition, another current practice to detect drought occurrence to apply the ‘bottom-up approach’ is implemented by the Indonesian Meteorological, Climatological, and Geophysical Agency (BMKG). This institution collects relevant weather data from the ground station (such as rainfall, wind speeds), which is publicly accessible through a website (http://cews.bmkg.go.id/). There are weather reports from across Indonesia, mostly concentrated in Sumatra and Java Islands, as well as some parts of Borneo and Sulawesi as can be seen in the figure above. The lack of weather stations to comprehensively cover all regions of Indonesia makes it nearly impossible for communities to access near real-time drought alerts and related information. Another drawback is the methods used to convey drought alerts/early warnings, which may not reach all communities in affected parts of Indonesia. For instance, the red box on right side in Image 6.1 shows an example of drought early warning message. In principle, at a certain tim BMKG releases a statement indicating potential districts and cities/regencies that will be affected by drought due to rainfall records. Nevertheless, there is no auxiliary information as to the potential impact of the drought or advice on potential countermeasures by end-users (general public).

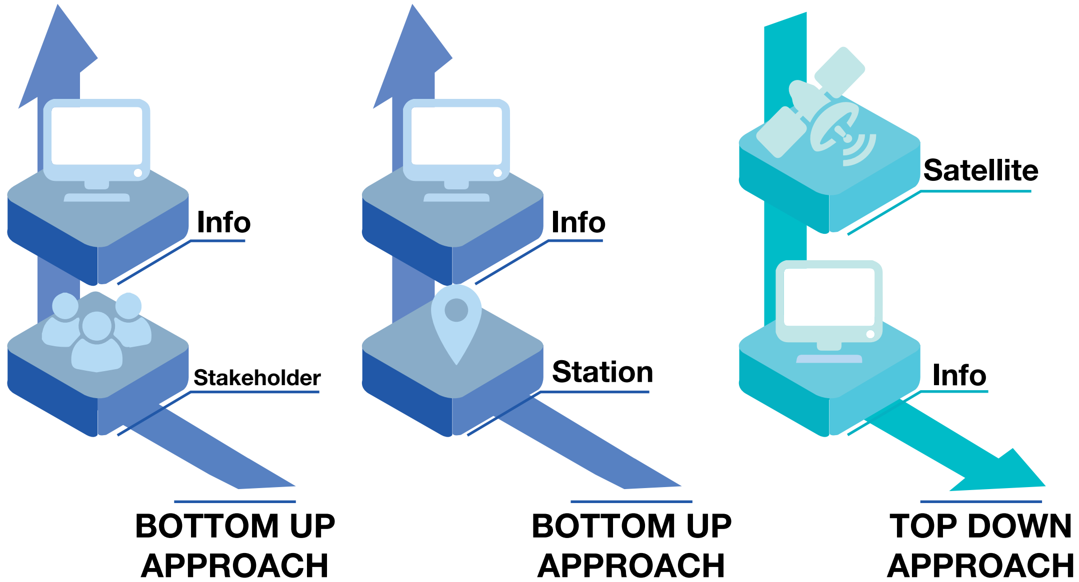

Figure 6.1 BFAST Method as a Top Down Approach

This paper aims to showcase the potential use of Break Detection in the Seasonal and Trend (BFAST) to complement the bottom-up approach on drought monitoring and early warning provisions. BFAST relies on satellite data and provides potential drought estimations based on NDVI (Normalised Difference Vegetation Index) data. Through BFAST, the end-users can make well-informed decisions on crop rotation, and application for future scenarios. Nevertheless, the most accurate information still requires efforts through a bottom-up approach, as satellite data cannot gather detailed on-ground information (e.g. vegetation type, land use).

6.2 How Does Breaks For Additive Season and Trend (BFAST) Work?

BFAST[1] is a method that can be used by operating R. It detects either significant or gradual changes of a global range in a time series with magnitude and direction. It combines the decomposition of a time series into trend, seasonal, and the remaining components (Aulia, Setiawan, & Fatikhunnada, 2016). BFAST equation is displayed as follows:

$$Y_t = T_t + S_t + et \quad (t = 1 \ldots n)$$

Equation 6.1

Based on the formula, Yt is observed as data at time t, Tt is the trend component, St is the seasonal component, and et is the remainder component. It can be accepted that Tt is piecewise linear. There are breakpoints t1*,.....,tm*, and it is defined t0*=0

$$T_t = \alpha_j + \beta_j t \qquad (\tau_i^*-1 < t < \tau_i^*)$$

Equation 6.2

A piecewise phenological cycle is St that is divided with seasonal breakpoints, τ_1# , ..., τ_p# (τ_0# = 0 and τ_{p+1}# = n).

$$St = \sum_{k=1}^{K} \square \left[Yj,k \frac{2\pi kt}{f}) + \theta j,k \frac{2\pi kt}{f})\right] \quad (\tau_{i-1}^{\#} < t < \tau_1^{\#})$$

Equation 6.3

Where the coefficient is Yj,k and θj,k, K is number of harmonic pattern and f is frequency. This study used the parameters to be analysed that are explained in Table 1. The description of the parameters according to the 'Library' of BFAST R Package.

[1]BFAST package in R software are available on the website (http://bfast.r-forge.rproject.org/). For more information on obtaining material refer to https://cran.r-project.org/web/packages/bfast/bfast.pdf.

PARAMETERS	VALUE	DESCRIPTION
Yt	ts	Univariate time series to be analysed.
H factor (h)	rdistance at 10/length	Minimal segment size between potentially detected breaks in the trend model given as fraction relative to the sample size (i.e. the minimal number of observations in each segment divided by the total length of the timeseries.
Season	'harmonic'	The seasonal model used to fit the seasonal component and detect seasonal breaks (i.e. significant phenological change). There are three options: "dummy", "harmonic", or "none" where "dummy" is the model proposed in the first Remote Sensing of Environment paper and "harmonic" is the model used in the second Remote Sensing of Environment paper (see paper for more details) and where "none" indicates that no seasonal model will be fitted (i.e. St = 0). If there is no seasonal cycle (e.g. frequency of the time series is 1) "none" can be selected to avoid fitting a seasonal model.
Maximum iteration	1	Maximum amount of iterations allowed for estimation of breakpoints in seasonal and trend component.
Breaks	2	Integer specifying the maximal number of breaks to be calculated. By default the maximal number allowed by h is used.

Table 6.1 BFAST Parameters Used

6.3 BFAST in Monitoring Drought Occurrence within ASEAN Region

Based on the ADINet site, the AHA Centre compiled drought information in three different ASEAN regions – Cilacap (Indonesia), Chiang Rai (Thailand), and Dak Lak (Viet Nam). From three areas, potential drought conditions were observed using BFAST.

Drought in Cilacap, Indonesia

The AHA Centre's ADInet reported that the emergency preparedness drought disaster alert in Cilacap was broadcast from 15th of May to the 15th of August 2018. To understand the extremity of the drought, detection was undertaken through the use of value of vegetation indices, such as the normalised difference vegetation index (NDVI). Early-on, observations registered a medium index value of the NDVI at 0.44 on the 25th of May 2018, which indicated a moderately healthy plant. However, the breakpoint has not been detected during the 18 years since the beginning of seasonal, trend, and remainder observations.

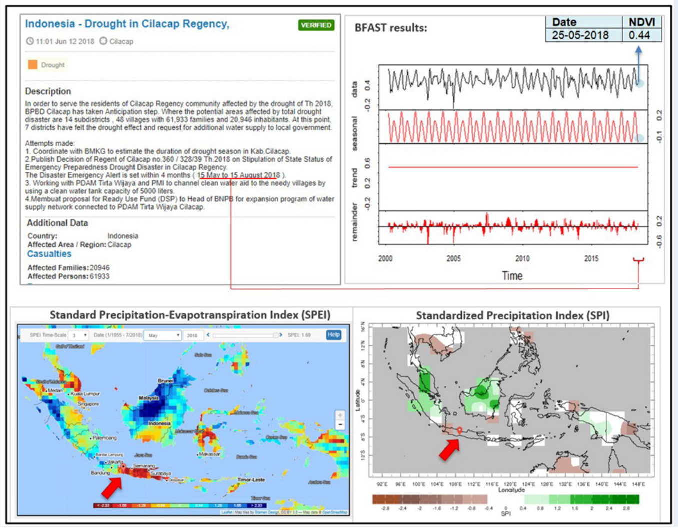

Figure 6.2 SPEI and SPI for the drought in Cilacap, Indonesia

This finding was confirmed by Standard Precipitation-Evapotranspiration Index (SPEI) and Standardised Precipitation Index (SPI) (Figure 6.2). The SPEI showed -0.99 unit which is classified as moderate drought, while the value of SPI could not be found. A study from Sudaryatno (2016) found that southern parts of Central Java, including Cilacap, formed a normal class area regarding land drought vulnerability, based on the parameters of slope, drainage condition, Available Water Capacity (AWC), permeability, landform and land usage. It was vulnerable to geomorphological drought, but it would not be overly extreme.

Drought in Chiang Rai, Thailand

On the 20th of March 2013, Thailand experienced drought that was reported by ADINet and the AHA Centre. There were 39 provinces affected by this natural hazard – including Chiang Rai. At 19.762979 of latitude and 99.927657 of longitude (Chiang Rai), the index value of vegetation was detected at 0.53, which indicated moderately healthy crops. In addition, there was no breakpoint detected on the trend component throughout 18 years, so it can be assumed that the drought was not severe in Thailand. This was also in line with the value of SPI and SPEI that had a normal condition from -0.4 to 0.4 and -0.861 respectively. However, this finding did not correspond to the ADINet, that reported drought conditions in Chiang Rai, Thailand.

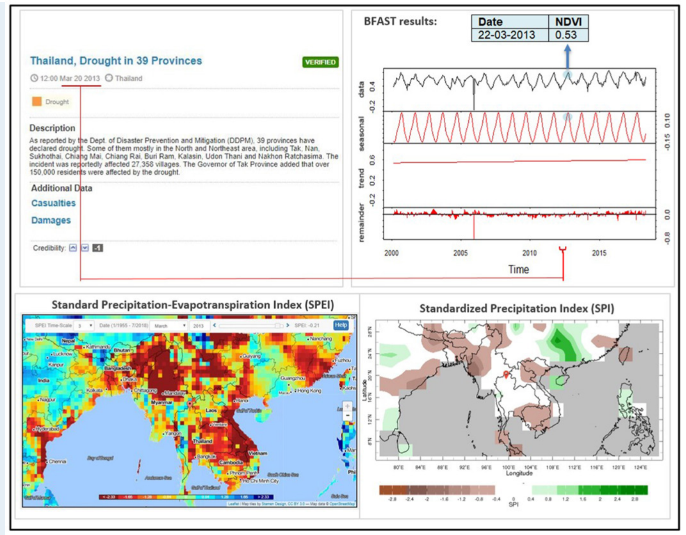

Figure 6.3 SPEI and SPI for the drought in Chiang Rai, Thailand

Drought in Dak Lak, Viet Nam

Based on the ADINet report, the water crisis in Viet Nam occurred on the 18th of April 2014. One of the districts affected by this incident was Dak Lak, in which 2,008 ha of agricultural areas was affected. After analysis through the BFAST method, it was observed that 0.42 unit of NDVI was the level of the vegetation indices – indicating moderately healthy crops, with the trend depicting no breakpoint throughout the period. This finding was also confirmed by SPEI and SPI. The Standard Precipitation-Evapotranspiration Index showed normal conditions at 0.59 index value, and likewise the Standardised Precipitation Index showed normal precipitation between -0.4 and 0.4. Overall, even though there was no breakpoint detected during the timeseries of the BFAST method, the NDVI value showed that there was an indication of unhealthy crop symptoms. However, when SPEI and SPI were observed, drought was not detected in the site, as the index of precipitation-evapotranspiration and the index of precipitation depicted normal conditions.

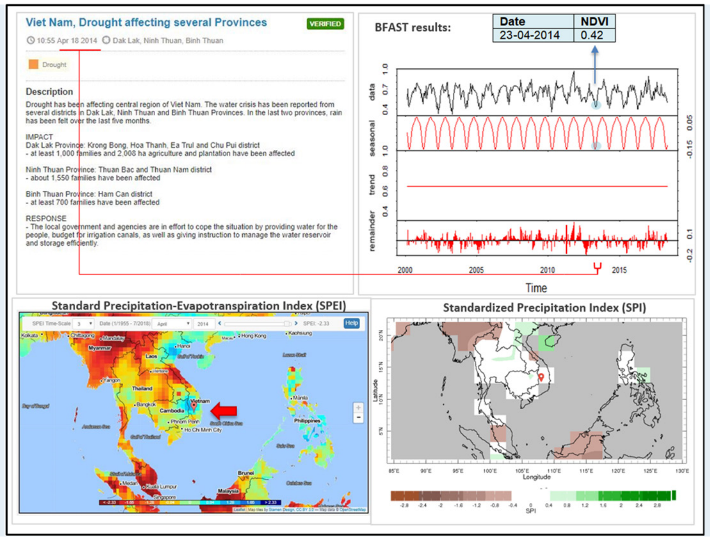

Figure 6.4 SPEI and SPI for the drought in Dak Lak, Viet Nam

6.4 Potential Application of BFAST Method on the App

There is scope to explore the possibility of tailoring the BFAST method into an application that can be used by end-users, such as smallholder farmers, to provide information about potential drought, and to lead organisations or companies on overcoming it. While the targeted end-users of the app are smallholder farmers, companies that work with them may experience benefits of its use. At this stage, it is merely a concept, and some of the essential features could be further developed in the future.

App Utilisation for Farmers

The app for the farmers comprises three different functions, which are Notifications, Advice, and Report. The 'Notifications' icon is for providing information about the potential drought on a farmer's land. 'Advice' provides information on how to address the potential drought detected. When users press the 'Report' icon, it may allow them to capture what they have found on the crops with a camera. Therefore, it could create a feed-back loop to the system, in a similar format as the current user/crowd-sourced information currently utilised through ADINet, however in a more detailed manner.

Notifications

The current problem is that many smallholder farmers make their decisions on intuition rather than scientific data. Based on remote sensing data through the BFAST method, the exact locations of potential drought will pop-up in the 'Notification' icon on the app, allowing farmers to use water effectively in the certain locations. Nevertheless, the notifications design can be targeted for sub-national level instead of fully personalised. With BFAST approach, the notification and potential drought alert may be more detailed than the current system, as depicted in Image 6.1.

Advice

Based on remote sensing data and the farmer's report, an application can provide a tailor-made advice for farmers. Using satellite data, any issues on nutrient availability or damage caused by drought can be portrayed quickly. The advice, for example, may be that farmers need to apply increased water. Information about how to properly apply the fertiliser could be provided. Through examples such as this, decision-making can be more accurate, effective, and efficient.

Report

Another important element that may be utilised is to introduce a reporting feature through which farmers can ask about crop problems that they identify on their farms. For instance, if they find yellow leaves or symptoms on leaves caused by drought, they can take a picture and send it to the managing authority. Then, an advice can be provided to them, and if there is potential for a serious damage, the managing authority could inform the companies immediately, to allow them to undertake required mitigation efforts.

FARMERS INTERFACE-APP

Figure 6.5 Potential front-end of a drought early warning app

Anticipated Benefits

The data that farmers record, and the data from remote sensing, would also be available for companies to allow them to easily monitor farms. They would receive updates about all events taking place on a farm. For instance, soybean or tomato sauce companies rely on the soybean and tomato farm production to remain strong. When drought hits, companies need to plan how to act, as it can affect the production and in the end their sales. If early harvest is required, companies could prepare the transportation logistics in advance. Moreover, supporting the supply of water could be another outcome. Overall, companies need to ensure the state of production is as stable as possible.

Conclusion & Recommendation

The state of agricultural production must be stable, especially crops that are pivotal to a nation for export and import. When demand increases but supply decreases, the overall profit will be affected. Using the example of rice paddy as the Asian staple food that always has high demand, this plant relies on water to maintain its growth, and therefore drought will influence its price and production. Hence, it is necessary to support stable pricing of crops for a country. For further research, it may be of interest to observe the drought effect on price fluctuations for an identified crop (e.g. maize, palm oil etc.), and on the overall economic impact for a country.

It has been found that free or low-cost satellite imagery results in lower resolution images, making it difficult to detect specific vegetation and field sizes. There are two key ways to improve accuracy of such imaging. Firstly, images must utilise high resolution, and secondly, there should be a ground-truth process undertaken. Such elements should become part of the methodology of detecting drought based on satellite imagery processing. Future studies should also consider the vegetation type and field size (ground-observation) for tailored detection and increased accuracy.

From a practical perspective, comparative studies are required to be conducted on the use of quantitative data versus experiential data, and how they impact decision-making for harvesting crops. When drought occurs at a site, it is preferable to undertake an early harvest. Based on scientific data, drought records can be developed to determine when and how many times drought occurs in one year, so that the correct time for early harvest can be estimated through scientific agricultural calculation. On the other hand, farmers can also make predictions based on experiential data. They can estimate the time for earlier harvest due to drought based on intuition. Therefore, scientific and non-scientific data are of potential interest to be included in future studies with regard to decision-making for crop harvesting.

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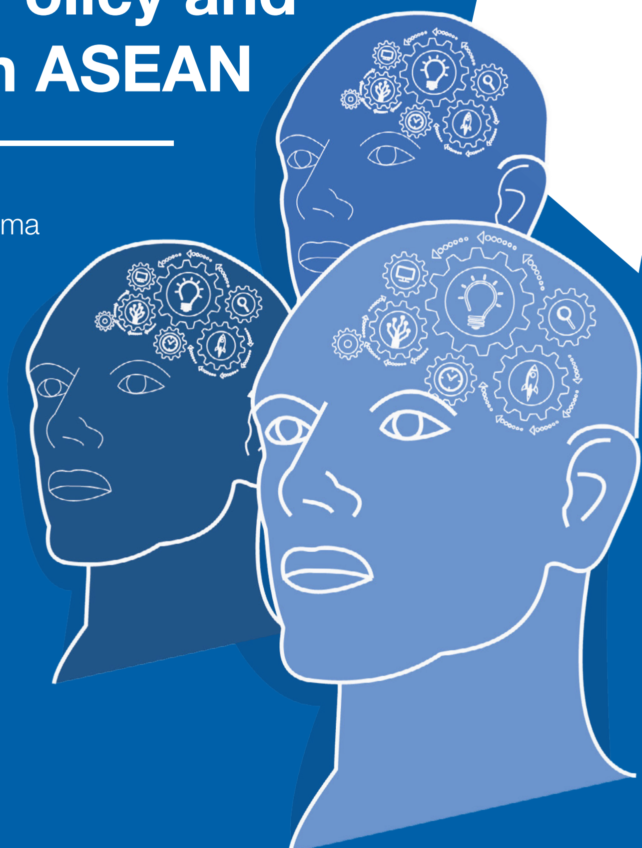
CHAPTER

Regional Knowledge Hub for Disaster Management: Strategy, Policy and Practice in ASEAN

Author:
Dipo Djungdjungan Summa



Abstract

The Work Programme for the implementation of the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) 2016-2020 gives the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (the AHA Centre) the mandate of becoming a regional knowledge hub for disaster management. Until now, however, there is no clear definition of the roles the AHA Centre will be expected to fulfil as the regional knowledge hub. By examining several critical regional instruments, including the AADMER, the Agreement on the Establishment of the AHA Centre, and the One ASEAN One Response Declaration, this article attempts to clarify how the AHA Centre should perform its role as a regional knowledge hub. It also proposes a working strategy that will enable the AHA Centre to do this.

Keywords: knowledge hub, knowledge management, disaster knowledge

7.1 Background

The AADMER Work Programme 2016-2020, under priority 8 on Lead and Component 1, instructs the AHA Centre to “establish an integrated regional disaster management knowledge hub”. However, it does not provide further explanation on what constitutes a regional disaster management knowledge hub. Some basis for how the title “regional disaster management knowledge hub” can be understood must be provided, by linking it with the AHA Centre’s expected knowledge management roles, as contained in several strategic documents.

This article will reference these strategic documents, including the ASEAN Agreement on Disaster Management and Emergency Response (AADMER), the Agreement on the Establishment of the AHA Centre, the ASEAN Vision 2025 on Disaster Management, the AADMER Work Programme 2016-2020, and the AHA Centre Work Plan 2020.

It is important to examine some of the concept documents as well as the work plan produced by the AHA Centre and the ASEAN Secretariat, in order to gain more clarity on the development of the regional knowledge hub concept. Earlier discussions regarding the AHA Centre’s potential roles as knowledge hub preceded many of the documents mentioned above. Many of these discussions were captured in the Strategy and Priorities for AADMER Work Programme Phase 2 (2013-2015), which was a further prioritisation of the AADMER Work Programme 2010-2015. The Strategy and Priorities consisted of 21 different concept notes, each of which envisioned the various potential roles the AHA Centre can play in the region, including the role in ASEAN Disaster Knowledge Management (Concept Note #10).

7.2 Capturing Disaster Knowledge in Southeast Asia

ASEAN is the world's most disaster-prone region. More than 50 percent of global disaster mortalities occurred in the ASEAN region from 2004 to 2014. From the global total of 700,000 fatalities due to disasters that occurred during this period, 354,000 fatalities (or more than half) occurred in Southeast Asia.[1] The United Nations Office for Disaster Risk Reduction reported in 2015 that two ASEAN countries, Indonesia and Myanmar, were among the top 10 countries with the highest disaster mortalities from 1996 to 2015.[2] According to INFORM (a global, open-source risk assessment for humanitarian crises and disasters), Indonesia, along with Myanmar, the Philippines, Nepal and Bangladesh, are among the top five Asia Pacific countries at the highest risk of suffering the next large-scale disasters.[3]

The ASEAN region is prone to almost all types of natural disasters. Indonesia and the Philippines sit on the 'ring of fire', a belt of active volcanoes around the Pacific, making the two countries prone to volcanic eruptions. The region is also home to the convergence of several tectonic plates, making it seismically active and prone to earthquakes and tsunamis, especially in Indonesia, the Philippines, and Myanmar. The Philippines and Viet Nam are prone to typhoons and storms, while Thailand, Viet Nam, Cambodia, Malaysia, and Myanmar are prone to floods and landslides. On average, the ASEAN region suffers USD 4.4 billion in economic losses due to disasters annually.[4] The losses double or triple in the event of large-scale disasters, such as the Indian Ocean Tsunami (2004), Cyclone Nargis in Myanmar (2008), Thailand Flood (2011), and Typhoon Haiyan in the Philippines (2013).

As they are in a disaster-prone region, Southeast Asian countries have accumulated extensive experience and knowledge in dealing with disasters. This is true not only at the government level but also at the community level, as significant disaster-related local wisdom is ingrained into the communities' respective cultures. Often this local knowledge is the crucial element in maintaining community resilience against disaster, as well as in helping communities to recover from disasters.[5]

Despite the abundance of disaster-related knowledge in Southeast Asia, capturing and sharing it remains a challenge at the regional level. The region's size, vast population, and cultural and linguistic diversity, all contribute to the challenge of capturing this knowledge.

[1]ASEAN Vision 2025 on Disaster Management, p. 4
[2]Poverty and Death: Disaster Mortality 1996 – 2015, Centre for Research on the Epidemiology of Disasters and the United Nations Office for Disaster Risk Reduction, 2016, p. 13
[3]Ibid. p. 13
[4]Advancing Disaster Risk Financing and Insurance in ASEAN Countries, World Bank, and GFDRR, p. 1
[5]See, for example, the study on how local wisdom was incorporated into the recovery strategies of the government in the aftermath of the Yogyakarta earthquake in 2006 at Bevaola Kusumasari, Quamrul Alam, (2012) "Local Wisdom-based disaster recovery model in Indonesia", Disaster Prevention and Management: An International Journal, Vol 21, Issue: 3, pp.351-369, https://doi.org/10.1108/09653561211234525

There have been efforts to capture, document and share disaster-related knowledge, and in some instances these efforts have initiated real changes in disaster management. One example is the process of documenting lessons learned from the emergency response to Super Typhoon Haiyan in 2013.

Typhoon Haiyan was one of the three mega disasters impacting the region between 2004-2013. It left massive and widespread damage, and caused a high number of casualties. The death toll was more than an estimated 6,300, with over 1,000 missing and more than 28,000 injured, with an estimated USD 142 million worth of damages.

This was the first time that the AHA Centre responded to a major disaster, playing the role as regional coordinating agency for emergency response. Following the emergency response, the AHA Centre initiated an expanded After-Action Review (AAR), involving a wide range of stakeholders to review and evaluate ASEAN's collective response, as well as propose recommendations for future emergencies. The AAR was carefully documented and made publicly available through a book published on the subject.[6]

The process did not end there, however. The AAR triggered more intense discussions on how to improve ASEAN's collective response, which the AHA Centre continued to facilitate. This ultimately birthed the idea of One ASEAN One Response,[7] which was formally adopted by the ASEAN Leaders in September 2016 as the "ASEAN Declaration on One ASEAN One Response: ASEAN Responding to Disasters as One in the Region and Outside the Region".

The example of Super Typhoon Haiyan and how it inspired the Declaration on One ASEAN One Response, demonstrated the AHA Centre's important role in facilitating learning and promoting changes inspired by strategic and policy level learning. Furthermore, it demonstrated the AHA Centre's potential as the regional knowledge hub in disaster management. This article is an attempt to clarify the role of knowledge hub that will further enhance the AHA Centre's position as Southeast Asia's primary regional coordinating agency.

7.3 Why Utilise the AHA Centre as a Regional Knowledge Hub

The AHA Centre is well placed to become a regional knowledge hub in disaster management because of its comparative advantages. First, as an operational organisation, the AHA Centre has first-hand operational experience in disaster response, as well as experience in facilitating and coordinating responses in different ASEAN countries for different types of disasters. Over time, the Centre has accumulated experience and knowledge from its

[6]The ASEAN Secretariat, "Weathering the Perfect Storm: Lessons Learnt on the ASEAN's Response to the Aftermath of Typhoon Haiyan", Jakarta, 2014
[7]The AHA Centre, "Operationalising One ASEAN One Response: Speed, Scale, Solidarity", Jakarta, 2018

operations, which it then applies to its capacity building activities, such as the AHA Centre Executive (ACE) Programme, and ASEAN Emergency Response and Assessment Team (ASEAN-ERAT) courses, as well as the development of standard operating procedures (SASOP). In addition, due to its extensive hands-on and operational experience, the AHA Centre is capable of identifying which improvements are required within the operational regional mechanisms and SASOP. Furthermore, operational experience increases the ability to identify suitable actors who can contribute and complement knowledge, experience, data, information and resources.

It must be acknowledged that the AHA Centre has already performed the coordination functions, as mandated under AADMER and the One ASEAN One Response Declaration. As the primary regional coordinating agency, it has performed the role as connection and collaboration point for various stakeholders, organisations, and sectors, as well knowledge sources. This connecting power can be further utilised as part of its operation as knowledge hub.

Lastly, the AHA Centre can fulfil its role as knowledge hub as it has already performed capacity building functions, for example, through its ACE Programme, ASEAN-ERAT courses, and ASEAN Regional Disaster Emergency Response Simulation Exercises (ARDEX). As such, the AHA Centre benefits from this accumulated hands-on experience in facilitating knowledge exchange between various participants and trainers, and this experience could ignite further discussions.

7.4 The Role of the AHA Centre in Disaster Knowledge

As a disaster-prone region, disaster knowledge is essential for Southeast Asia. Disaster knowledge includes causes of disaster, potential impacts on societies, as well as disaster response. As an organisation working in disaster management, the AHA Centre understands that the right knowledge can provide direction and inform humanitarian action during emergencies. Disaster knowledge, if properly utilised, will enhance regional preparedness and local community resilience to disasters. With the right knowledge and understanding, decision makers will be able to formulate intervention policies that may help communities to anticipate the impacts of disasters and prepare for them. Poor disaster knowledge results in poor preparation, and this will therefore impact negatively on disaster resilience.

The AHA Centre is expected to play a vital role in the development of regional disaster knowledge. This was expressed in AADMER, the Agreement on the Establishment of the AHA Centre, as well as the AHA Centre Work Plan 2020, which was developed based on the AADMER Work Programme 2016-2020, among others.

The AADMER outlines that the AHA Centre's main task is to facilitate cooperation and coordination among the Member States and, with the relevant UN and international organisations, promote regional collaboration on disaster management.[8] In addition, articles 18 and 19 of the AADMER further mandate the AHA Centre to play a role in facilitating technical cooperation and scientific and technical research. These two articles provide guidance in understanding the AHA Centre's expected role in the knowledge sector. Paragraph 1 of Article 18 on technical cooperation lists several duties related to knowledge management, such as promoting "exchange of relevant information, expertise, technology, techniques and know-how" (sub-para c), "provide or make arrangements for relevant training, public awareness and education" (sub-para d), "develop and undertake training programmes for policy makers, disaster managers and disaster responders" (sub-para e), and "strengthen and enhance the technical capacity of the Parties" (sub-para f).

Article 19 further outlines the role of the AHA Centre to "promote and whenever possible, support scientific and technical research programmes related to the causes and consequence of disasters and the means, methods, techniques and equipment for disaster risk reduction."

The Agreement on the Establishment of the AHA Centre provides additional description of the AHA Centre's roles, specifically Article 4 of the Agreement. Functions related to the enhancement of disaster knowledge in the region are listed below:

- (i) Receive and consolidate data as analysed by and recommendations on risk level from the National Focal Points;
- (ii) On the basis of such information, disseminate to each Party, through its National Focal Point, the analysed data and risk level arising from the identified hazards;
- (iii) Where appropriate, conduct analysis on possible regional-level implications;
- (xiii) Facilitate activities for technical co-operation;
- (xiv) Facilitate activities for scientific and technical research.

Considered as the AHA Centre's constitutions, the two agreements provide a general understanding of the roles the AHA Centre is expected to play in the knowledge sector of disaster management. The AADMER, in particular, also outlines the ultimate objectives of regional disaster management, which are: "…to achieve substantial reduction of disaster losses in lives and in the social, economic and environmental assets of the Parties, and to jointly respond to disaster emergencies through concerted national efforts and intensified regional and international cooperation" (article 2 of the AADMER). It is important to keep this ultimate objective in mind as the AHA Centre continues to grow and progress.

[8] See article 20, paragraph 1

7.5 ASEAN Vision 2025 on Disaster Management and the Need for a Regional Knowledge Hub

The ASEAN Vision 2025 on Disaster Management establishes a broad regional strategic direction for AADMER's implementation until 2025. It highlights ASEAN's growing confidence as a community and its ambition to become one of the global players in disaster management. The document expresses the ambition as follows:

> **"…this policy document proposes to position ASEAN as a pioneer in transforming the disaster management landscape in the Southeast Asian region and beyond, and strengthen its leadership to maintain ASEAN centrality."[9]**

Knowledge management is recognised as one of the core components in realising this ambition. The document identifies three strategic elements: (i) institutionalisation and communications; (ii) partnerships and innovations, and; (iii) finance and resource mobilisation. Knowledge management is crucial in these three elements, but is particularly pervasive in institutionalisation and communications, and partnerships and innovations.

Institutionalisation and Communication. ASEAN will seek to promote a multi-layered and cross-sectoral governance approach integrating ASEAN's three pillars into disaster management: the socio-cultural pillar, the economic pillar, and the political-security pillar. Institutionalisation refers to the process of capturing and formalising ideas, ambitions, and examples of best practice in regional disaster management. This can be done through various means, for example, by signing declarations, issuing statements, establishing new institutions or expanding existing ones, adopting new norms or values, or developing new mechanisms and procedures. The ultimate aim of institutionalisation is to create a disaster resilient community at all levels in ASEAN. By institutionalising the norms, procedures, and ideas, ASEAN aims to become one of the global leaders in disaster management by 2025. A good knowledge management system will be essential in enhancing ASEAN's institutionalisation and communication processes. In fact, the ASEAN Vision 2025 expressed that ASEAN is very much "well placed to become a global leader given its vast experience, knowledge and expertise in disaster management and emergency response by 2025".[10]

Partnership and Innovation. ASEAN will seek to expand its involvement with a diverse range of stakeholders, such as local civil society organisations, including faith-based and youth groups, as well as with the private sector, and academic and scientific communities. The partnership will enable ASEAN to increase its capacity to respond and build community resilience against disaster. Through these partnerships, ASEAN will be able to harness the community's creative and innovative power. This element will seek to support the integration of local knowledge and capacity of key stakeholders into the disaster management and emergency response,[11] including local communities in the disaster management decision making process.

Through the spirit of innovation, ASEAN will also build partnerships and networks with think tanks and universities to establish itself as a research and development hub for disaster management innovation. This vision also expresses the ambition that by 2025, the AHA Centre will serve as the platform for the "exchange and repository of information, sharing of lessons learned and best practices experienced on reducing risks and enhancing resilience to impending disasters."[12]

Strategic engagement with youth will also be crucial for the future. ASEAN is aiming to become one of the global leaders in disaster education by 2025, by ensuring "…skills transfer and the training of the next generation of disaster management and emergency response specialists".[13]

This element mentions several targets for the ASEAN community in general, and the AHA Centre in particular, regarding disaster management innovation, including to:

- a. Function as a Research and Development hub for humanitarian innovation, through partnership with think tanks and universities, as well as through close engagement with the youth sector.[14]
- b. Serve as a platform for the exchange and repository of information sharing of lessons learned and best practices experienced on reducing risks and enhancing resiliency to impending disasters, drawing on technological development.[15]
- c. Establish a network of ASEAN centres for training and leadership in disasters within Southeast Asia.[16]
- d. Enhance skills and competencies to improve disaster management and emergency response.[17]

[9] ASEAN Vision 2025 on Disaster Management, page 3
[10] Ibid. page 10

[11] Ibid. page 18
[12] Ibid. page 19
[13] Ibid. page 19
[14] Ibid. page 18
[15] Ibid. page 19
[16] Ibid. page 19
[17] Ibid. page 19

7.6 Becoming a Regional Knowledge Hub

Having examined several key policy documents, one clear conclusion that can be drawn is that the expectation of the AHA Centre's ability to manage and develop regional disaster management knowledge is high and diverse. There is no indication that the Member States have changed their expectations of the AHA Centre. Alternatively, on numerous occasions, Member States have expressed appreciation for the AHA Centre's important role in capacity building of the National Disaster Management Organisations (NDMOs), database management, and documentation of regional experience and knowledge through After-Action-Reviews and book publications. These are the knowledge management roles the AHA Centre has performed since its establishment.

This paper proposes that the term 'knowledge hub' should be used as the umbrella term to address all expectations of the AHA Centre in the management of regional disaster knowledge, as expressed in the three core strategic documents: the AADMER, the ASEAN Agreement on the Establishment of the AHA Centre, and the ASEAN Vision 2025 on Disaster Management. In order to move forward, it is important to recognise these expectations and identify the appropriate roles the AHA Centre can perform in order to fulfil them.

The ultimate objective of the AHA Centre as a regional knowledge hub is to enhance regional disaster resilience. Knowledge will enable a better response, and better preparedness. Knowledge distilled from actual experience will inform policy makers, as well as the affected community, of the steps required to prevent similar catastrophes from reoccurring. Therefore, promoting knowledge is promoting disaster resilience.

The AADMER Work Programme 2010-2015 identified at least one potential role the AHA Centre can play, which is to become the main regional data hub for disaster knowledge. In particular, the Work Programme identified two critical types of data and information: disaster response information, and strategic disaster risk reduction information, comprising lessons learned from previous disasters, disaster patterns, etc.[18] This role was further developed under Concept Note 10 on ASEAN Knowledge Management (KM) Hub under the Strategy and Priorities for AADMER Work Programme Phase 2 (2013-2015), which sets out the data hub's objective to "document, disseminate and institutionalise knowledge on disaster management in the ASEAN region, and strengthen the AHA Centre website to effectively serve as the main regional information gateway on disaster management in the ASEAN region."[19]

[18] The ASEAN Secretariat, "The ASEAN Agreement on Disaster Management and Emergency Response (AADMER) Work Programme for 2010-2015, Jakarta, 2010, p. 87
[19] The ASEAN Secretariat, "Strategy and Priorities For AADMER Work Programme Phase 2 (2013-2015)", Jakarta, 2014

Based on the identified expectation towards the AHA Centre, in particular on disaster management knowledge, the AHA Centre can play a number of crucial roles as regional knowledge hub, including advocating for evidence-based policy making, promoting professionalism and regional innovation, managing a comprehensive database system, and sharing regional disaster management experience beyond the region. Figure 7.1 below illustrates the regional knowledge hub's five strategic roles and eight supporting pillars. We will examine them one by one.

Figure 7.1 The regional knowledge hub's five strategic roles and eight pillars

The first proposed role is to advocate for *evidence-based policy making* in disaster management. Evidence-based policy making is an approach that will enable policy makers to make better strategic decisions, especially in the areas of disaster management. This approach will help Member States develop their resilience to disasters, because policy will be based on evidence. In this role, the AHA Centre can partner with reputable universities and think tanks that can provide the ASEAN Member States' respective governments with useful policy inputs based on reliable research.

A second proposed role is for the AHA Centre *to promote professionalism in disaster management and build the capacities of disaster workers in the region*. Disaster workers are critical for disaster management, as they are at the front line, in the field, and directly in touch with affected communities. Developing disaster workers' professionalism will help enhance the quality of the Member States' disaster response, as well as positively contribute to each country's overall disaster management system. By promoting professionalism, the AHA Centre may consider working closely with a diverse range of partners, including universities, training institutions, and National Disaster Management Organisations (NDMOs), to develop standards and capacity building activities. In addition, the AHA Centre may establish a network of disaster management scientists and practitioners.

The AHA Centre should also work *to promote innovation in the management of disasters*. Innovation is the application of better solutions to existing challenges. By promoting innovation in disaster management, the AHA Centre will be aiming to encourage and facilitate new ideas to improve regional disaster mitigation and resilience. New technologies will be one of the main tools of innovation. However, innovation in disaster management will explore both technological and non-technological innovations, such as changing the disaster structure mechanisms, improving processes, changing mindsets and paradigms, building community resilience, and revising rules and regulations that can facilitate faster, more efficient, and more flexible emergency response operations.

As a knowledge hub, the AHA Centre should also *manage a comprehensive database system on disaster-related information in the region*. Database management is already identified under Concept Note 10 as the potential role of the AHA Centre as knowledge hub. The AHA Centre will collect diverse types of disaster information, including databases on research, experts, disaster management professionals, regional disaster management laws, and many others. By performing this role, the AHA Centre is seeking to support the regional disaster community by ensuring the availability of relevant information that can support decision-making processes, research initiatives, innovation, as well as partnership and networking between different stakeholders.

The AHA Centre currently hosts several databases, such as the ASEAN Disaster Information Network (ADINet), which collects information regarding regional disasters, and the ASEAN Science-based Disaster Management Platform (ASDMP). The AHA Centre should expand and improve the current databases to create a comprehensive and integrated database system on regional disaster knowledge.

Lastly, but equally as important, the AHA Centre should also *share and disseminate ASEAN knowledge beyond the region*. The AHA Centre can disseminate ASEAN's collective as well as individual Member States' knowledge, lessons and best practices across and beyond the ASEAN region, in line with the vision to make ASEAN a global leader on disaster management by 2025.

7.6 Strategising the Knowledge Hub: How AHA Centre Can Become a True Regional Knowledge Hub

The roles expected of the AHA Centre as a regional knowledge hub are highly diverse. As a relatively young organisation with resource and capacity constraints, the AHA Centre needs to strategise its approach so it can fulfil most, if not all, of the expectations. The following section will elaborate the strategic pillars of the AHA Centre as the knowledge hub.

A Strategic and Policy Guidance

The ASEAN Committee on Disaster Management (ACDM) Working Group on Knowledge and Innovation Management (WG KIM) will be the advisory body that can provide strategic guidance to the AHA Centre as the knowledge hub. The AHA Centre will regularly update WG KIM on the progress of the knowledge hub at the WG KIM's regular meetings. If necessary, for high-level policy support, the WG KIM can also refer to the ACDM for further direction and policy guidance, as well as to the ASEAN Ministerial Meeting on Disaster Management (AMMDM) and AADMER Conference of the Parties.

B Whole-of-Organisation Approach

To perform as knowledge hub, the AHA Centre must recognise that it requires the contribution of all AHA Centre staff; not just of one officer, one unit or one department. The responsibility to conduct the activities of the knowledge hub will be carried by all staff members across the departments. To support this approach, the AHA Centre should follow the basic principles of knowledge management. It is also important to note that it is insufficient to just manage knowledge. The AHA Centre's Internal Guideline on Knowledge and Change Management explains that "Knowledge & Change Management is a Process that systematically transforms AHA Centre into a learning organisation that continuously changes, improves and innovates to do things better in everything that we do in order to become a world class regional organisation."[20] The guidelines further explain that the process will not be limited to capturing, storing and sharing knowledge, but that it is "most important [...] the knowledge that has been transferred from individual to the organisation can create continuous change that improves AHA Centre performance".[21]

[20]Source derived from the intranet of the AHA Centre (not publicly available)
[21]Ibid.

C Formation of Knowledge Unit under the AHA Centre

The AHA Centre would need to establish a knowledge unit as part of its structure to fully realise its regional knowledge hub role. It will coordinate internal knowledge activities, as well as those between Member States and partner institutions. Under the AHA Centre Work Plan 2020, the possibility of forming a knowledge unit in the AHA Centre is already recognised and approved, specifically under Priority 2 on Knowledge Management and Capacity Building. The Work Plan mandates the AHA Centre to enhance the Knowledge Management Unit with adequate resources and manpower by 2018. Shortly, the AHA Centre will use the opportunity from projects with ASEAN Dialogue Partners and other relevant partners to form the unit, before mainstreaming it in the core structure.

D Initiate Pilot Studies to Identify Priorities and Potential Impact

The role as knowledge hub will require considerable resources from the AHA Centre. With its current resource constraints, it will be difficult for the AHA Centre to fulfil all the expected roles. In order to fully perform the roles of knowledge hub, the AHA Centre will need to approach them sequentially. The AHA Centre should also consider prioritising activities that have a larger potential impact.

To identify which activities it can prioritise, the AHA Centre can initiate a series of pilot studies. This can take the form of projects that can be financially supported by ASEAN Dialogue Partners and other potential donors. This has been implemented by the AHA Centre for some time, and over time the Centre has built a solid reputation as a transparent and credible organisation. The AHA Centre would need to continue to maintain this reputation and enhance it, in order to continue to earn Partners' trust and respect.

With Partners and donor support, the AHA Centre will be able to identify critical activities that must be sustained. To ensure sustainability, strategic guidance from the WG KIM and the ACDM is critical to building a support mechanism that can sustain the AHA Centre's knowledge management activities with less dependence on external partners.

E Member States Patronage

In addition to seeking support from donors, Member States can also provide support to a particular activity or set of activities. Member States can take the lead, or provide the AHA Centre with financial and/or capacity support. As Co-Chair of the WG KIM, Singapore takes the lead of the ASEAN Strategic Policy Dialogue on Disaster Management (SPDDM). Similarly, Indonesia, also as WG KIM Co-Chair, takes the lead for development of the ASEAN Standards and Certification for Experts in Disaster Management (ASCEND). The AHA Centre welcomes the support from Member States, in particular from the WG KIM members for other key activities.

F Communication Strategy

As part of its role as the regional hub on disaster knowledge, the AHA Centre should devise a communication strategy to support its knowledge function. The communication strategy will attempt to communicate regional disaster knowledge updates, such as the latest research, innovation, or capacity building activities, as well as any AHA Centre knowledge hub initiatives.

In devising the knowledge hub communication strategy, the Knowledge and Change Management Officer should work closely with the AHA Centre's Communication Officer. The knowledge hub will utilise the AHA Centre's existing communication channels, as well as initiate new ones, including the production of new AHA Centre scientific publications.

In addition, the AHA Centre may attempt to establish communication focal points in each Member State. The main responsibility of The Member States' focal points is to act as information gatekeeper for the AHA Centre, and vice versa. The communication focal points will also support the AHA Centre in the localisation of new relevant knowledge that can benefit the Member States.

G Engagement with Knowledge Actors in the Region/Creating Community of Practice

As a knowledge hub, the AHA Centre should engage the region's critical knowledge actors. Through this, the AHA Centre should seek to create a community of practice in the disaster management field. A community of practice is a group of people who share the same passions and aim to learn together to improve their knowledge. There are several ways the AHA Centre can engage a community of practice. Firstly, the AHA Centre can facilitate the establishment of an ASEAN network of disaster management scientists and practitioners. The basic idea is that it will serve as the forum to connect disaster management scientists with practitioners. Secondly, the AHA Centre can also seek to establish partnerships with reputable regional think tanks, research institutes, and universities. This partnership will enable the AHA Centre to access their knowledge and expertise. The AHA Centre can also help facilitate opinion, information and knowledge exchange between the disaster knowledge actors.

The AHA Centre should explore the use of technology to improve its capability and capacity. Currently the organisation is supported by a wide range of technology, including the Disaster Monitoring and Response System (DMRS), the ASEAN Disaster Information Network (ADINet), WebEOC (Web-based Emergency Operations Centre), and the intranet system for internal file sharing.

With support from the Information Communication Technology (ICT) Phase IV project, the AHA Centre has the capacity to integrate all ICT supporting systems into a single platform, improving accessibility to different AHA Centre web systems. It will also host a knowledge portal for disaster professionals. Currently the AHA Centre hosts the ASEAN Science-based Disaster Monitoring Platform (ASDMP), an online portal for researchers and policy makers to store and share research, as well as disaster management policy documents. However, the ASDMP is still limited, and therefore the AHA Centre should aim for it to become the primary knowledge portal for disaster management professionals.

E-learning will help enhance participants' learning experience by utilising various innovative devices and applications. This will enable the AHA Centre to deliver difficult and complicated disaster management subjects in relatively easy to understand methods, thereby ensuring widespread understanding of critical topics, such as the disaster management mechanism in ASEAN, the AADMER, and others. Additionally, through e-learning, the AHA Centre should expand its outreach by creating educational content accessible to all Southeast Asian communities, without the need to be physically present in the same classroom. Lastly, the e-learning system will enable the AHA Centre to increase its impact in disaster management through education and learning processes with less of a financial burden.

7.7 Experiencing the Knowledge Hub: Past and Present Practices of the AHA Centre

It is important to note that the knowledge hub is not new for the AHA Centre. Since its inception, the Centre has performed the roles of knowledge hub in varying degrees. The example described in the previous section, on the AHA Centre's role in collecting lessons learned from the Typhoon Haiyan emergency response, demonstrates that the Centre has been performing the role as regional disaster management knowledge hub for a significant period.

Since its earliest days, the AHA Centre has aspired to be the region's data centre for disaster events. Just two months after its establishment, the AHA Centre launched ADINet, an online database platform that collects regional disaster information. By the end of January 2019, seven years after its launch, the ADINet has evolved into the region's primary repository of disaster event information, containing information and reports from 1,317 regional disaster events, organised into 10 separate categories.

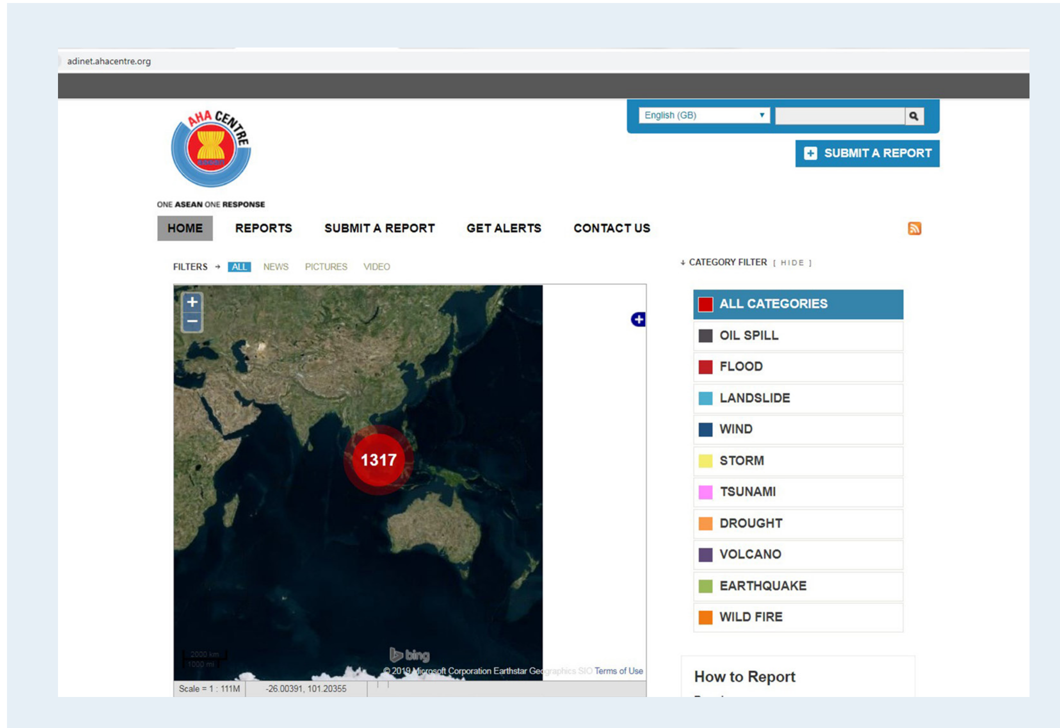


Image 7.1 Screengrab of ADINet as of 31 January 2019

Following the ADINet, the AHA Centre launched another database, the ASDMP, developed with the support of the APEC Climate Centre (APCC) based in the Republic of Korea. The ASDMP is a database of disaster management experts and documents. Since its launch in December 2017 and until the end of January 2019, it collected the data of 35 disaster management experts and more than 1,230 academic papers, in addition to a small number of regional disaster management policy papers and laws. The management of both ADINet and the ASDMP demonstrate that the AHA Centre's database management is an integral part of its service as a regional knowledge hub.

ASDMP
ASEAN Science-based Disaster Management Platform

Image 7.2 Logo of the ASDMP

The AHA Centre has also initiated several capacity building activities targeting staff of the 10 ASEAN Member States' National Disaster Management Organisations (NDMOs). One such activity is the AHA Centre Executive (ACE) programme, which is currently entering its sixth year. Under this programme, each NDMO sends two staff members to the AHA Centre to participate in a 5-month programme, which covers hard technical skills such as project management training, as well as soft skills such as leadership training. This programme has been deemed successful and to date has produced 79 graduates from almost all ASEAN countries.

Another long-running AHA Centre training programme is the ASEAN-ERAT induction course. The ASEAN-ERAT is ASEAN's rapid response team which can be deployed anywhere within the region to support any emergency response. The One ASEAN One Response Declaration recognises ASEAN-ERAT as the official resource of ASEAN. The ACDM has tasked the AHA Centre with its management, and since 2014 the AHA Centre has conducted induction courses for new ASEAN-ERAT members. In 2018, as part of the ongoing effort to enhance the ASEAN-ERAT system, the AHA Centre conducted three specialised advanced courses on humanitarian logistics, information management, and rapid assessment. To date, the ASEAN-ERAT roster consists of 275 trained members from the 10 ASEAN Member States, with the objective of increasing the roster to at least 500 members trained through induction courses, and 50 specialists trained through advanced courses.

Figure 7.2 The ACE Programme has produced 79 graduates from across ASEAN to date

Another service of the AHA Centre's knowledge hub is the documentation of existing knowledge and practices that promotes learning and knowledge transfer among the region's disaster management actors. Since its inception, the AHA Centre has produced several publications, one of which is its Knowledge Series, launched to commemorate the Centre's five-year anniversary in 2016. Comprising eight books, the Series attempts to capture the AHA Centre's work, mechanisms, and accomplishments. In addition, the AHA Centre publishes its annual report, which can be accessed by the public from its homepage at www.ahacentre.org. Physical copies of AHA Centre publications are also available in the Knowledge Corner of the AHA Centre office in Jakarta.

Image 7.3 The Knowledge Corner in the AHA Centre's office

Image 7.4 AHA Centre Knowledge Series

Conclusion & Recommendation

For the AHA Centre to perform as regional knowledge hub, this paper proposes a holistic role that goes beyond database management and is not limited to storing knowledge. The role also contributes to knowledge dissemination, policy advocacy, and promotion of innovation and professionalism in the region.

As one of the world's most disaster-prone regions, Southeast Asia has accumulated an abundance of disaster management experience and knowledge. Yet, despite this abundance, it has not been captured and shared sufficiently. The region's size, vast population, and cultural and linguistic diversity all contribute to the challenge of capturing this knowledge. The ASEAN Vision 2025 on Disaster Management aims to transform ASEAN into the global leader in disaster management, and the ability to capture regional disaster knowledge is crucial to achieving this vision. The establishment of the regional knowledge hub will enable ASEAN to capture and share its disaster knowledge with other regional organisations, and with the rest of the world.

From a policy perspective, the need for a regional knowledge hub is clearly articulated in several strategic documents, such as the AADMER, the Agreement on the Establishment of the AHA Centre, the ASEAN Vision 2025 on Disaster Management, the AADMER Work Programme 2016-2020, and the AHA Centre Work Plan 2020. The ACDM also tasks the AHA Centre to establish itself as a regional knowledge hub through the AADMER Work Programme 2016-2020 under Priority 8 on "Lead", Component 1 on "establishing integrated regional disaster management knowledge hub".

The AHA Centre is well placed to become a regional knowledge hub because of its vast operational hands-on experience, its function as a coordinating agency, and its experience in facilitating knowledge exchange in various capacity building activities. As a regional knowledge hub, the AHA Centre can assist the region to develop and utilise its knowledge to transform and improve disaster management in ASEAN. It can also act as a connecting point and melting pot for diverse knowledge actors and stakeholders within the region and beyond.

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CHAPTER 8

Regional Centrality and the Shift of Humanitarian Landscape: The Case of ASEAN

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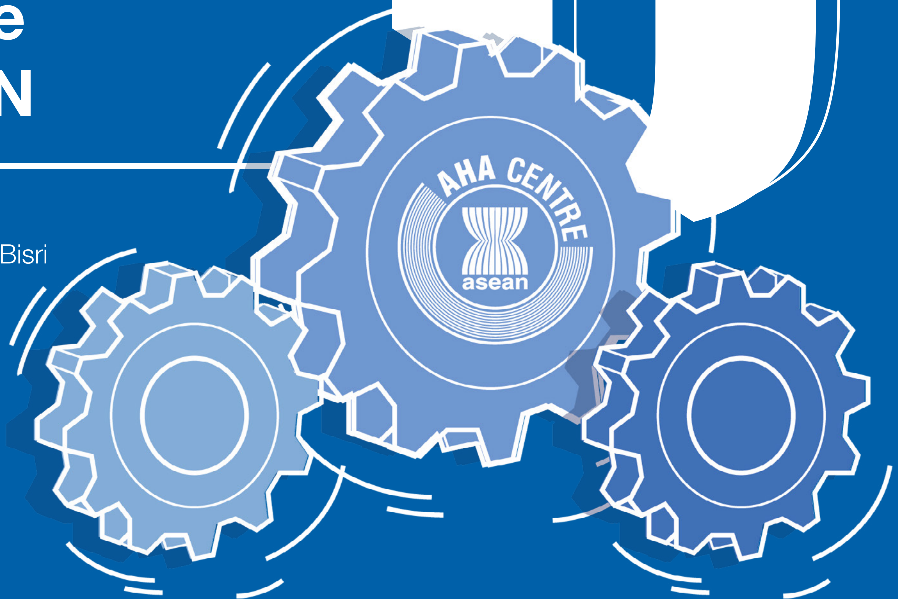


Abstract

This chapter unravels the inter-organisational network of emergency response in the Southeast Asian region, and historically analyses the progress of centrality and humanitarian operations of its regional body, the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre). Two large-scale disasters during a five-year period, the 2013 Typhoon Haiyan in the Philippines and the 2018 Central Sulawesi Earthquake and Tsunami in Indonesia, were selected to reflect ASEAN's distinct characteristics of disaster response, and the AHA Centre's early establishment to full operationalisation. These cases are comparable as international humanitarian response assistance offered to ASEAN was accepted by both the affected countries. A combination of Social Network Analysis (SNA) was applied to model the network of each case, and was supplemented by regional responders' insights on ASEAN's emergency response performance. Several concluding key points are presented, along with a pathway for strengthening ASEAN's coordination and centrality in the humanitarian field.

Keywords: ASEAN centrality, social network analysis, inter-organisational network, ASEAN emergency response, Central Sulawesi Earthquake and Tsunami, Typhoon Haiyan/ Yolanda

8.1 Introduction

When the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) was signed by the ASEAN Foreign Ministers, the memory of the 2004 Indian Ocean Earthquake and Tsunami was still fresh in the minds of everyone in Southeast Asia. The discussion for the Agreement had started some time before the disaster struck Indonesia, Malaysia, Myanmar and Thailand. The disaster accelerated the negotiation, and by July 2005, seven months after the tsunami, the Agreement was signed in Vientiane, Lao PDR. After four years the Agreement came into force, with full ratification by all ASEAN Member States.

The sheer scale of destruction caused by the Indian Ocean Tsunami forced ASEAN Leaders to rethink disaster management, and the Agreement reflects the mindset that was forming during that period. This mindset was expressed by the ASEAN Secretary-General at the time, H.E. Ong Keng Yong, that "the Indian Ocean Tsunami in its epic proportion has motivated Member Countries of the Association of Southeast Asian Nations (ASEAN) to come to terms with their individual country's vulnerability to natural disasters."[1] It also triggered the idea that ASEAN, as the primary regional grouping, can do more to help its members mitigate and reduce the impact of disasters.

[1]Statement by the ASEAN Secretary-General, at Senior Policy Forum ""Mega Disasters – a Global "Tipping Point" in Natural Disaster Policy, Planning and Development" at Pacific Disaster Centre, Maui, Hawaii, https://asean.org/?static_post=statement-by-secretary-general-of-asean-2

The ultimate objective of the Agreement is the 'substantial reduction of disaster losses and in the social, economic and environmental assets' of the Member States. The Agreement articulates clearly the principle of ASEAN centrality by laying the foundation for regional cooperation, coordination, technical assistance and resource mobilisation in disaster management through the ASEAN mechanism. This spirit was articulated again in subsequent agreements and declarations, including in the Agreement on the Establishment of the AHA Centre in November 2011, the One ASEAN One Response Declaration, as well as the ASEAN Vision 2025 on Disaster Management. This last document outlines ASEAN's vision of becoming a global leader in disaster management, through strengthening regional cooperation in communication, financing and resource mobilisation, and partnership and innovation.

This chapter aims to illuminate the value of ASEAN centrality in a networked constellation of international organisations responding to disasters in the Southeast Asian region. It will unravel the regional inter-organisational network of emergency response and historically analyse the progress of centrality and humanitarian operations of its regional body, the AHA Centre, in regards to ASEAN as a whole. In addition, it also seeks to illustrate the hub of humanitarian operations within ASEAN, and to assess whether the AHA Centre has been progressing in its role of coordination hub.

Two large-scale disasters prompting regional and international humanitarian operations, the 2013 Typhoon Haiyan in the Philippines and the 2018 Central Sulawesi Earthquake and Tsunami in Indonesia, were selected to reflect ASEAN's distinct characteristics in responding to catastrophic disasters, and the AHA Centre's early establishment to its full operationalisation. The five-year time span is potentially useful for understanding whether institutional improvements at the regional level add value to the response. These cases are also comparable as international humanitarian response assistance offered to ASEAN was accepted by the affected countries. SNA was applied to model the network of each case, and this was supplemented by insights from ASEAN's emergency response.

The chapter is organised with an introduction as its first sub-chapter, which is followed by a brief section on the methodology. It will then be followed by two separate sub-chapters discussing the case studies. For each case, the sub-chapter begins with a brief introduction of disaster management governance in each country prior to the disasters, modelling and analysis of the network during the emergency response, followed by a review of the humanitarian assistance provided by ASEAN through the AHA Centre, and assessment of its performance/value. The final sub-chapter provides conclusions and recommendations.

8.2 Methodology

Inter-organisational Network Mapping is an adaptive approach to utilise SNA for modelling inter-organisational networks during international humanitarian operations to large-scale disasters (Kapucu, 2010; Bisri, 2016a; Bisri, 2016b; Bisri, 2016c; Bisri, 2017a; Bisri, 2017b). This approach is known for its versatility in addressing many research queries in the field of disaster management and humanitarian affairs, ranging from networks at individual, community, and organisational levels. It was used for the 2003 Mozambique Flood (Moore et al, 2003), the 2004 Indian Ocean Tsunami (Lassa, 2015; Guarnacci, 2016), the 2005 Hurricane Katrina (Kapucu et al, 2010; Doerfel et al, 2013), the 2007 Peru Earthquake (Kumar, 2010), the 2009 West Java Earthquake (Bisri 2013; Bisri, 2016), the 2009 West Sumatra Earthquake (Bisri, 2016a; Siciliano & Wukich, 2016); the 2011 Great East Japan Earthquake and Tsunami (Aldrich, 2012; Bisri, 2016b; Siciliano & Wukich, 2016); and the 2015 Nepal Earthquake (Bisri & Beniya, 2016). It was also used for regular assessment of emergency management readiness in the US, e.g. in Florida (Choi & Brower, 2006; Kapucu & Hu, 2014), Texas (Andrew & Carr, 2012), and Pennsylvania (Wukich & Robinson, 2014).

Two key measurements typically used in SNA as proxy for understanding a network structure, and for identifying potential key actors in a network, are degree centrality and betweenness centrality. Therefore, it will be used to assess the AHA Centre's response to Typhoon Haiyan and the Central Sulawesi Earthquake and Tsunami. It should be noted, however, that for the purposes of this paper, only the AHA Centre's degree centrality and betweenness centrality will be disclosed. Other research has investigated and provided complete measurements of all humanitarian actors in the Typhoon Haiyan response (Saban, 2015; Bisri, 2017b), while research on the Central Sulawesi Earthquake and Tsunami response is yet to be published. However, the visualisations provided in this chapter can be used as reference for brief understanding of the network itself.

The Degree Centrality indicates the position of a point within a given network. Generally, it indicates how well an actor is connected within the overall network, as such, it is an individual measurement. It can also help predict the level of strength/power between units within an organisation. Prell (2012) provides the formula to measure the degree centrality, as illustrated below. In the formula, "i" is the focal vertex (node), "j" represents all ties (or links), and N is the total number of nodes in the given network.

$$CD\,(Si) = \sum_{j}^{N} \frac{Sij}{N}$$

Equation 8.1 Formula to calculate degree of centrality

The second egocentric measurement is the Betweenness Centrality, which is another method to calculate centrality by determining 'betweenness' of nodes. It refers to a specific node that is 'between' other nodes in the network. A node with a smaller degree of betweenness may hold an important liaison role, and as a result will be very concentrated in the network (Scott, 2000). Betweenness centrality is the measurement to determine the organisational leader(s) in a network within a society. Betweenness can also be defined as a measurement to what extent an actor is located in the direct path of communication exchange between two other actors in the network (Scott, 2000; Wasserman & Faust, 1994). In this measurement, one can identify the highest value of betweenness centrality. The greater the betweenness centrality power of an actor, the greater dependence of other actors on that actor to communicate with others. Arbesman and Christakis (2010, p.6) rewrite the equation as illustrated below. Pi(kj) is the number of geodesics (the shortest path) between k and j that i rests on, and P(kj) is the total number of geodesics between k and j (Arbesman and Christakis 2010). The betweenness centrality has a value between 0 and 1. The higher the value of centrality of the node in the network is an indicator of leadership. It is also common to use betweenness centrality as a proxy to identify coordinators or brokers in a network.

$$Cb\,(Si) = \sum_{j}^{N} \frac{\frac{Pi\,(kj)}{P\,(kj)}}{\frac{(N-1)N-2)}{2}}$$

Equation 8.2 Formula to calculate Betweeness Centrality

To this end, it can be clarified that in the context of networks in this chapter, the nodes identified are organisations involved in emergency response to disasters. Activation of the node's attribute will help the reader to understand the type of an organisation in the network. Meanwhile, the ties visualised in the network represent the overall emergency response activities (e.g. financial donations, in-kind, food items, relief items, etc.).

For the 2013 Typhoon Haiyan case, data is derived from various situation reports produced and archived by the Government of the Philippines (GPH), i.e. National Disaster Risk Reduction and Management Council (NDRRMC) and Department of Social Welfare and Development (DSWD); the AHA Centre; the United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA); the European Civil Protection and Humanitarian Aid Operations (ECHO); Foreign Aid Transparency Hub (FAITH), and Google's Typhoon Yolanda Relief support. This generated a sample of 390 emergency response activities (480 identified ties) and 275 organisations (275 nodes) operating in Typhoon Haiyan affected areas from November 2013 until February 2014. For the 2018 Central Sulawesi Earthquake and Tsunami case, data is derived from the AHA Centre's record of assistance and situation reports, daily updates from the National Disaster Management Authority of Indonesia (BNPB), and UN-OCHA's situational reports. This generated a sample of 269 emergency response activities (338 identified ties) conducted by 140 organisations (140 nodes), during the period of 28 September to 31 October 2018.

Reflective qualitative description of the coordination will also address the three layers of coordination commonly understood in the ASEAN context: strategic, operational, and tactical level (AHA Centre, 2018), as illustrated by the figure below. Strategic level coordination comprises activities undertaken in Jakarta (as the central point for many ASEAN activities), with the aim to work closely with ASEAN countries, Dialogue Partners, and the international community. Operational level coordination is undertaken in the capital cities of the affected ASEAN countries. Tactical level coordination is undertaken on the ground to ensure close communication with field-level decision makers and responders, through the ASEAN Emergency Response and Assessment Team (ASEAN-ERAT). The dynamics and insights from each level of coordination during Typhoon Haiyan and the Central Sulawesi Earthquake and Tsunami will be elaborated, to understand the mechanism behind the identified inter-organisational network structure through SNA.

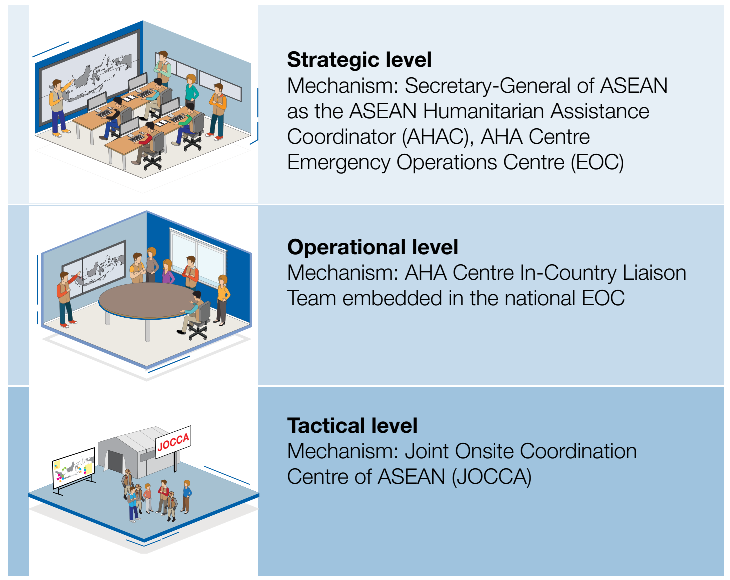


Figure 8.1 Three Levels of Coordination of One ASEAN One Response Operationalisation

8.3 The 2013 Typhoon Haiyan

In the Philippines, the enactment of Presidential Decree 1566 of 1978 marks the country's first initial stance on disaster management. It was followed by the enactment of the National Calamities and Preparedness Plan of 1983. However, from that point until the end of the first decade of the 2000s, in the Philippines 'disaster management' was essentially part of the civil defense despite large-scale disasters, e.g. the 1991 Mount Pinatubo Eruption, and despite the global push for the adoption of the Hyogo Framework for Action (HFA) 2005-2015. The Philippines waited until 2010 before enacting their Republic Act 10121 on Philippines Disaster Risk Reduction and Management (RA 10121).

In terms of organisational design for disaster management, the RA 10121 did not change much. The name of the National Disaster Coordinating Council (NDCC) was simply changed to the National Disaster Risk Reduction and Management Council (NDRR), therefore it is still operating with a council-like approach, and is still under the Office of Civil Defense (OCD) as the chair. The Philippines' council-like arrangement mainly requires representatives of various ministries of specific sectors and other organisations to coordinate implementation of four thematic areas of the country's disaster management, each chaired by a national government department. Disaster response, the main subject of this chapter, is chaired by the Department of Social Welfare (DSWD). However, early warning is under the authority of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), while the Department of Interior and Local Government is in charge of preparedness at the local government level.

Prior to the 2013 Typhoon Haiyan, the key disaster management policy document was the National Disaster Risk Reduction and Management Plan (NDRRMP) 2011-2028 of the Philippines (NDRRMC, 2011), however, it does not refer to the need to prepare a Disaster Risk Financing (DRF)-like policy document, such as the one created in 1983. In addition, prior to Typhoon Haiyan, the Department of the Interior and Local Government (DILG), which essentially has authority to strengthen the capacity of local governments, only introduced an Incident Command System (ICS)-like approach for disaster response. It did not advise that a DRF policy should be prepared, and did not provide information about humanitarian clusters with involvement in international organisations in the case of national disaster.[2] However, the NDRRMP did list emergency response outputs and corresponding activities that were divided into the following timeline: 1-7 days, 1-3 months and 'beyond 3 months' (NDRRMC, 2011, pp. 27-31).

The disaster response and international humanitarian assistance at that time was required to follow RA 10121 Section 6 on 'State of Calamity' and Section 18 on 'Mechanism for International Assistance'. The section stated that a declaration of 'State of Calamity' by the President is required to indicate acceptance of international assistance. Regarding the mode of accepting international assistance, Section 18 (b) specifically stated that other countries or international organisations must address offers of international assistance to the Department of Foreign Affairs (DFA), subsequently the DFA must consult the disaster management authority and, based on its direction, the DFA may accept international assistance offers either partially or entirely. There was no mention of humanitarian clusters in RA 10121, but it does address customs relaxation for international assistance. Therefore, the author argues that in the Philippines in 2013, no disaster response frameworks adopting the humanitarian clusters arrangement in a meaningful way were in place.

There was also a gap between policy and implementation of disaster preparedness for emergency response at the local level, including understanding of the mechanism of international humanitarian assistance. A review on large-scale disasters in the Philippines from 2009-2012 resulted in a report - published by ASEAN and Save the Children in August 2013 (two months before the typhoon). The report stated that even though the country had started to issue policy directives endorsing and adopting the humanitarian cluster approach, significant gaps persisted between government officers at local government levels and other domestic actors, regarding the role of humanitarian clusters, cluster-lead agencies, and the technical guidelines and standards within a cluster (Barber, 2013). Citing a statement during the emergency response to the 2012 Bopha Earthquake, the effect of non-inclusion of humanitarian clusters is clear: "in the new law [RA 10121), somehow they forgot to mention the cluster system … (local governments) were looking at the law and seeing that the clusters were not there. It would have been easier if they'd been there ... so, if local officials say who are you, you can show them the law" (Barber, 2013, p. 18). Non-inclusion of humanitarian clusters is also potentially observed in the case of Typhoon Haiyan.

Typhoon Haiyan made landfall on 8 November 2013 in Guiuan town, Eastern Samar, and affected several other provinces until leaving the Philippines Area of Responsibility on 11 November 2013. According to the NDRRMC, Typhoon Haiyan directly affected 3.4 million families (16 million people) in 12,122 barangays across 44 provinces in 591 municipalities and 57 cities. Approximately 1,140,332 houses were damaged; 550,928 houses were totally destroyed, and 589,404 houses were partially damaged in nine regions (NDRRMC, 2013).

[2]Based on interviews conducted by the first author with resource persons from nine local governments in Region VII and VIII, Philippines, July 2015 and August 2016.

Given the immediate impact of the typhoon, the Government of the Philippines declared a State of Calamity across the affected areas through Presidential Proclamation No 682 on 11 November 2013, which also declared acceptance of offers of international assistance. In the proclamation, the clause for international assistance acceptance still referred to an even older NDCC order than the 2007 or 2008 orders explained in sub-chapter 6.1; i.e. the NDCC Memo Order no 4/1998 (CoA, 2014, p. 14). Subsequently, the UN Humanitarian Country Team (HCT) and Inter-Agency Standing Committee (IASC) in the Philippines responded by releasing a separate Humanitarian Action Plan. On 12 November 2013, the Emergency Relief Coordinator (ERC) formally activated an IASC system-wide level 3 (L3) emergency response to the typhoon (Hanley, et al., 2014).

In coordination with the Philippines government, the HCT began preparations for response before Haiyan made landfall. United Nations Disaster Assessment and Coordination (UNDAC) was pre-deployed to Manila in order to be ready for travel to the affected areas. Within four days of the typhoon making landfall, the HCT released a Humanitarian Action Plan. A massive response was launched with 462 surge personnel deployed within three weeks. The 12-month Strategic Response Plan (SRP) was published on 10 December 2013. Its total budget of USD 788 million was 60% funded. The activated clusters in the response to Haiyan included early recovery and livelihood, nutrition, WASH, education, health, food security and agriculture, and emergency shelter clusters. Even though both the international community and the Government of Philippines activated the humanitarian clusters, there were differences in the cluster system established in the Philippines with that agreed to at the international level (Hanley et al., 2014, p. 43).

To further explore and understand the dynamics and interactions between international and national humanitarian organisations, it is important to assess the disaster response and recovery stages in the Haiyan case. There were two different but inter-related perspectives on the stages of response to and recovery from the typhoon; i.e. the Government of the Philippines' perspective and the international community perspective.[3] The Government formally recognised two phases: the government humanitarian phase and recovery-reconstruction phase. The government humanitarian phase can be dated from November 2013 until July 2014, for which the coordination between international and national responders was initially led by the Office of Civil Defense (OCD)/NDRRMC (from November 2013), DSWD (from February 2014), and by the Presidential Assistant for Rehabilitation and Recovery (OPARR) from June 2014 onwards. The change in the government's coordination focal point, from OCD/NDRRMC to the DSWD and to the OPARR, implies that the government viewed the emergency response as completed by June 2014.

[3]See Hanley et al. (2014) for the result of IASC's evaluation on the 2013 Typhoon Haiyan.

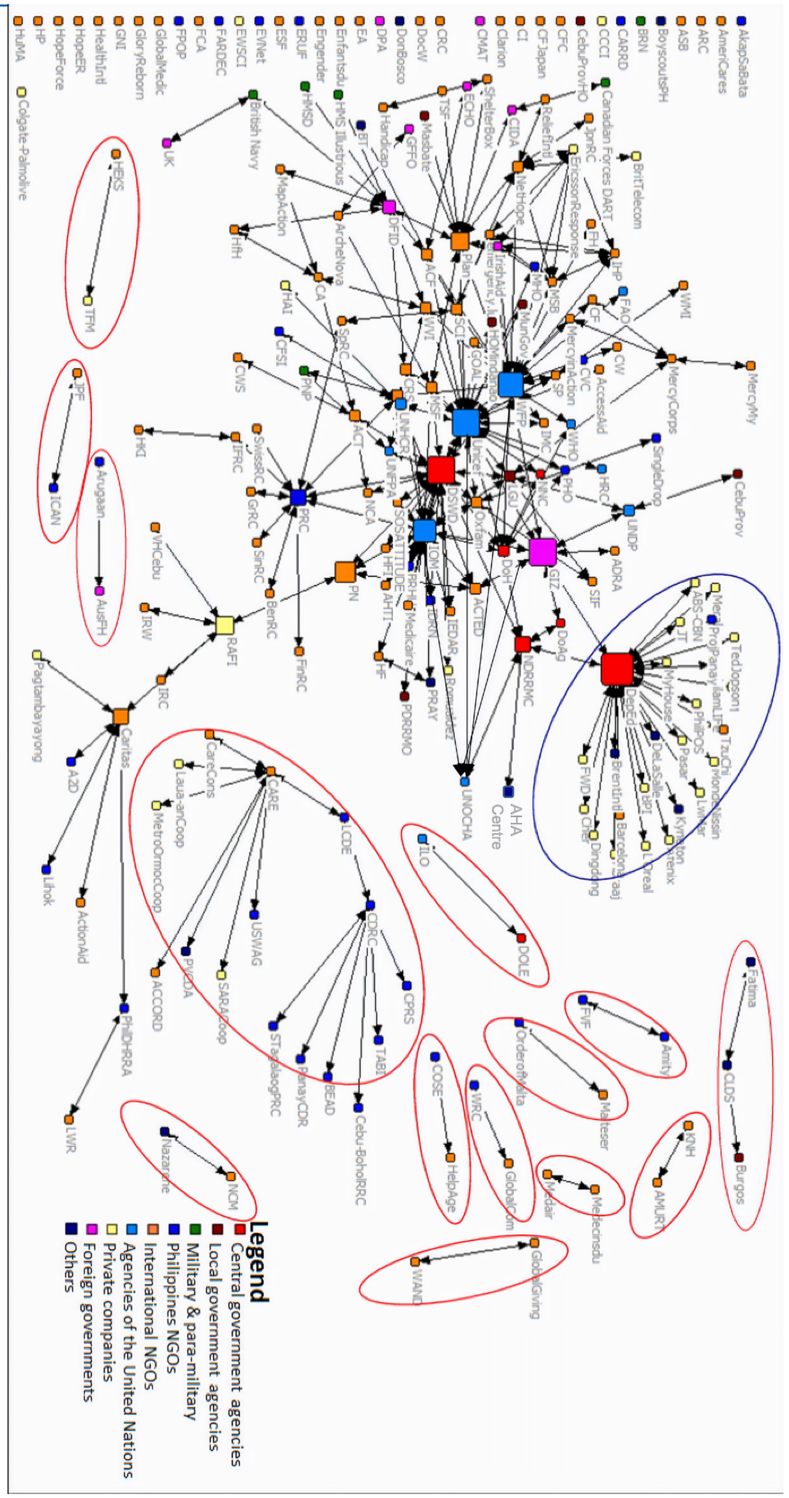
During this period, the government completed the Reconstruction Assistance for Yolanda (RAY) document, Post Disaster Needs Assessment (PDNA), and line agency plans. On the other hand, under the international humanitarian agencies (IASC's humanitarian clusters co-lead agencies and UN-HCT), the level-3 emergency (the highest in IASC's terms) was active from November 2013 until February 2014. At the same time, international humanitarian organisations released flash-appeals for fundraising for the emergency response, as well as the Humanitarian Action Plan (HAP), Multi-cluster/Sector Initial Rapid Assessment (MIRA), Strategic Response Plan (SRP), and Periodic Monitoring Report (PMR 1). In principle, for all humanitarian clusters incorporating international organisations into the response, the SRP was the key document. It clearly stated that the international disaster response would be effective for the period of one year; i.e. it was expected to operate until November 2014. Beyond February 2014, humanitarian clusters continued reporting through Cluster Needs Assessments and PMR 2. Between November 2013 and July 2014, the coordination mechanisms between national and international actors included OPARR/DSWD/HCT meetings, GPH/HCT meetings, cluster coordination meetings and local government level coordination. These coordination mechanisms were then effectively closed on 4 July 2014, when the GPH decided to end the Haiyan response's government humanitarian phase. The HCT then made the decision to close the SRP on 31 August 2014.[4] The divergent perspectives of the stage of disaster response in the case of Haiyan can be summarised as "a shorter disaster response and early move into recovery" from the government perspective, and "a longer disaster response and shorter recovery phase" from the international humanitarian agencies perspective (Hanley et al., 2014).

The inter-organisational cooperation and network model was created to demonstrate the reality of various organisations' emergency response and relief efforts during the 2013 Typhoon Haiyan. A previous attempt at mapping actors' interactions during the 2013 Typhoon Haiyan emergency response (Saban, 2015) captured interactions from 10 November to 9 December 2013. However, after further analysis, these interactions can be considered general, e.g. coordination meetings are included. It is this author's intention to capture actual inter-organisational cooperation of emergency response activities. Furthermore, Saban's timeframe was shorter than the actual emergency response period, which lasted at least until February 2014 as discussed earlier. Accordingly, the author turns to OCHA's consolidated data, which recorded 19,083 entries of emergency response activities. Data consolidation by the author, e.g. combining entries of the same emergency response activity in several municipalities into one, or removing entries that do not have an implementing partner, resulted in a SNA dataset that includes 390 samples of emergency response activities between November 2013 and February 2014.

The result of inter-organisational networks operating during Typhoon Haiyan is illustrated in the next figure, which uses the 'valued' and 'directed' mode, i.e., the frequency/intensity of the relationship was calculated, and the direction of relations can be identified, whether

[4]Although inconclusive and unverified, it seems that some key decision makers in GPH perceived the End of L3 status as a trigger to end the emergency response, and that the international community agreed on the transition to early recovery phase.

Figure 8.2 Inter-organisational Network during Emergency Response of the 2013 Typhoon Haiyan, Philippines



one-way or two-way. Within the network, there are 480 ties, and each organisation type is colored differently. It should be noted that the number of ties is not the same as the number of activities, because one emergency response activity may involve more than two organisations. The size of the node represents the value of each organisation's betweenness centrality, and the maximum size of a node is four times the initial/minimum node size. From the SNA sociometric measurements, it was found that the network density was 0.006, degree centralisation was 0.089, fragmentation was 0.749, and compactness was 0.077. Furthermore, the value of transitivity of the network was 0.101. These sociometric measurements imply that the network has several sub-groups and is not fully connected as a whole, which can be seen in several loose sub-networks identified in several red circles that do not directly link with the main network of various humanitarian clusters, i.e. they do not directly link with the green circle.

In the main network (circled in green), there are several organisations (represented by a larger square), i.e. DSWD, IOM, UNICEF and WFP. These organisations were involved in several humanitarian clusters, such as camp management, food and non-food items and livelihood, as a led or co-lead agency. The education cluster (circled in blue) has a distinctive characteristic where numerous donors from private companies and implementing partners (NGOs) were connected with the Department of Education (DepED), with the DepEd holding crucial links with international NGOs through UNICEF. In addition, there were 38 various organisations performing emergency response activities independently. Furthermore, as can be seen in the above figure, the AHA Centre's position was very central, and closely attached to the NDRRMC. However, limited ties and mandate, and duration of the mission (November 2013 - January 2014) compromised the value of coordination between AHA Centre (degree centrality: 0.026; betweenness centrality: 0.024), when compared with other international humanitarian actors such as UNICEF (0.095, the highest degree centrality with 0.066 in betweenness centrality).

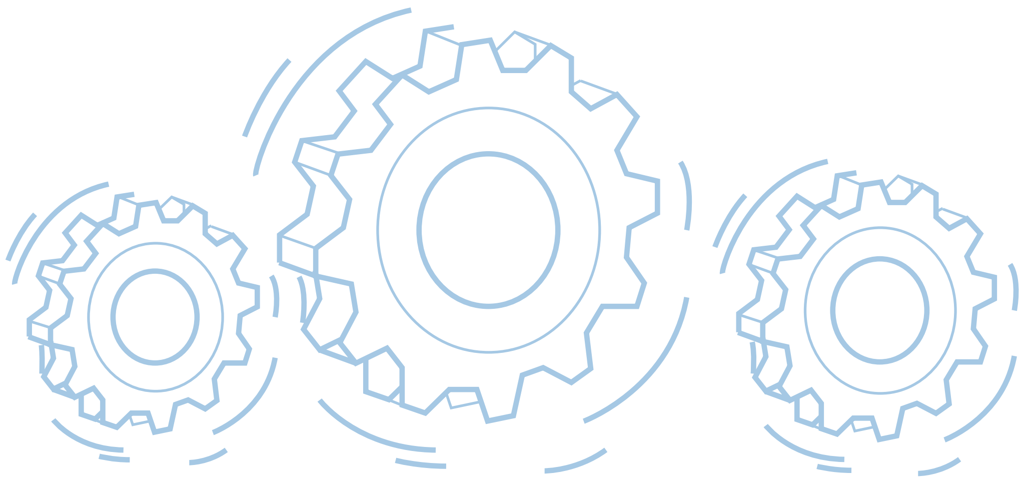
The AHA Centre's emergency operation was estimated at around USD 606,700. This figure included deployment of ASEAN-ERAT and provision of relief items such as rice, bottled water, family tents, multi-storage units, tarpaulins and shelter kits.

Typhoon Haiyan put the vision first laid out in AADMER, in which Member States work together to reduce disaster impact, with facilitation from a regional coordinating body such as the AHA Centre, to the test. When Haiyan occurred, the AHA Centre was barely two years old and it was the 10th emergency response of the AHA Centre. With limited experience and resources, the AHA Centre can only provide limited coordination support to the NDMO of the Philippines. Its relative inexperience at that point in time may have affected its ability to establish links with other organisations during the emergency response, as well as perform the mandate given by the Government of the Philippines. The AHA Centre was probably relatively unknown by other organisations.

The Centre deployed two AHA Centre staff members one day before the typhoon's landfall, which was followed by deployment of two ASEAN-ERAT Members from Brunei Darussalam on 8 November 2013, and one civil society ERAT the following day. The ASEAN-ERAT immediately attached themselves to the local emergency management authority to provide support in rapid assessment.

One of the major contributions of the ASEAN-ERAT was the establishment of initial communication from inside Tacloban city, the most severely affected city, to the GPH. The ASEAN-ERAT prepositioned in Tacloban was equipped with an emergency telecommunication device that was used by its Mayor to contact the Secretary of National Defense of the Philippines immediately after the storm had passed. The initial communication proved crucial in the days ahead to coordination of the emergency response.

The AHA Centre's emergency response was strongly supported by the Member States. All assisting Member States used the 'Offer of Assistance Form' of the Standard Operating Procedure for Regional Standby Arrangements and Coordination of Joint Disaster Relief and Emergency Response Operations (SASOP), which was submitted to the AHA Centre, thereby enabling the AHA Centre to support the GPH in tracking and monitoring incoming relief assistance from ASEAN countries. In total, ASEAN Member States collectively contributed USD 5 million to the Philippines.



8.4 The 2018 Central Sulawesi Earthquake & Tsunami

The year 2018 was ostensibly a period of institutional maturity for Indonesian disaster management, following the enactment of Law 24/2007 on disaster management more than ten years ago, along with the various institutional changes that followed. This law, enacted on 26 April 2007, aimed for more democratic, accountable, and risk reduction-oriented disaster management governance. It was enacted in response to the UN-led establishment of the Hyogo Framework for Action 2005-2015 (HFA), of which the 1st Priority of Action in the HFA is to 'ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation' (UNISDR, 2005). Consequently, various policy, regulations, governmental bodies and capacity building adjustments were needed.

Before Law 24/2007, for almost forty years (natural) disaster management in Indonesia was fully reactive, both in terms of managing the aftermath and the refugees and internally-displaced people created by the disasters, and heavily relied on ad hoc Presidential discretions, i.e. a 'council' or 'committee' that functioned only during disaster situations was named (Lassa, 2010, p. 98, 109). The ad hoc nature of Indonesia's disaster management is evident in the six Presidential Decrees and two Presidential Regulations related to disaster management during the period of 1960-2007.[5] Initially the Indonesian Law 6/1946 on 'Emergency Situation' included natural disasters in its legal scope, and provided space for civil society actors as an alternative for dealing with emergencies. However, it was revised through Law 1/1948 in the amendment of Emergency Situation Law, and Law 30/1948 on Transfer of Full Sovereignty to the President during Danger Situations. The most recent body before enactment of Law 24/2007 was the National Coordinating Council for Disaster Management (Bakornas PB), which was followed by the Local Task Force for Disaster Management (Satkorlak PB) in respective provinces and cities/regencies. Both Bakornas PB and Satkorlak PB functioned only during disaster situations and without the authority, permanent staff or financial power to conduct mitigation or preparedness for effective disaster response, let alone pre-disaster recovery, as is the present-day norm.

With Law 24/2007, Indonesia subsequently established the National Disaster Management Authority (BNPB), a ministerial level body for overseeing the entire disaster management cycle. Ideally, the BNPB holds coordinating authority over other ministries and local governments during pre- and post-disaster periods, and holds authority during the 'national level' disaster response period. Similarly, the counterpart at local government levels, provincial and city/regency, the Local Disaster Management Agency (BPBDs) is tasked with coordinating disaster management during normal periods and post-disaster periods, and assumes the command function over other local government agencies

[5] The Presidential Decrees (Keppres) and Presidential Regulations (Perpres) are: Keppres 54/1961 and 312/1965 on Central Committee for Natural Disaster Shelter; Keppres 256/1966 on Coordinating Team for Natural Disaster Management Implementation; Keppres 256/1966 on Advisory Agency on Natural Disaster Management; Keppres 28/1979 on National Coordinating Agency for Disaster Management; Keppres 43/1990 on National Coordinating Council for Disaster Management; Keppres 106/1999 on National Coordinating Council for Disaster Management; Perpres 83/2005 and its successor Perpres 3/2007 on National Coordinating Council for Disaster Management; Keppres 111/2001 on National Coordinating Council for Disaster Management and Internally Displaced People.

during an emergency response. The BNPB was inaugurated on 26 January 2008 through Presidential Regulation 08/2008 on the National Disaster Management Authority.

After the law's enactment, several government regulations (PP) and Head of BNPB Regulations were still in effect, and were decisive for coordination and network formulation during the 2018 Central Sulawesi Earthquake and Tsunami response: PP 21/2008 on Disaster Management Implementation, PP 22/2008 on Disaster Aid Funding and Management, as well as PP 23/2008 on the Role of International Organisations and International Non-Government Organisations in Disaster Management. PP 22/2008 and PP 23/2008 were key references during the 2009 Sumatra Earthquake emergency response. Within the BNPB and in relation to BPBDs across the country, there were several BNPB regulations that were enacted one year earlier: BNPB regulation 1/2008 on Organisational Arrangement of the BNPB, BNPB regulation 3/2008 on Guidelines for Establishment of BPBD, BNPB regulation 4/2008 on Guidelines for the Enactment of Disaster Management Plan, BNPB Regulation 6/2008 on On-Call Budget, BNPB Regulation 8/2008 on Guidelines on Provision of Condolence Money, BNPB Regulation 9/2008 on Standard Operating Procedures of BNPB's Rapid Response Team, BNPB Regulation 10/2008 on Guidelines of Command System in Disaster Response, and BNPB Regulation 11/2008 on Guidelines for Post-Disaster Rehabilitation and Reconstruction.

After careful content analysis of the regulations above and reflection on the operations in Sulawesi, it is apparent there is a significant gap in understanding of the regulations and response guidelines between national level responders, and local government and non-government actors. The regulations did not cross-reference each other at the national level and were not well-understood by actors at the local level.

On one hand, it is clear that from 2008 onwards, a strong Incident Command System-like regulation existed in the form of BNPB Regulation 10/2008 on Guidelines of Command System in Disaster Response. The ICS approach was evident in the concept of "command system during disaster emergency response" and its organisational structure. In essence, the regulation states that in responding to a disaster, the pattern of response includes activation of an operation plan (based on a contingency plan), request (from local government to central government), and mobilisation of resources supported by the command facility, in accordance with the disaster's type, location and scale (BNPB, 2008e). This is also the regulation that clearly defines the disaster-scale in Indonesia: a city/regency-level disaster is to be declared by the Regent/Mayor, a provincial level disaster is to be declared by the Governor, and a national level disaster is to be declared by the President. Based on the disaster level, the Head of BNPB or related BPBDs can appoint a government officer as incident commander for the duration of the emergency response.

On the other hand, BNPB Regulation 9/2008 only regulates procedures for BNPB's own disaster rapid response team's dispatch to disaster affected areas, which includes a list of activities of the team reporting forms mainly used for conveying requests from local governments to BNPB to support the emergency response (BNPB, 2008d). The regulation does not regulate or list emergency response activities requiring cooperation between BNPB with other organisations, does not have a clear timeframe for emergency response periods, or criteria for the type and scale of disasters requiring dispatch of BNPB's rapid response team.

Furthermore, the authors would like to highlight four parallel initiatives conducted during the period of 2016-2017 that have affected various perceptions on how coordination of large-scale disasters should be managed in Indonesia, which may include the 2018 Central Sulawesi Earthquake and Tsunami case. These four initiatives include the BNPB-led revision process for the BNPB Regulation 10/2008 on Guidelines of Command System in Disaster Response, ASEAN regional contingency plan as part of the development of ASEAN Joint-Disaster Response Plan (AJDRP) (AHA Centre, 2017), OCHA (2016), and the New Zealand sponsored National Disaster Response Framework (NDRF) (Brown et al., 2016). The BNPB and New Zealand team led initiatives were generic, and the UN-HCT and AHA Centre used a similar scenario (earthquake and tsunami in Sunda Strait), but they do have implications for the coordination approach at the national and field level. Prior to the 2018 disaster, these four initiatives were near completion, having engaged various national actors to discuss and deliberate views on how to coordinate a response that may affect cognitive perceptions of disaster responders. None of them, however, had legal power during the Central Sulawesi Earthquake and Tsunami. All initiatives also have minimum outreach to responders (including local governments) in Central Sulawesi. It is also important to highlight that several key coordination aspects have not been formally agreed to, e.g. 1) whether NDRF is the backbone of the successor to the BNPB regulation 10/2008, 2) formal adoption of UN humanitarian clusters, 3) positioning of ASEAN and UN-HCT contingency plan in national frameworks.

Amid these ongoing changes influenced by the four initiatives above, the M 7.7 Central Sulawesi Earthquake occurred on 28 September 2018 at 17:02 WITA triggering the tsunami. It was a catastrophic disaster scenario where major earthquakes triggered a near-field tsunami, major liquefaction, and landslides, resulting in direct damages, impacts, and constrained humanitarian access (AHA Centre, 2018). Earlier that day the province was also struck by M 6.0 earthquake at around 13:59 local time, but it was the M 7.7 earthquake later that evening that triggered a near-field tsunami due to sea-slide in the Palu Gulf. Within less than 30 minutes the tsunami struck Talise beach in Palu City, and beaches in Donggala and some settlements and buildings on the beach.

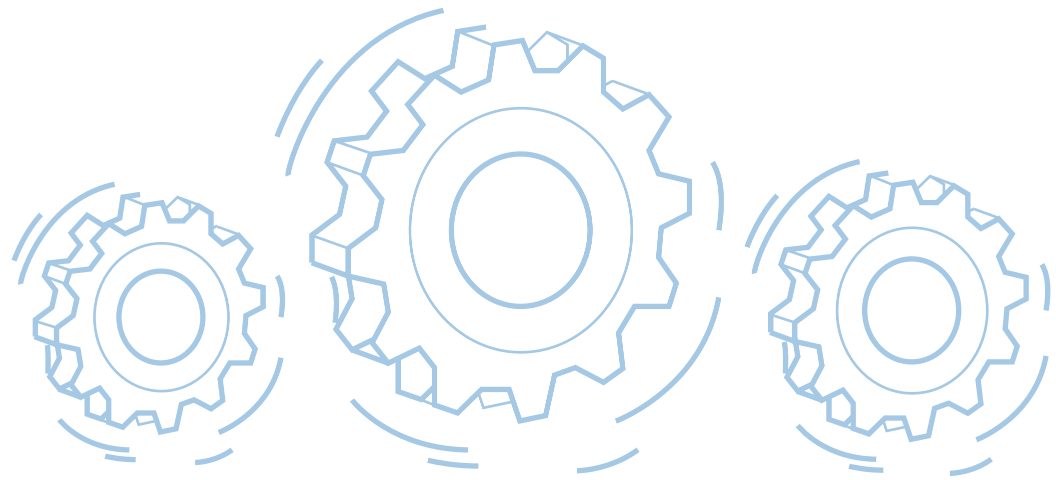
BNPB's final estimation suggests that in total around 2.4 million people were affected, in Banggai, Banggai Kepulauan, Donggala, Morowali, Palu, Parigi Moutong, Poso, Sigi, Tojo Una-una, and Toli-toli. Further assessment confirmed that the most affected areas were Palu City, Parigi Moutong, Sigi, and Donggala (approximately 500,000 people). The disaster caused more than 2,000 fatalities, injured more than 4,000, and displaced more than 206,000 people (AHA Centre, 28 October 2018).

Three days after the disaster (1 October 2018), the Government of Indonesia, through BNPB and Ministry of Foreign Affairs, welcomed offers of international assistance. This statement was also delivered by BNPB during Emergency Briefing and Coordination Meeting Partners at AHA Centre's Emergency Operations Centre (EOC), and during BNPB Press Briefing on 1 October 2018. At one point, BNPB also welcomed the proposal to use ASEAN SASOP's offer of assistance form. Within a few hours after the disaster on 28 September, BNPB also accepted the AHA Centre's offer for mobilisation of ASEAN-ERAT to the disaster's ground zero, to support international assistance coordination. These critical decisions show the value of strategic and operational level coordination.

Given clear instruction by the Indonesian Government to facilitate international assistance during the Central Sulawesi earthquake, the AHA Centre performed three levels of coordination, i.e. strategic, operational, and tactical. At the strategic level, SASOP forms were used as the mechanism to offer and accept international assistance, particularly from international organisations and NGOs. Regular coordination meetings involving in-country humanitarian partners and the Dialogue Partners' embassies (comprising ASEAN Member States as well as partners based outside the country through video conferences), were held at the AHA Centre. The coordination meetings then shifted to the BNPB EOC during the second week of the operations. The joint situation updates between the AHA Centre and BNPB which addressed the Government's priorities, and ASEAN Member States and humanitarian partners' response, played important roles in supporting decision making and resource mobilisation at the strategic levels.

At the operational level, the AHA Centre EOC worked closely with the BNPB EOC in processing offers of assistance based on the Indonesian Government priorities. The AHA Centre EOC also worked closely with partners in facilitating response planning at the operational level. The UNOCHA and International Federation of Red Cross and Red Crescent Societies (IFRC) assigned their liaison officers to the AHA Centre EOC to ease the operational level coordination. The information management unit of the AHA Centre, supported by partners such as UNOCHA, World Food Programme, and MapAction (an NGO specialising in providing mapping for humanitarian emergencies), produced joint information products and data analysis to inform the response planning and align it with the Government priorities. A joint team comprising AHA Centre, ASEAN-ERAT, UNDAC and WFP personnel was deployed to support civil military coordination at the entry point of international assistance, which was established by the Government of Indonesia in Balikpapan Airport. The team in Balikpapan supported the airbridge operations led by the Indonesian Army by prioritising relief goods to be transported to Central Sulawesi through Palu Airport.

At the tactical level, the first ASEAN-ERAT that arrived in Palu after the earthquake immediately supported the BNPB's forwarded national assisting post (POSPENAS) in on-site coordination, rapid assessment, logistics management and international team registration. Being among the first on the ground was crucial for the ASEAN-ERAT in registering arriving international teams, and establishing the international response coordination centre. The ASEAN-ERAT, with BNPB and Ministry of Foreign Affairs, established the Joint Coordination Centre for International Assistance (JOCCIA) that served as a coordination hub for international responders on the ground. The ASEAN-ERAT facilitated a coordinated assessment involving 16 organisations using the agreed Joint Needs Assessment (JNA) tools developed by the Humanitarian Forum Indonesia. Supported by the UNDAC and MapAction, the team analysed the data and supported the cluster coordination. To facilitate smooth entry of relief goods, the team established a logistics management system for international assistance, including to establish two Mobile Storage Units (MSU) in Palu Airport, which were crucial to ensuring international relief goods arriving from Balikpapan were managed and distributed properly. Given these dynamics at the strategic, operational, and tactical coordination levels, the authors would argue that they produced conditions which resulted in the inter-organisational network illustrated on the next page (Figure 8.3).



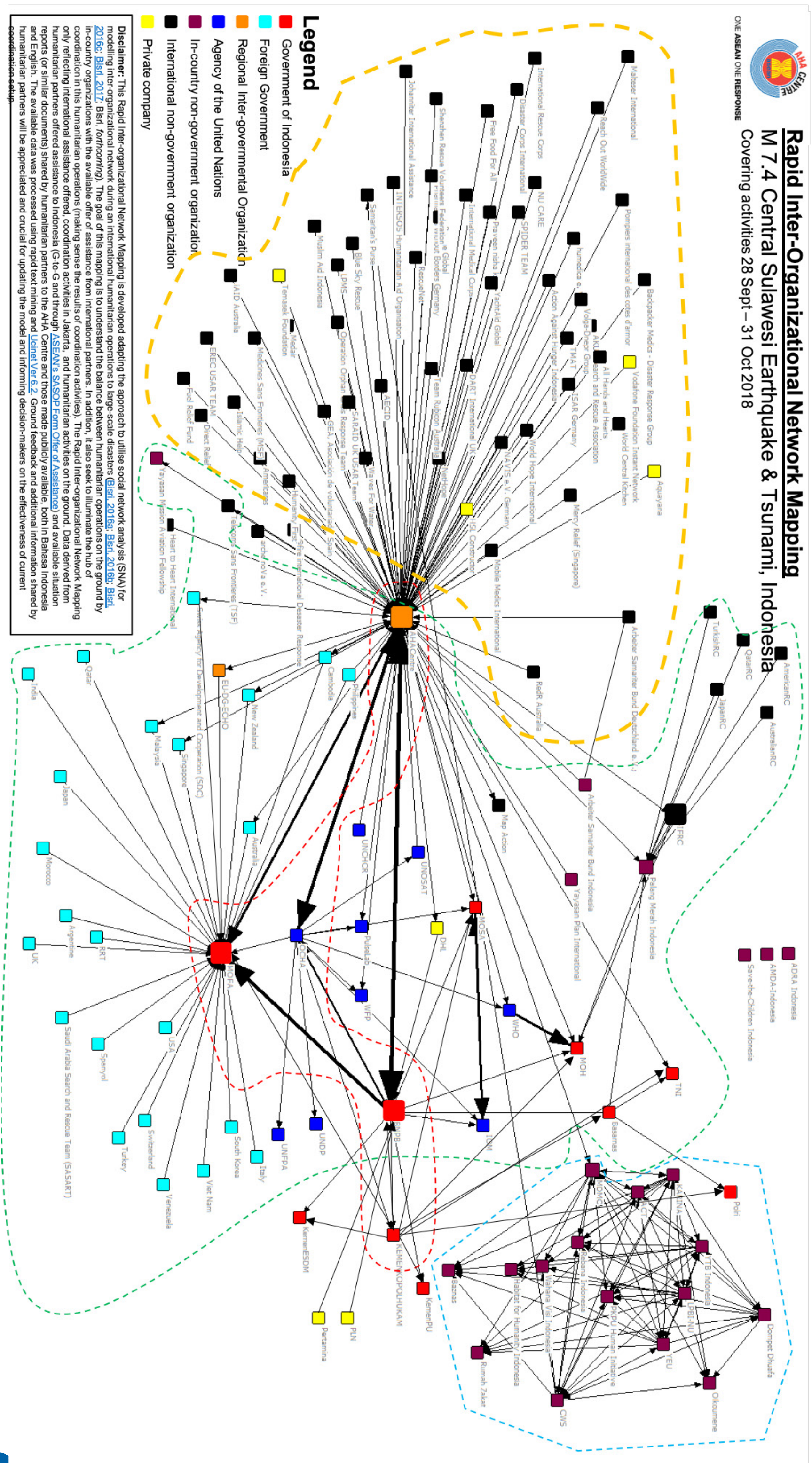


Figure 8.3 Inter-organisational Network during Emergency Response to the 2018 Central Sulawesi Earthquake and Tsunami, Indonesia

Several characteristics of the inter-organisational network illustrated in Figure 8.3 can be observed. First, three sub-networks emerged. This includes the total number of in-country national and local NGOs present at ground zero within the first 72 hours of the emergency response period, which can be found within the blue dash boundary. The presence of loose-networks during normal times, such as Humanitarian Forum Indonesia, the Indonesian Society for Disaster Management (MPBI), and others, supported the swift operations of these nodes and in turn increased the number of ties among them. Second, nodes within the green dash area were national government ministries/agencies and in-country United Nations, the AHA Centre, as well as foreign governments represented by embassy staff. Interactions between nodes in this sub-network occurred at all coordination levels, in Jakarta, in Balikpapan as staging area for international assistance, and in Palu where JOCCIA is located. Third, nodes in the orange polygon were mainly NGOs without in-country presence, which offered their assistance in reaction to the Government of Indonesia's statement.

With regard to inter-organisational network structure, two key characteristics will be highlighted. First, the key nodes of BNPB, Ministry of Foreign Affairs, AHA Centre, and OCHA Indonesia Office are essentially the key hubs in the coordination efforts. Those nodes are well placed in the centre of the network within the red boundary. Second, it can be seen that the AHA Centre played the role of gate-keeper between 'outsider nodes' and 'in-country networks'. Accordingly, the proxy coordination values of AHA Centre are 0.077 on degree centrality (normalised) and 0.068 on betweenness centrality (normalised). At this stage, five years after Typhoon Haiyan, the AHA Centre had been operating for almost seven years, and had responded to 29 regional disasters, making Palu the AHA Centre's 30th mission since its establishment.

All nine ASEAN Member States collectively supported the response operations bilaterally and regionally, including through the deployment of military airlift capacity, ASEAN-ERAT members, relief items and cash donations. Singapore, Malaysia and the Philippines mobilised their C-130s to support air bridge operations in carrying relief aid from the international entry point in Balikpapan Airport to Palu. All nine ASEAN Member States provided cash donations amounting to USD 1,565,000. ASEAN-ERAT was deployed to Palu and Balikpapan in several batches over a one-month period. It provided specialised and targeted support which was crucial to coordination, such as information management, logistics coordination, on-site coordination, and rapid assessment.

In addition to relief items provided by the ASEAN Member States, with the Disaster Emergency Logistics System of ASEAN (DELSA), the AHA Centre mobilised relief items such as family tents and MSUs from Subang, Malaysia. The AHA Centre's response to Palu is unique compared to its Typhoon Haiyan response, as it shifted its priorities from providing logistical support, including relief items, and re-allocated its resources to focus on its coordination function. The relief items provided by the AHA Centre to Indonesia stopped at the second batch of deployment as a result of consultation with the BNPB, and assessment of the availability of relief items. The AHA Centre concluded that the additional deployment of relief items from the AHA Centre was no longer required.

Conclusion & Recommendation

The AHA Centre is mandated to perform the role of primary regional coordinating agency for disaster management and emergency response in the ASEAN region. The AHA Centre has performed the role in varying degrees for the 30 emergency and preparedness responses conducted since its establishment in 2011. In the past, the AHA Centre's contribution to an emergency response was often measured by the value of the relief items it deployed, along with the deployment of its personnel and ASEAN-ERAT. Using the inter-organisational network mapping methodology, this paper attempts to perform the difficult task of measuring one of its key contributions: its role as a regional coordinating agency.

Through its focus on two large-scale emergency responses in 2013 and 2018, this paper shows that as time progresses and more investment on capacity building and infrastructure has been made, the AHA Centre has evolved into the region's primary emergency response coordinator. This can be seen from the relative increase of the AHA Centre's proxy coordination values calculated with SNA, as illustrated in Table 8.1.

During the response to Typhoon Haiyan, the AHA Centre was able to provide some crucial support to the Government of the Philippines by prepositioning its personnel in Tacloban, as well as the immediate deployment of ASEAN-ERAT, one day after the typhoon made landfall. The AHA Centre, however, only played the coordination role for the ASEAN Member States during the Haiyan response. During the Sulawesi response, the AHA Centre was able to perform a more accomplished role as a coordinating agency. The Government of Indonesia, through BNPB, tasked it with the prominent role of becoming the coordinating agency to help facilitate international partners' offers of assistance. At the ground level, the AHA Centre worked closely with BNPB at the reception and departure centre in Balikpapan to provide logistical support. It also worked closely with the national assisting post (POSPENAS) in Palu on the establishment of JOCCIA.

Case Parameter	The 2013 Typhoon Haiyan	The 2018 Central Sulawesi Earthquake & Tsunami
AHA Centre's degree centrality value (normalised)*	0.026	0.077
AHA Centre's betweenness centrality value (normalised)**	0.024	0.068
Size of networks	275	140
Strategic coordination	Briefing for ASEAN Secretary-General and other regional stakeholders at the AHA Centre EOC in Jakarta	Facilitate coordination meetings, emergency response briefings, and registration of offers of assistance at the AHA Centre EOC in Jakarta
Operational coordination	N/A	Close coordination with BNPB EOC at key meetings, Press briefings, facilitating communication and information sharing
Tactical coordination	Attached to the NDRRMC command centre, provided emergency telecommunications support	Establishment and operations of Joint Coordination Centre for International Assistance (JOCCIA) in Palu. Establishment and operations of staging area hub in Balikpapan.

Table 8.1 Coordination Characteristics of ASEAN

The AHA Centre should expect that the role it played in Central Sulawesi will be repeated, given its growing reputation as well as Member States' confidence in its capabilities. Therefore, the AHA Centre should conduct further examination of its roles in Central Sulawesi to assess how it can improve in the future. It is recommended that the best practices and major lessons learned from the Central Sulawesi response be documented carefully for future reference, in anticipation of expanding expectations from the Member States.

The AHA Centre should also acknowledge that despite the achievements of the Central Sulawesi response, there were some critical shortcomings. As all networks potentially show, centrality may not mean effective scaling up of collective regional resources. While the AHA Centre has evolved and progressed significantly as the primary regional coordinating agency, it has not fully accessed all potential regional assets and capabilities, such as resources from the private sector, the military, civil society, and other stakeholders. While continuing to improve its coordination capacity, mobilisation of resources, which includes financial assets and capabilities, should serve as one of the core functions the AHA Centre should give more attention to.

The AHA Centre does have a comparative advantage. As part of the regional mechanism, Member States have more direct control of the AHA Centre's policies and operations on the ground. This gives the AHA Centre a distinct leverage over other humanitarian agencies, as the AHA Centre has immediate access to the national disaster management authorities. Long-term investment in capacity building of NDMOs, such as that conducted by the AHA Centre Executive (ACE) programme, also helps to increase trust between the AHA Centre and the NDMOs.

A further study needs to be designed to gauge the possibility of other ASEAN countries replicating this ASEAN centrality model. In addition, it would be interesting to explore whether other regional organisations will use this regional centrality model as a reference. From an academic perspective, empirical evidence supporting the notion of ASEAN centrality through robust SNA still needs to be investigated to the other 23 disasters to which ASEAN responded. This chapter is limited in its SNA, and therefore the value of measurements should be treated as indicative rather than absolute. Furthermore, as tested against the 'humanitarian clusters' concept (Bisri, 2017), a more objective degree and betweenness centrality comparison of other humanitarian organisations with a coordination function is needed. Finally, moving forward, when ASEAN applies a monetary function to humanitarian assistance and coordination services performed, it is important to demonstrate the AHA Centre's tangible value, and to convert its intangible value into a tangible value. At heart, this can further bolster the spirit of one coordinating body within the One ASEAN One Response implementation.

Acknowledgement

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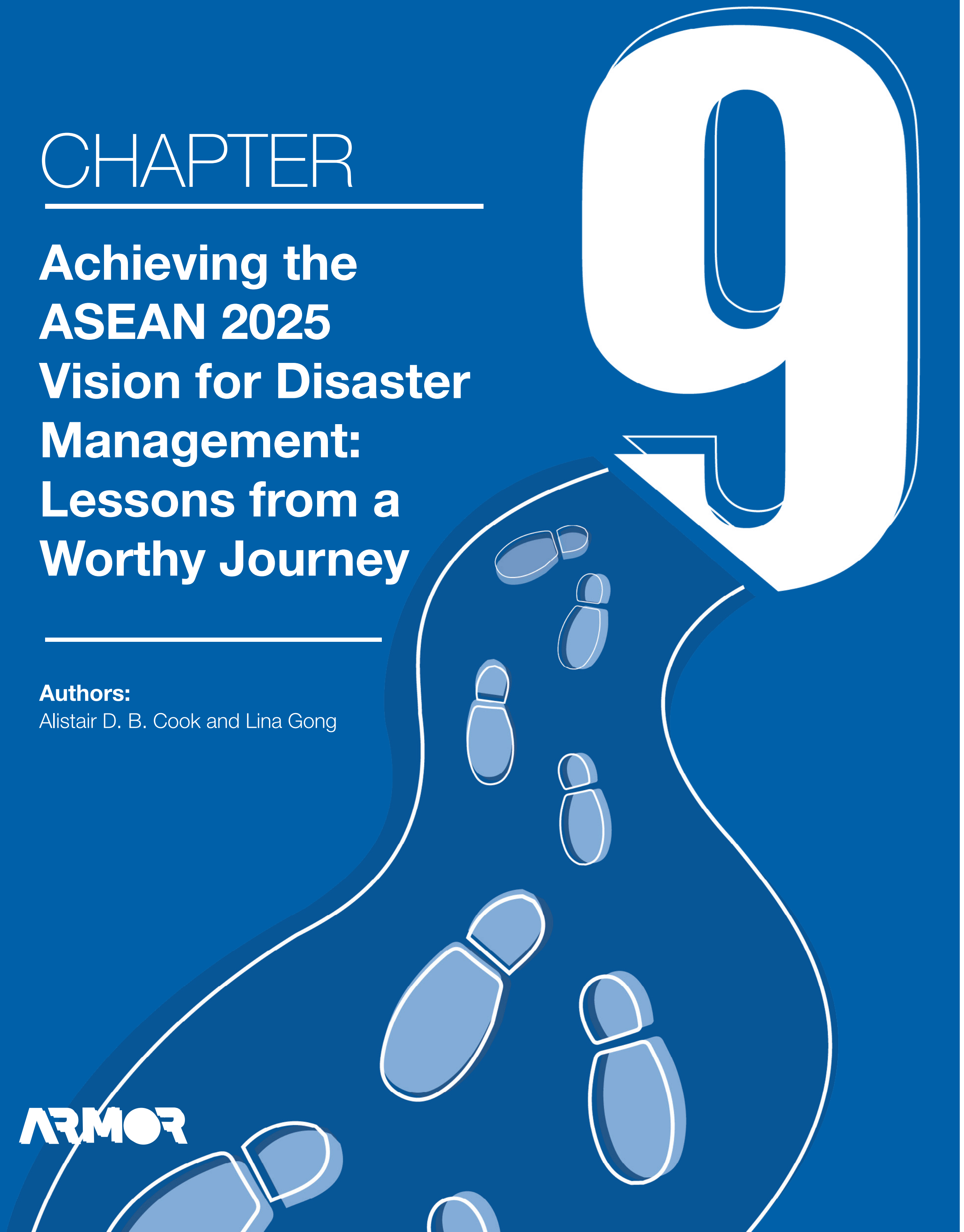
CHAPTER 9

Achieving the ASEAN 2025 Vision for Disaster Management: Lessons from a Worthy Journey



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Abstract

Over the past two years, Southeast Asia witnessed a series of simultaneous disasters, to which ASEAN humanitarian response mechanisms were activated. Successive earthquakes affected the Indonesian island of Lombok in July and August 2018, with the most severe killing over 400 people and causing over USD 340 million worth of damage.[1] The death toll from the September 2018 Central Sulawesi Earthquake and Tsunami reached more than 2,000, and damaged more than 68,000 homes.[2] Devastating floods affected the southern part of Lao PDR's Attapeu Province in July, with a death toll of 30 and 16,000 displaced. Although the monsoon season brought continuous heavy rains to the area, the tragedy was actually caused by the collapse of a saddle dam of the Xe-Pian Xe-Namnoy hydroelectric power project in Attapeu. A year earlier in the Southern Philippines the siege of Marawi resulted in a human-induced disaster, as did the crisis in Myanmar's Rahkine State. These natural and human-induced disasters highlight the types of disasters ASEAN mechanisms respond to, which are encapsulated in the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) that came into force a decade ago.

With these challenges in mind, the S. Rajaratnam School of International Studies, Nanyang Technological University, and the Pacific Disaster Center co-presented a workshop with the Knowledge and Innovation Working Group of the ASEAN Committee on Disaster Management (ACDM). Titled 'Achieving the ASEAN 2025 Vision for Disaster Management: Lessons from a Worthy Journey', the workshop was conducted on 15-16 August 2018 in Singapore. Its overall aim was to draw lessons from the analysis of two key aspects of ASEAN's experience with Humanitarian Assistance and Disaster Relief (HADR): performance/impact and institutionalisation. Workshop participants included representatives from the AHA Centre, ASEAN Secretariat, ACDM Focal Points, Asia-Pacific Economic Community Secretariat, Pacific Islands Forum Secretariat, Changi Regional HADR Coordination Centre, Royal Thai Armed Forces, Singapore Armed Forces, United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA), diplomatic corps, academia, think tanks, donor agencies and non-governmental organisations. This article draws on the workshop discussions and consolidates them with the authors' own research to provide potential pathways for achieving the ASEAN Vision 2025 on Disaster Management.

Keywords: ASEAN HADR, ASEAN Vision, the AHA Centre, ASEAN emergency response

[1] "Lombok Quake Death Toll Rises to 436 as Economic Losses, Damage Hit $470m", The Straits Times, 13 August 2018, https://www.straitstimes.com/asia/se-asia/lombok-death-toll-rises-to-436-as-economic-losses-damage-hits-472m.
[2] AHA Centre, Situation Update No. 15 – Final M7.4 Earthquake & Tsunami Sulawesi, Indonesia, 26 October 2018, https://ahacentre.org/wp-content/uploads/2018/10/AHA-Situation_Update-no15-Sulawesi-EQ-rev.pdf

9.1 Introduction

The Asia-Pacific region is the most vulnerable to natural disasters in the world. In Southeast Asia, natural hazards such as tropical storms, earthquakes and floods caused 362,000 fatalities and affected 250 million between 2000 and 2016.[3] Southeast Asia is also home to various human-induced disasters including conflicts and poorly planned development projects that force people to flee their homes in search of safety and security. This high vulnerability to disasters has produced a complex regional architecture for enhancing humanitarian assistance and disaster relief in ASEAN. The traditional ASEAN components of this architecture under the AADMER include the ACDM, the ASEAN Regional Programme on Disaster Management (ARPDM), and the AHA Centre. Furthermore, ASEAN adopted the ASEAN Vision 2025 on Disaster Management in December 2015, setting the target for ASEAN to become a global leader in the field. In September 2016 ASEAN Leaders signed the 'One ASEAN, One Response' Declaration. These documents build upon the AADMER to enhance national and regional disaster response capacities, and respond in a strong, efficient and united manner.

The institutional developments in ASEAN represent the region's progress in disaster relief and emergency response since the 2014 Indian Ocean Earthquake and Tsunami. Alongside these developments, the increasing complexity of disasters and the growing use of new technologies and social media in HADR operations, a review of the achievements of the ASEAN regional architecture is necessary. Workshop discussions and research, reflections on how the regional arrangements facilitate disaster response at the regional and national levels, and suggestions on where gaps exist in the current approach and modalities will inform potential pathways for improving humanitarian assistance and disaster relief in the region. A few issues in particular hinder effective emergency response in ASEAN Member States, such as the growing complexity of disasters, the need to develop capacity and capability at various levels, the lack of connection between actors at different levels, and the lack of consistency between regional and national plans. Drawing on these conversations there are several pathways forward (which are by no means comprehensive) to tackle the challenges facing humanitarian assistance and disaster response in ASEAN.

[3]UNESCAP, Disaster Resilience for Sustainable Development: Asia-Pacific Disaster Report 2017 (Bangkok: United Nations Publication, 2018): 13.

Develop an ASEAN comprehensive all-hazard approach

- ***Design a cross-sectoral framework for emergencies that establishes the procedures and facilities for effective coordination of individual agencies responding to major emergencies***

While Southeast Asian countries are prone to natural disasters, other types of disaster can also threaten state security and societies, such as the failure of large-scale infrastructure projects, humanitarian emergencies caused by armed conflicts, and the emerging risk of critical infrastructure containing hazardous materials, e.g. nuclear/radioactive materials and other chemical and biological-related materials. Large-scale infrastructure projects such hydropower dams offer countries an important electricity source, but they also pose a risk to populations in their immediate vicinity as well as those downstream. This risk highlights the need to develop stronger governance mechanisms, including emergency preparedness and response, environmental standards and more robust impact assessments. Southeast Asia is also afflicted by internal conflicts that affect the safety and security of states and societies. As part of a people-centred ASEAN, it is important to identify individual capabilities to respond to the needs of those affected by conflict and physical violence.

Although the AHA Centre sees radiological and nuclear disasters as long-term risks, response to these emergencies and crises is not included in the current disaster management framework. There are other ASEAN pillars, entities, mechanisms and conventions, such as ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM), that respond to chemical, biological, radiological and nuclear-related issues. They need to coordinate with and be co-implemented by the ACDM and the AHA Centre, which have core competencies in emergency preparedness and response that can be adapted to different types of disasters. Further, senior-level decisionmakers have expressed the need to recalibrate the method for defining disasters in ASEAN. The AADMER provides a legal framework to respond to natural and human-induced hazards and vulnerable conditions. When the agreement took effect and the AHA Centre was established, ASEAN's initial focus was only on natural disasters. While they remain dominant, there is now a need for ASEAN to consider how it can best respond to the second category of human-induced hazards and vulnerable conditions, so the combined result is greater than the sum of individual agency parts and avoids sectoral duplication.

Adopt a holistic approach to managing disaster risk

The outbreak of the severe acute respiratory syndrome (SARS) epidemic in 2003 first alerted the region to the importance of prevention and mitigation when faced with non-traditional security (NTS) challenges. Within the disaster management context, Southeast Asian countries now focus more on disaster risk management consistent with their commitments to the Hyogo Framework for Action and the Sendai Framework. In 2010, the Philippines passed the Disaster Risk Reduction and Management Act to mandate local organisations to focus on Disaster Risk Reduction. This shift recognises that a holistic approach to disaster management is more effective than mere disaster response, and as studies show, every dollar spent on improving disaster resilience can save up to six dollars.[4]

In addition to disasters that immediately threaten state and human security such as humanitarian crises, earthquakes and floods, countries in the region should also implement measures to prepare for, respond to, and mitigate the impacts of slow-onset natural hazards such as droughts. For example, land-use planning and land conversion can be measures for drought mitigation. However, a significant disconnect remains between the humanitarian action and development fields. It is therefore crucial for the different actors involved to bridge this gap by adopting a holistic approach allowing for a smooth transition from short-term humanitarian action to longer-term sustainable development work.

Synergy among different pillars could be cultivated and promoted in the work of the ASEAN Political and Security Community (APSC), the ASEAN Economic Community (AEC), and ASEAN Socio-Cultural Community (ASCC), in accordance with the ASEAN Community Vision 2025. The agricultural sector, for example, could increase investment in agricultural science and technology to better cope with slow-onset disasters. The use and dissemination of such information and knowledge could be integrated into building communities resilient to different types of disasters. The ACDM Working Group system could therefore focus on developing a more effective transition phase through an inter-working group that draws on the expertise of each group, to identify an action plan for more effective transition between the humanitarian and sustainable development phases.

Link disaster risk management with sustainable development

Disaster management interrelates organically with sustainable development as disasters cause significant economic losses, while a lack of sustainable development results in high vulnerability to disasters. Several UN Sustainable Development Goals (SDG) include targets for different aspects of disaster risk reduction, such as Goal 11, which aims to significantly reduce the number of deaths, the number of people affected, and economic losses caused by disasters. Since 2000, however, ASEAN has seen regress rather than progress with SDG 11, in terms of building sustainable cities and communities, according to a 2017 assessment report by United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) titled 'ASEAN SDG Baseline'. While the regression might be due to multiple causes, it indicates the necessity and urgency for Southeast Asian countries to improve their efforts to maintain the expected progress with SDG 11. Other regions' experiences and practices can provide insights and existing regional platforms can facilitate the efforts of ASEAN Member States. Sustainable development is a central component of disaster management in the Framework for Resilient Development in the Pacific, which is highly vulnerable to the impacts of climate change. In the Asia-Pacific region, the Asia-Pacific Economic Cooperation (APEC) can be a platform to strengthen the link between disaster management and sustainable development, as several member economies are implementing Capacity Building and Emergency Preparedness for Sustainable Development in Agricultural Communities through "Plant Back Better" (PBB) Initiatives. While individual countries may have socio-economic plans that incorporate disaster risk reduction, implementation needs to be improved.

Ensure an inclusive and participatory process

Enhance information sharing through the AHA Centre

In 2017, the AHA Centre responded to new humanitarian emergencies in Marawi in the Philippines and Rakhine State in Myanmar. The AHA Centre has become the primary platform for coordination among ASEAN Member States. As AHA Centre develops further, it is worth assessing whether the organisation needs to build expertise and capacity beyond coordination, to better respond to different types of regional disasters. However, the consensus-based ASEAN way determines that involvement in politically sensitive situations remains case specific. An understanding and sympathetic approach towards the position of the affected country can encourage more cooperation in information sharing.

Sensitise local government and civil society to ASEAN humanitarian coordination mechanisms

A bottom-up approach allowing local actors to play a greater role in the cycle of disaster risk management is more effective for dealing with the risks and consequences of disasters than traditional top-down approaches. An example of the importance of

[4] National Institute of Building Sciences, Natural Hazard Mitigation Saves: 2017 Interim Report, 2017, https://www.nibs.org/page/mitigationsaves.

local actors is the Muhammadiyah Disaster Management Centre which, after the 2004 Indian Ocean Earthquake and Tsunami, provided crucial channels through its internal infrastructure for international agencies and humanitarian organisations to distribute aid and supplies. Further, the community-based disaster risk management model (CBDRM) draws on local experience and knowledge and facilitates community participation in disaster management. It is therefore important for national governments to utilise local knowledge in the formulation of national policies. In addition, it is also necessary to familiarise actors at the subnational level with how various ASEAN mechanisms operate during disaster, to enable them to more effectively engage in these processes. However, some participants of the abovementioned workshop in Singapore in August 2018 noted many cases of disconnection between local actors and ASEAN coordinated-processes. It therefore requires efforts at the national and ASEAN levels to increase awareness.

Build cross-sectoral and multi-stakeholder partnerships for effective disaster management

There are many diverse actors in the humanitarian landscape. There is significant but underdeveloped attention given to the private sector's potential contribution to disaster management, as getting businesses back on their feet after a disaster can be beneficial for all. Further exploration of how corporate actors can assume a complementary and mutually-beneficial role in various aspects, such as new funding arrangements, resources and expertise, will contribute to a more sustainable sector. Private sector engagement in the UN Global Compact has contributed to raising awareness of the SDGs. Building on the experience of 465 participating entities[5] across the ten Member States can offer ASEAN private sector insights that can contribute to their achievement. Given the importance of cross-sectoral and multi-stakeholder approaches to disasters, a specific mandate should be provided to the working groups collectively through an inter-working group for cross-sectoral alignment, and another provided for multi-stakeholder partnerships. Both these mandates can draw on the expertise of each working group of the ASEAN Committee on Disaster Management as two potential pathways.

There are multiple examples of corporate actors participating in disaster response. DHL, for example, includes disaster resilience as a component of its corporate social responsibility. DHL's Response and Disaster Assistance Response Team (DART) are centrally steered but locally managed. The company activates its locally-based teams, which are familiar with the local context and culture, to respond to disasters. After the dam collapse in Lao PDR, foreign companies operating in the country offered immediate emergency aid and provided equipment and technical support to local authorities.[6] Some rebuilt the damaged infrastructure to enable access for rescue and relief efforts.[7]

[5]For more information on participants in the UN Global Compact, please visit: https://www.unglobalcompact.org/
[6]Justin Ong Guang-Xi, "Laos Dam Collapse: Singapore Firms Donate Portable Water System to Shelters", Today, 31 July 2018, https://www.todayonline.com/singapore/laos-dam-collapse-singapore-firms-set-potable-water-systems-shelters.
[7]"Feature: Chinese Companies, Businesses in Laos Join Rescue Work in Flood-hit Area", Xinhua, 27 July 2018, http://www.xinhuanet.com/english/2018-07/27/c_137351858.htm.

In addition to the immediate response, companies are important actors for disaster risk reduction as the private sector can assist financially with building resilient infrastructure. For example, the objective of the ASEAN Storm Resilience Fund is to strengthen the resilience of rural communities. As the primary motivation of the private sector is financial profit, governments should incentivise companies to facilitate innovation in disaster management.

As technology and social media are increasingly utilised in disaster management, another role for the private sector is to provide technological support during disasters. For example, the Philippines government signed a Memorandum of Understanding (MoU) with telecommunication companies to ensure people receive early warning messages.

Optimise resource allocation by improving coordination and building partnerships

Improve coordination frameworks between international, regional, national and local levels.

While the multiplicity of actors generates more resources and capacities, it necessitates clear definition of roles and responsibilities and effective coordination, to optimise allocation of resources and capabilities and therefore minimise gaps. Meetings and reflections before, during and after the response may provide clarity between different actors' respective roles. The UN cluster approach established one model in this regard, which has been adopted by the Philippines in responding to disasters like Typhoon Haiyan. In other countries in the region, the national government concerned centralises the processes, and international assistance must be channelled through the designated national agency. In Indonesia, for example, the National Disaster Management Authority (BNPB) leads disaster management including disaster response. In times of disaster, any form of foreign assistance must be cleared by BNPB in conjunction with related ministries and the Indonesian military. A multi-agency coordination centre coordinates the overall process with three components in charge of different aspects of the response. The AHA Centre, for example, plays the role of facilitating and coordinating international assistance.

However, there are incidences in which ad hoc measures are implemented, despite existing disaster response mechanisms. In some cases disaster response is politicised, as effective response can increase the popularity of leaders and officials campaigning for election or re-election. These parallel structures may trigger questions regarding the authority of the existing mechanisms. It is helpful to institutionalise national disaster response and operationalise these procedures. Although the national government remains the central actor, local authorities are usually the first responders and have first-hand information about the situation on the ground. Close engagement with local authorities provides a more accurate assessment and therefore avoids a disconnect between supply and actual requirements. There is a clear need for decentralisation, which requires the empowerment of local authorities through the implementation of appropriate knowledge, capabilities and resources through sustainable political, legal and financial frameworks.

Align offers of assistance with priorities of the receiving countries and regions

Partnerships expand resource bases and capacities for disaster management. Successful and sustainable partnerships depend on common goals, clear definitions of expected contributions, and each partners' respective interests. By identifying the complementarity of respective organisational mandates, comparative skills and institutional strengths, communities can be better empowered to reduce risk and respond to disasters. In response to the Lao PDR dam collapse, ASEAN deployed the Emergency Response and Assessment Team (ERAT) to assist in the emergency needs assessment, and the various UN agencies followed the cluster approach and contributed to different components. The World Food Programme focused on food security and logistics, and the World Health Organisation oversaw epidemic prevention and the mental health of the affected population. In the aftermath of the 2018 Central Sulawesi Earthquake and Tsunami, the AHA Centre played an important role in facilitating the provision of international assistance to Indonesia, in addition to sending ASEAN-ERAT and relief supplies. After the Indonesian government provided a list of required assistance, the AHA Centre facilitated meetings between the Indonesian agencies and international donors, during which Indonesia's requests and requirements were communicated to international humanitarian partners. This contributed to reducing overlaps and gaps, therefore improving the effectiveness of international assistance provision. The partnership between the World Bank and the World Meteorological Organisation on hydrometeorological risk is another good example, which includes forecasting and monitoring. To manage the growing flood risks in Southeast Asia, the World Bank draws on Singapore's expertise in drainage to offer technical examinations on specific issues. Through the development of niche areas for countries, corporations and the humanitarian community, achieving a more effective response is possible.

Build capacity of different actors at multiple levels

Develop knowledge and change management strategies

Southeast Asian countries have accumulated significant experience and methods through past operations. To share this knowledge among actors and stakeholders, it is necessary to have effective knowledge and change management policies in place, which may include the documentation of experiences, knowledge sharing and human resource training.

As ASEAN countries are culturally diverse, language is recognised as a major barrier to cooperation in disaster response. Humanitarian practitioners have identified language barriers as a problem when they are deployed to a foreign context and this has been echoed by staff in local organisations. One way to address this problem is to improve training for local trainers, which enables better knowledge transfer at the local level. In addition, implementing standards also enhances cooperation and facilitates knowledge transfer, while exchange and secondment of staff also contributes. Interaction with the epistemic community can draw on rich academic knowledge for policymaking, therefore creating a synthesis between knowledge and practice. Through the development of robust knowledge and change management strategies in this sector, Southeast Asia would become a global leader in disaster management and be a resource for the sector and international community.

Mainstream disaster management in the budget of national and local governments to ensure sustainability of the humanitarian sector

Disaster management is now included as a budget line item in some regional countries due to the frequency of natural hazards. For example, Myanmar passed legislation in 2015 that established a disaster management fund which can be used for sustainable development, disaster response and preparedness. In addition, certain percentages of other national budget items can also be allocated for disaster response. The Myanmar government used part of the social affairs budget to deal with the emergency in the Rakhine State. Funds and grants like these are often distributed on an ad hoc basis.[8] In Lao PDR, there has yet to be dedicated funding for disaster management, and funding sources include national and provincial emergency funds, insurance, ad hoc mobilisation, and the national budget for poverty reduction. The Indonesian government is developing a new finance strategy to create a disaster risk financing mechanism managed with an 'insurance type' method, which local governments could draw on if their budgets were exhausted due to disaster. At the regional level, the finances of the AHA Centre are also under pressure, as there is a large gap between the funding available and that which is required. Recent agreement by ASEAN Member States to increase core funding for the AHA Centre from $50,000 to $90,000 per country per year highlights its increasing importance. Foreign donations are a key funding source for disaster management in ASEAN. However, it is important to ensure that donations align with national and regional priorities, and that national governments and regional bodies have ownership over how the funding is distributed.

[8] Roger Shotton, Zin Wint Yee and Khin Pwint Oo, 2016, State and Region Financing, Planning and Budgeting in Myanmar: What are the Procedures and What are the Outcomes? Renaissance Institute – Asia Society: Yangon, December, p.23.

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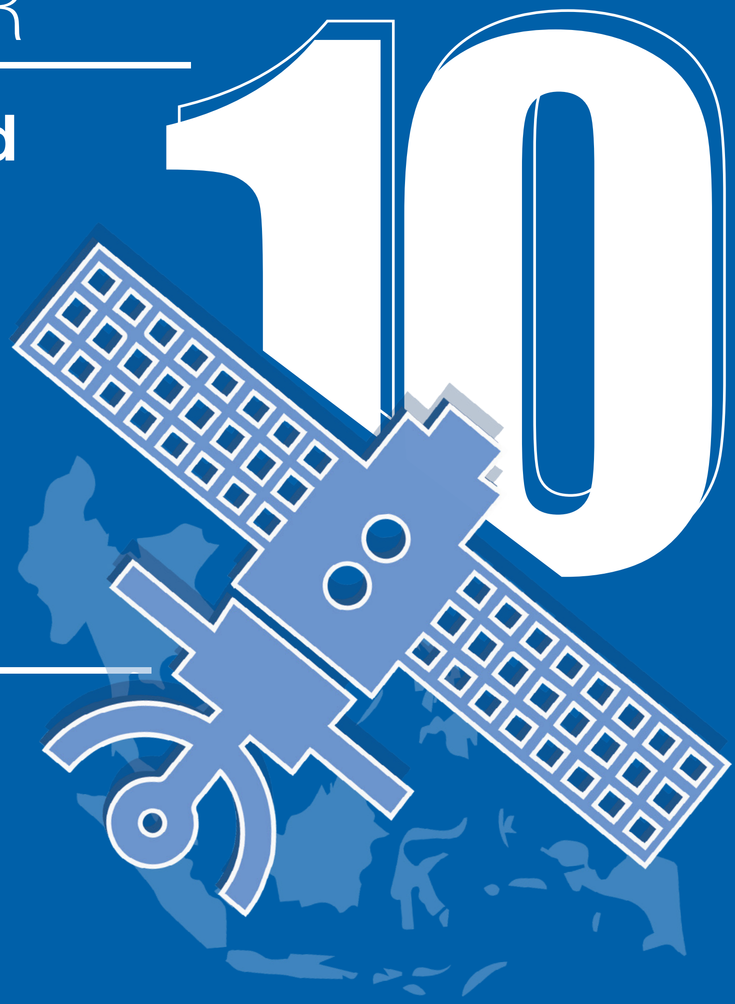
CHAPTER 10

Space-based Information Utilisation to Support Emergency Response & Recovery



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Abstract

Accurate and timely situational awareness following a disaster is crucial for planning and implementing an effective emergency response. Space-based information and Earth observation have been recognised as playing significant roles in supporting emergency responses. One of the channels for this information in the Asia-Pacific is Sentinel Asia, an Asia-Pacific Regional Space Agency Forum voluntary initiative that supports regional disaster management by applying Web-Geographical Information System (Web-GIS) and space-based technology. On average, from 2007-2016, more than half of Emergency Observation Requests (EOR) came from ASEAN Member States. Consequently, both space agency and disaster management agency members expressed the need to capture related knowledge and showcase good examples of space-based information supporting emergency response operations. Accordingly, this chapter will explore the links between previous EOR and their contribution to preparedness and emergency response operations in ASEAN. An overview of past EOR's relevance in supporting disaster emergency response operations in ASEAN is provided. A regional recommendation on strengthening the link between space agency and disaster management agency programs and activities is provided at the end of the chapter.

Keywords: space-based information, Earth observation, emergency response, ASEAN

10.1 Introduction

Natural disasters have increased worldwide, including in the Asia-Pacific region. The Asia-Pacific region suffers from different types of natural disasters, such as earthquakes, cyclones/typhoons, floods, landslides, droughts, tsunamis, volcanic eruptions and forest fires. Several of them have been large-scale, devastating disasters. Considering the region's high population (about 3 billion), and high frequency and magnitude of natural disasters, the integrated use of space technology, such as earth observation satellite data and GIS, can be effective in disaster management. In response to the increased frequency of natural disasters, the collaborative, regional project Sentinel Asia was conceptualised in 2005 and commenced operations in 2007. Sentinel Asia provides disaster-related information, including earth observation satellite images, via the internet to contribute to disaster management in the Asia-Pacific region. As of September 2018, it comprises 108 member organisations, including 92 agencies from 28 countries/regions, and 16 international organisations. The Japanese Aerospace Exploration Agency (JAXA) serves as secretariat.

Sentinel Asia aims to (i) improve safety in society through Information and Communication Technology (ICT) and space technology, (ii) improve the speed and accuracy of disaster preparedness and early warning, and (iii) minimise the number of victims and social/ economic losses. Various activities are conducted to achieve these aims, which are implemented in collaboration with these three communities (i) Space Community, e.g. the Asia-Pacific Regional Space Agency Forum (APRSAF), (ii) International Community, e.g. the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre), United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), the United Nations Office for Outer Space Affairs (UNOOSA) , and Asian Institute of Technology (AIT), and, (iii) Disaster Reduction Community, e.g. the Asian Disaster Reduction Centre (ADRC) and its member countries. Collectively, Sentinel Asia's member organisations are called the Joint Project Team (JPT), and membership is open to space agencies, disaster management organisations in the Asia-Pacific region, and regional/ international organisations that wish to participate in disaster information sharing activities.

In terms of the roles, Sentinel Asia is composed of two Nodes (Data Provider, and Data Analysis). The Data Provider Node (DPN) is composed of eight space agencies, namely, ISRO (India), JAXA (Japan), GISTDA (Thailand), KARI (Korea), NARL (Taiwan), CRISP (Singapore), STI/VAST (Vietnam) and MBRSC (United Arab Emirates). DPNs provide their own satellite data and other relevant data to JPT members when a disaster occurs and a JPT member submit an Emergency Observation Request (EOR). Such data provision is subject to the data policy of each DPN. The Data Analysis Node (DAN) analyses the satellite data provided by DPN, makes value added products and uploads and shares the result through the Sentinel Asia System as illustrated in the Figure 10.1. As such, Sentinel Asia intends to expand efforts and relevant data for disaster management stakeholder, particularly to those that do not own their own satellite reception facilities (Kaku & Held, 2013)

ASEAN Member States' interest in participating and contributing to the Sentinel Asia platform is quite high. As of September 2018, 51 of Sentinel Asia's 108 Members are organisations (government and non-government) based in the ASEAN region. The table below illustrates the membership of ASEAN-based organisations per country. As can be seen, only three ASEAN countries have Data Provider Nodes (DPN), i.e. Singapore, at the Centre for Remote Imaging, Sensing, and Processing (CRISP); Thailand, at the Geo-Informatics and Space Technology Development Agency (GISTDA); and Viet Nam, at the Vietnamese Academy of Science and Technology (VAST). Some ASEAN countries also have sufficient Data Analysis Nodes (DAN). Sentinel Asia's ASEAN-based regional/ international member organisations (including research institutions and universities) are ASEAN Secretariat, AHA Centre, Asian Disaster Preparedness Center (ADPC), Myanmar Information Management Unit (MIMU), Asian Development Bank, UNESCAP, and AIT. In addition, eight of the total ten National Disaster Management Organisations (NDMO) in ASEAN are registered as Sentinel Asia members.

COUNTRY	DPN	DAN	User Only
Brunei Darussalam	-	1	-
Cambodia	-	-	2
Indonesia	-	4	3
Lao PDR	-	-	2
Malaysia	-	1	2
Myanmar	-	-	3
Philippines	-	5	4
Singapore	1	2	
Thailand	1	2	6
Viet Nam	1	2	4
Regional/ international organisation based in ASEAN	-	2	3

Source: Sentinel Asia Secretariat

Table 10.1 Summary of Sentinel Asia Membership in ASEAN region

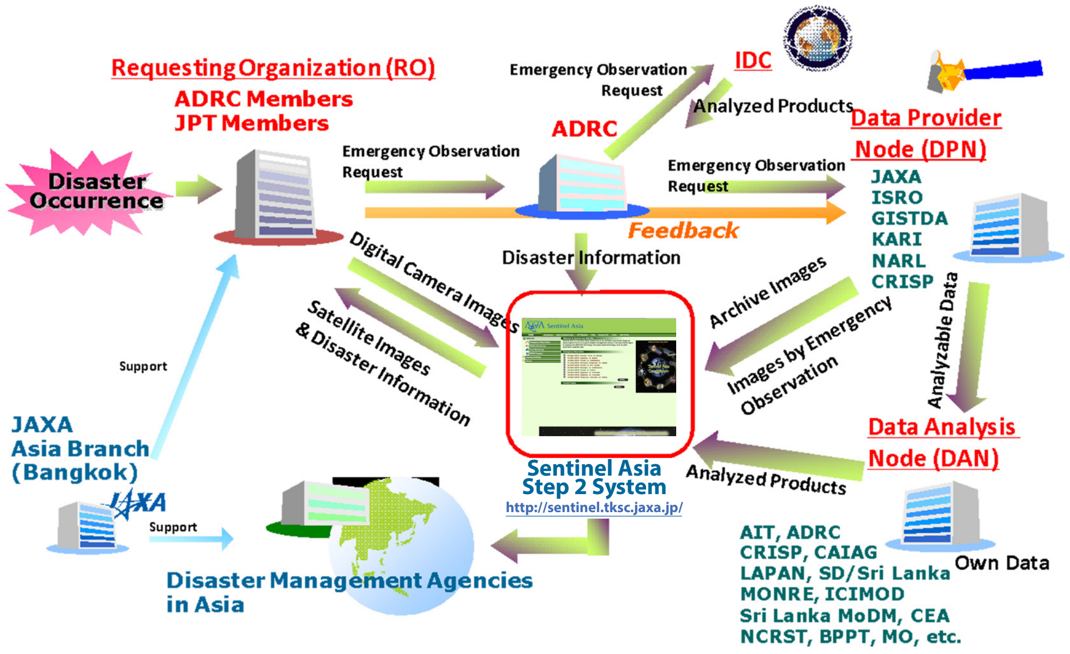

Figure 10.1 Flow of Sentinel Asia emergency observation (Sentinel Asia Secretariat)

A review of Sentinel Asia's initial trajectory and contribution across various phases of disaster management from 2006 to 2010 was conducted by Kaku and Held (2013). This paper can serve as an update on Sentinel Asia's operationalisation, with specific focus on its value in supporting the emergency response operations of the ASEAN Member States. It is divided into four sections. The first section (10.1) briefly outlined the Sentinel Asia initiative. The second provides a brief description of the emergency observations in ASEAN and, background in understanding the mechanics of Sentinel Asia, and explains the steps involved in emergency observations, from emergency observation request to data provision. The third section provides insights into the AHA Centre's emergency response operations in 2018, which were supported by space-based information provided by Sentinel Asia. The fourth section contains recommendations for improving the chain of activities between space-based observations in supporting emergency response observations.

10.2 Emergency Observations in ASEAN Region 2006-2016

Figure below presents the breakdown of EORs and their activation, according to type of disaster, during the period of 2006-2016. During this period, Sentinel Asia received a total of 270 EORs, from which 228 actual observations were conducted in response (84.4%). Floods accounted for the largest number of disasters, with 132 requests (48.9%), followed by earthquakes with 31 (11.5%), landslides with 21 (7.8%), typhoons with 20 (7.4%), forest fires and fires with 17 (6.3%), volcanic eruptions with 14 (5.2%), and cyclones with 10 (3.7%). Overall, most EORs were activated, amounting to an average of 80 to 90%, however, the activation rate for forest fires remained low with 41.2%.

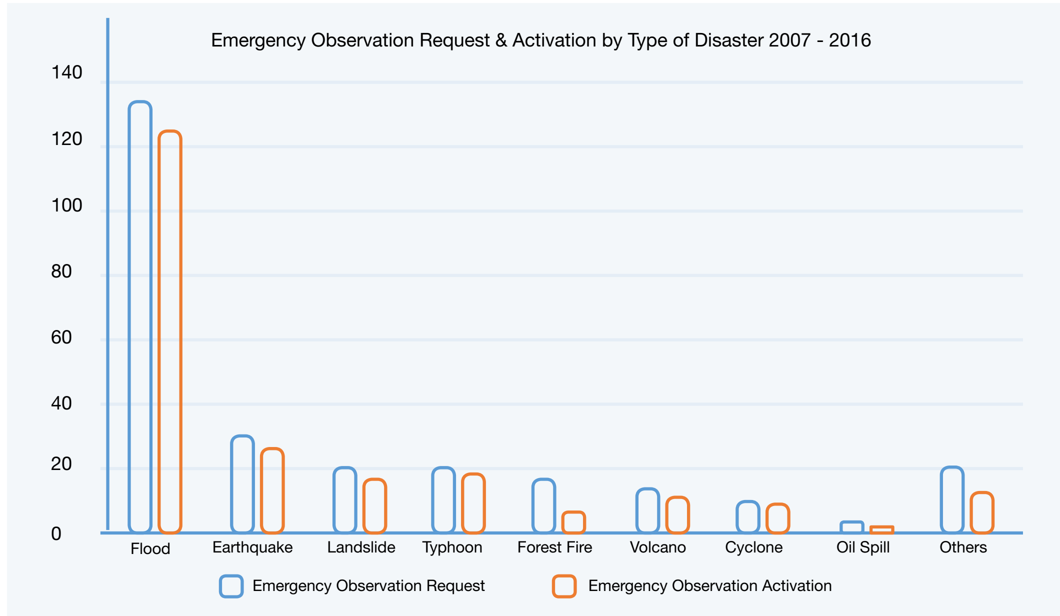

Figure 10.2 Emergency Observation Request & Activation by Type of Disaster 2006-2017 (Sentinel Asia Secretariat)

As a disaster-prone region, ASEAN Member States greatly benefit from Sentinel Asia initiatives. On average, from 2007-2016, more than half of EORs were issued by ASEAN Member States. Notably, ASEAN Member States account for three largest requesting countries, namely, Indonesia, the Philippines, and Viet Nam. As illustrated in Figure 10.3, on average it took 2.2 days from the time of EOR to emergency observation activation through Sentinel Asia's DPN (observations in ASEAN countries are underlined in red). For reference, in 2017, only 2 out of 17 activations in the ASEAN region took more than the average of 2.2 days. It should be noted that in the case of typhoon, which can be forecasted, an EOR had been submitted to ADRC in advance, meaning DPNs could start planning the observation quickly. This was the case with observation associated with the typhoon and floods in Viet Nam.

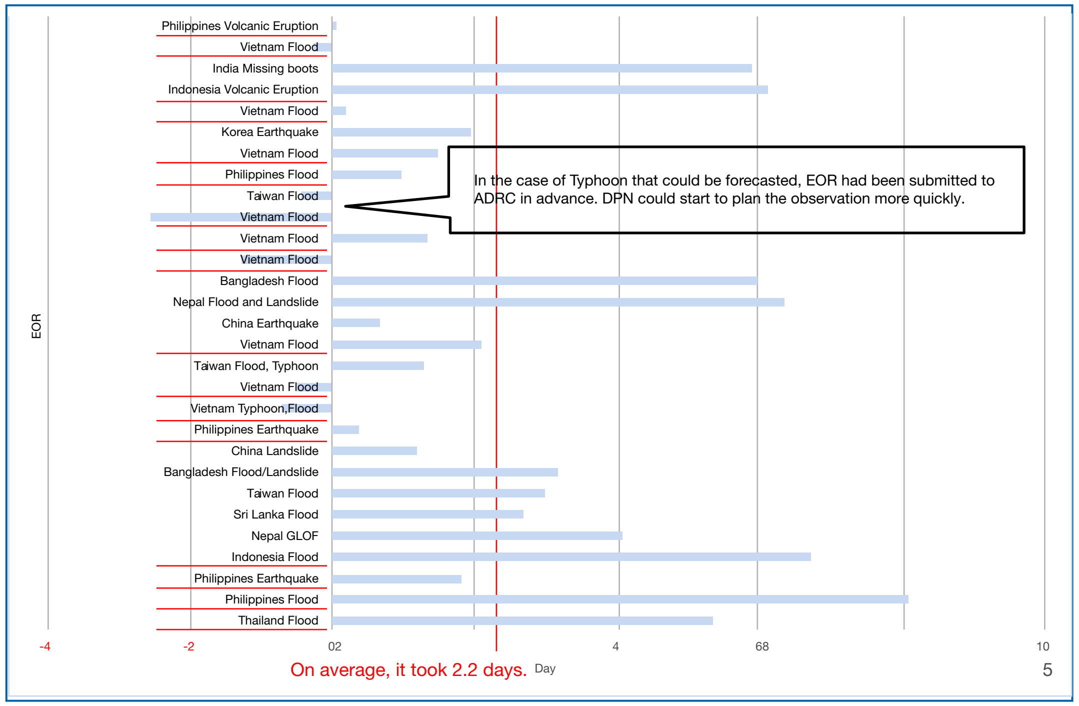

Figure 10.3 Emergency Observation Activation in 2017 (Sentinel Asia Secretariat)

After the EOR has been submitted and emergency observation activated, there is a time gap to the actual observation. As illustrated by Figure 10.4, on average it took 3.7 days including weekends and holidays from activation to actual observation, i.e. in the case of JAXA's Advanced Land Observing Satellite 2 (ALOS-2). Most of the observation in ASEAN countries was within this average. According to JAXA, taking into account that, in principle, the ALOS-2 observation can be tasked only on weekday during business hours and that certain types of disasters require archive data and the new observation must be conducted on the same condition, which inevitably results in additional time with the average of approximate 3 days from one ALOS-2 observation could not be decreased. However, if the DPNs' satellites could collaborate and complement each observation, this time could be shortened.

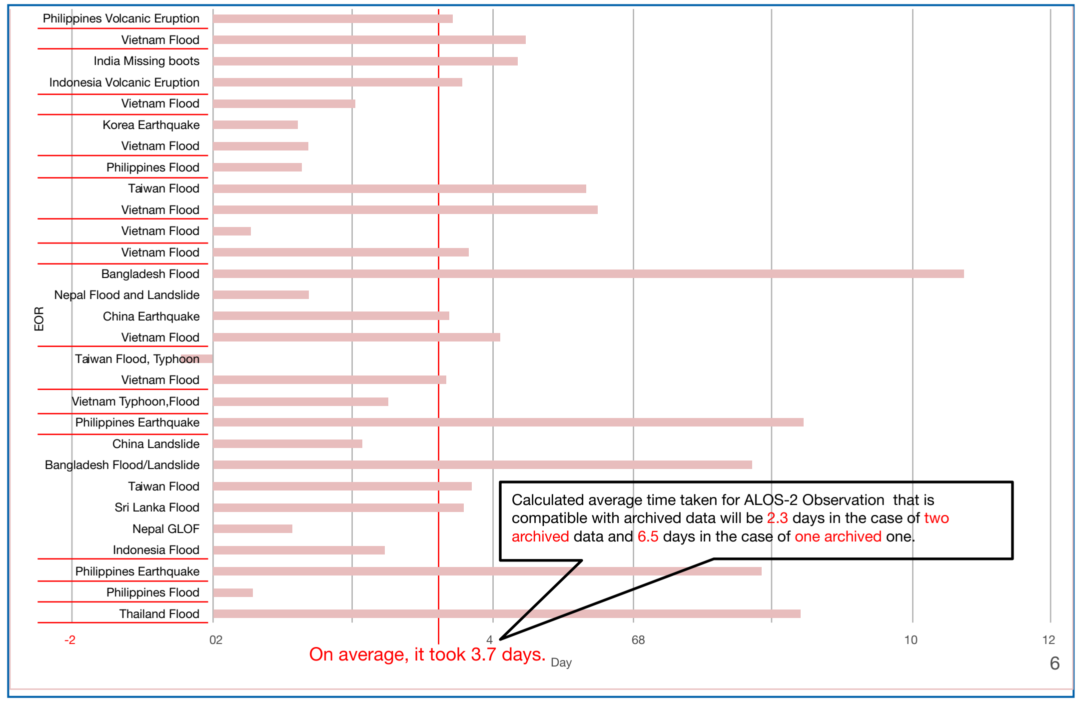

Figure 10.4 Time taken for ALOS-2 Observation after Sentinel Asia Activation in 2017 (Sentinel Asia Secretariat)

Following satellite observation, the data is then provided to the Sentinel Asia website, for further analysis by DANs or for utilisation by users. Figure 10.5 illustrates that on average it took 1.7 days for data from ALOS-2 to become available on the Sentinel Asia website. Most of the data for disaster observations in ASEAN was provided in under the average required time. According to JAXA, the required time of 1.7 days (41 hours) is given because at present, operations are still conducted by humans. In the future, with the new Sentinel Asia cloud-computing system that enables machine-to-machine processing, the time gap between observation and data provision could be reduced to less than one day.

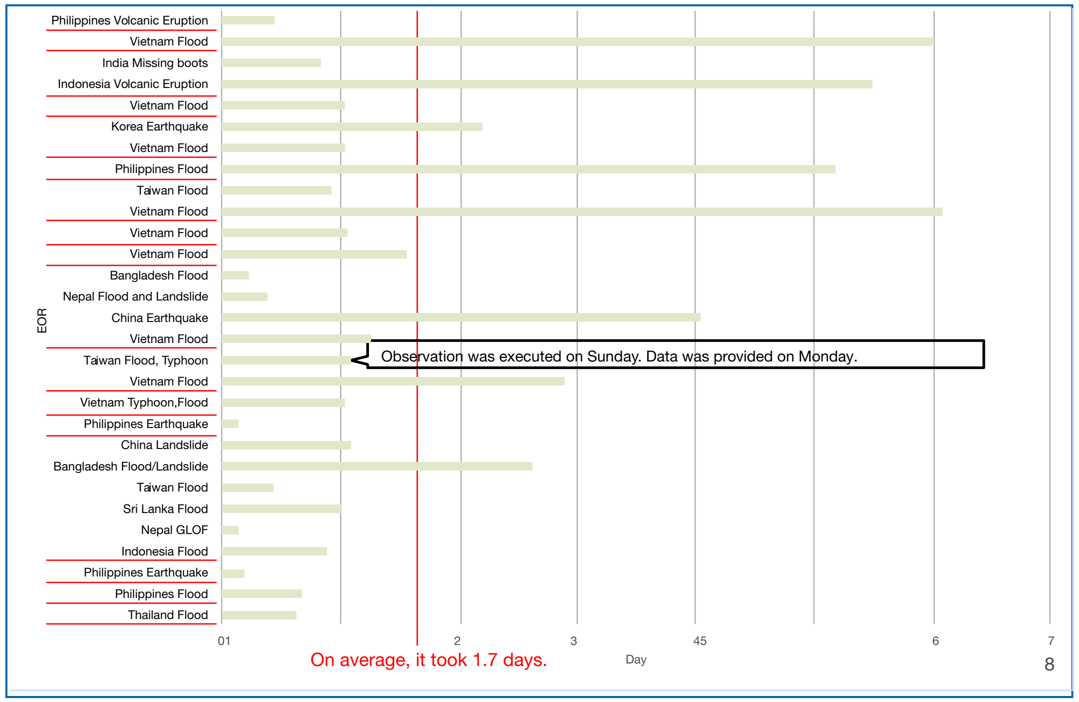

Figure 10.5 Time taken for ALOS-2 Data Provision after Observation in 2017 (Sentinel Asia Secretariat)

10.3 In Action: Space-based Information Support for Emergency Response Operations in 2018

In 2018, the AHA Centre responded to seven emergencies in the region, four of which involved satellite-based observation; i.e. the Yangon Dump Site Fire, Tropical Storm Son-Tinh and the Dam Collapse in Lao PDR, Monsoon Flood in Myanmar, and the Lombok Earthquake in Indonesia. This section will specifically investigate space-based information utilisation for the emergency response operations in Myanmar (March 2018), Lao PDR (July 2018), and Indonesia (August 2018). The Lao PDR and Indonesia cases are examples of the use of satellite imagery from Sentinel Asia, while the Myanmar case demonstrates an example of an alternative source of space-based information which is still accessible by the AHA Centre.

10.3.1 Effects of Tropical Storm Son-Tinh in Lao PDR

From 17 July 2018, the AHA Centre's Disaster Monitoring and Response System (DMRS) detected and alerted regional stakeholders about the movement of Tropical Storm (TS) Son-Tinh (Henry) in the north-west of the Philippines. From that point AHA Centre's flash updates were issued on a daily basis, updating stakeholders on the movement of TS Son-Tinh, preparedness, and response activities in the Philippines, Viet Nam, and Lao PDR. In Lao PDR alone, 349 villages in 41 districts and 10 provinces were flooded, with more than 2 million people affected.

The situation in Lao PDR then quickly deteriorated on 24 July 2018, due to water discharge caused by structural failure of the Xe-Pien Xe-Namnoy Dam in Attapeu Province, which caused flash flooding of villages downstream of the Xekong River. Immediately after, the Government of Lao PDR declared Sanamxay District, Attapeu Province, as a "National Disaster Emergency Zone". On 25 July 2018, the AHA Centre sent an EOR for TS Son-Tinh and the dam failure to the ADRC. Following this, the AHA Centre also deployed the ASEAN Emergency Response and Assessment Team (ERAT) and mobilised relief items from the Disaster Emergency Logistics System for ASEAN (DELSA) warehouse in Malaysia, i.e. family kits, hygiene kits, and a Mobile Storage Unit (MSU).

Following this, the satellite data and VAPs were available on the Sentinel Asia website from 26 July 2018. In this case satellite imagery was provided by Indian Remote Sensing Satellites (IRS), while the VAPs were provided by Sentinel Asia's DANs, including JAXA, AIT, International Water Management Institute, ADPC, and Earth Observatory of Singapore. The AHA Centre then collated all available satellite imagery into a single document and shared it with the Department of Social Welfare of Lao PDR, as the relevant NDMO.

Throughout the emergency response period from 24 July to 12 August 2018, there were several key points in which satellite-based information assisted the AHA Centre and the DSW (Department of Social Welfare) emergency response operations: 1) VAPs from Sentinel Asia's DANs were directly used and quoted in AHA Centre's Situation Updates, which informed regional and international stakeholder on the situation on the ground; 2) flood water monitoring informed the Government of Lao PDR about the status of the emergency response period and transition to early recovery; 3) flood inundation data assisted the AHA Centre in providing recommendations to the DSW regarding the best location for constructing the ASEAN MSU, and 4) the DSW and AHA Centre continuously updated the locations of evacuation sites according to their inundation status.

For example, on 29 July 2018, one of Sentinel Asia's DANs submitted the information that, based on its latest satellite observation in Sanamxay District, about 42.36 km² of the initial inundated area was still flooded (a decrease of 24.89 km²) as at 24 July 2018 (IWMI). It covered Yai Thae, Hinlad, Mai, Thasengchan, Tha Hin, and Samong, and Hinlad and Mai villages. The names of villages inundated were provided to the Government. Furthermore, at that time, 76.7% of the inundated area was agricultural land (32.53 km²). The space-based information also informed the Government that 302 buildings and 31.5 km worth of roads were submerged in the inundation zone. This is illustrated in the table and figure below.

DATE / PARAMETER	17 July	25 July	27 July	29 July
Inundation area (km²)	41.14	67.25	48.78	42.36
Inundated agriculture area (km²)	27.21	38.65	32.53	28.16
Number of villages Inundated in Sanamxay District	Chomphoy, Done, Donesoug, Kamphor, Kung, Moung, Somphoy, Tamoryose, Thabok, Thasangchan (10)	Gvilay, Chomphoy, Done, Donesoug, Hinlath, Kamphor, Kung, Mai, Moung, Namkong, Samongtay, Sivilay, Somphoy, Tamoryose, Thabok, Thahintay, Thasangchan (17)		Chomphoy, Kung, Samongtay, Tamoryose, Thabok, Thahintay, Thasangchan (7)

Source: (AHA Centre, 2018)

Table 10.2 Inundation Area in Sanamxay District, Attapeu Province. Lao PDR

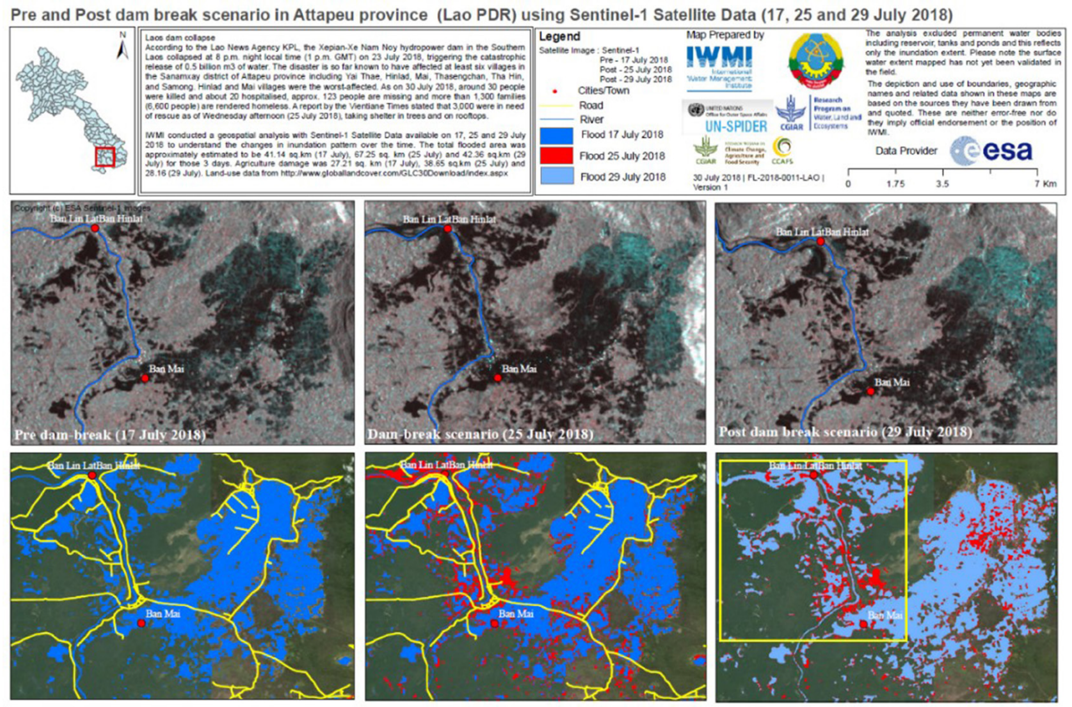

Figure 10.6 Dam Break Scenario in Attapeu Province, provided by Sentinel Asia DAN (Sentinel Asia Secretariat)

Mapping of evacuation sites in the flood inundated areas was one of the DSW's priorities during the emergency response period. For this, the AHA Centre provided mapping support by overlaying the coordinates of evacuation sites transmitted by the DSW personnel on the ground onto flood inundation data observed from the satellite, as illustrated below. In Sanamxay District, all three of the evacuation sites were protected from the inundated areas.

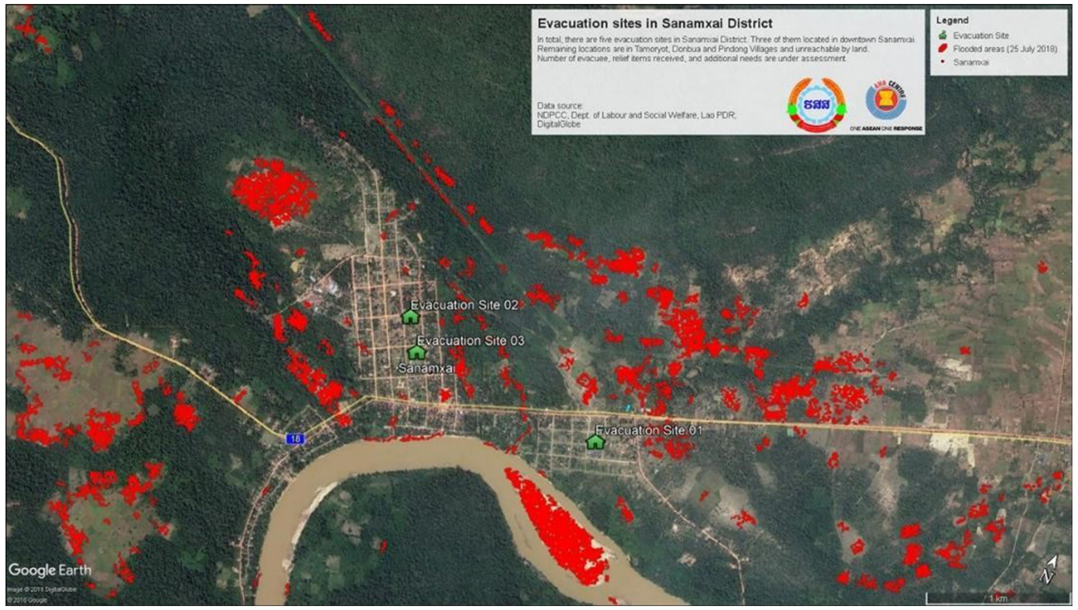

Figure 10.7 Use of Satellite-based observation 1: Overlay of Inundation Areas and Evacuation Sites in Sanamxay District

Satellite-based data on the inundation area was then used by the AHA Centre to provide recommendations to the DSW regarding four potential sites for establishing the ASEAN MSU, to support the management of relief items on the ground. The AHA Centre considered the inundation areas, terrain, and proximity to the river for this matter. Upon ground verification, the DSW decided to establish the MSU at the first proposed location near the city centre of Sanamxay District.

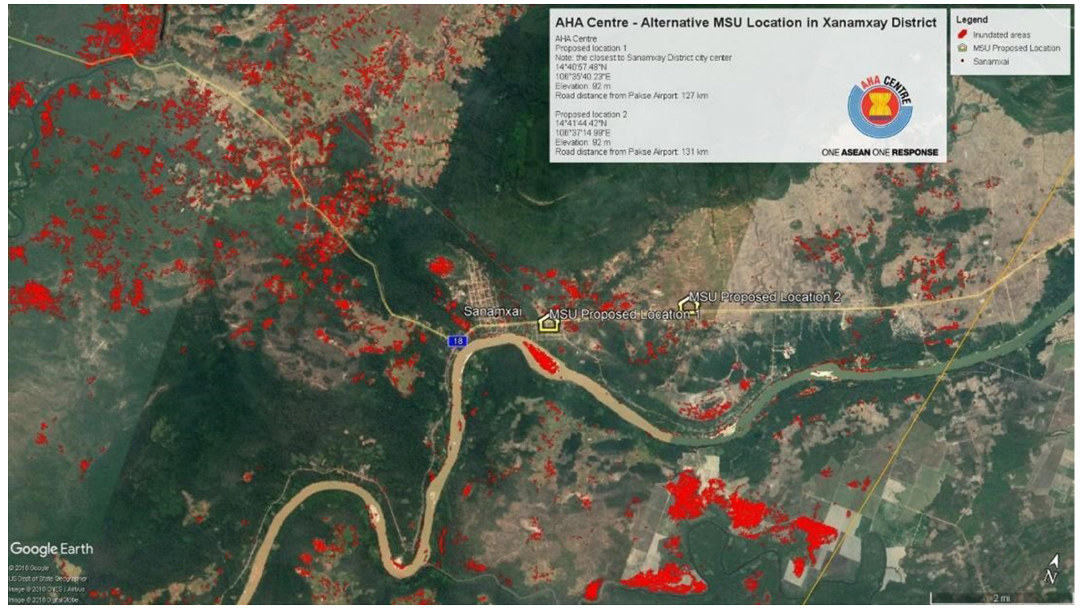

Figure 10.8 Use of Satellite-based observation 2: Overlay of Inundation Areas for determining location of Mobile Storage Unit

Towards the end of the emergency response period, the AHA Centre also utilised Sentinel Asia data to illustrate the subsiding rate of flooded areas in the region; i.e. by comparing the flood inundation maps of 24 and 31 July 2018, as illustrated below. As the Government of Lao PDR was informed of these observations it had a better understanding of the situation, and of when to declare the closure of the emergency response operations, and transition to early recovery.

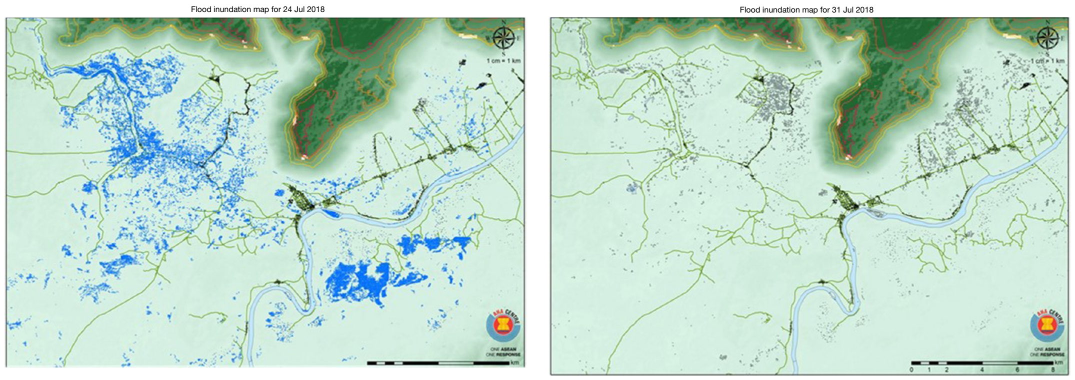

Figure 10.9

10.3.2 The 2018 Lombok Earthquake, Indonesia

In July and August 2018, a series of moderate and strong earthquakes rocked cities and regencies on Lombok Island, West Nusa Tenggara Province (NTB), Indonesia, with the following magnitudes: M 6.4 (29 July), M 7.0 (5 August), M 6.2 (9 August), M 6.5 (19 August), and M 6.9 (19 August). The Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) recorded more than a thousand aftershocks in the region. At the end of the emergency response period on 25 August 2018, the National Disaster Management Authority (BNPB) verified 561 fatalities, with 431,416 people displaced, and 74,361 houses damaged. Furthermore, the damage and losses due to the earthquakes was reported to be worth around IDR 7.7 trillion (+ USD 528 million).

Throughout the 2018 Lombok Earthquake emergency response, the Government of Indonesia maintained that it was fully supporting provincial emergency response operations with national support, and consistently maintained that international assistance was not required. Despite this, the AHA Centre supported the Government of Indonesia, through BNPB, by seconding staff to BNPB's emergency operation centre, and by collating and disseminating information to regional and international stakeholders (through AHA Centre's situation updates). BNPB also welcomed the deployment of ASEAN-ERAT, so it could be exposed to the ongoing emergency response operation. Furthermore, the AHA Centre and ASEAN-ERAT also supported the Government of Indonesia's retrieval process of ASEAN relief items, including family tents, hygiene kits, family kits, and one MSU.

The first EOR for the Lombok Earthquake was issued by Indonesian National Aeronautics and Space Agency (LAPAN) with the dedicated support by the AHA Centre on 29 July 2018, after the M 6.4 earthquake. At that time, based on communication with Government of Indonesia, the disaster was supposed to be handled internally. However, with a stronger M 7.0 earthquake on 5 August 2018, the AHA Centre sent a second EOR form to ADRC on 6 August 2018. Through Sentinel Asia, two sets of images were made available, via IRS and THEOS (Thailand). In addition, as the Sentinel Asia activations have been promptly escalated to the International Disaster Charter, the Government of France's Regional Service of Image Processing and Remote Sensing (SERTIT), UNOSAT, and DigitalGlobe (an American commercial vendor of space imagery and geospatial content), also provided and processed their respective images. Furthermore, JAXA, AIT, Yamaguchi University, Earth Observatory of Singapore, Indonesian Agency for the Assessment and Application of Technology (BPPT) and Indonesian National Institute of Aeronautics and Space (LAPAN) also made their satellite image analysis and products available.

The AHA Centre then consolidated all available products within its situation updates. Between the activation of the Sentinel Asia platform and Disaster Charter and 11 August 2018, five remote damage assessment activities through aerial surveys and satellite observation have been completed: 1) by Indonesian agencies BNPB, the Indonesia Geospatial Portal (BIG), BPPT, and the Centre for Volcanology and Geological Disaster Mitigation (PVMBG); 2) by UNITAR-UNOSAT following the M 7.0 earthquake; 3) by SERTIT; 4) by various Sentinel Asia DPNs and DANs; and 5) by DigitalGlobe. In particular, the Line of Sight and ground displacement maps available at the early stage of the emergency response were useful for predicting the concentrated areas of damaged houses. All observations identified by the AHA Centre are of various locations, and thus they can complement each other.

Fourteen out of a total 52 villages affected were assessed remotely, with around 3,081 buildings potentially damaged. Those villages (except for Gili Indah) were also identified by BNPB as isolated areas requiring immediate assistance. Aerial surveillance and satellite observation was largely targeted at total collapse of buildings, and destruction to roofs and building structures was clearly identified from satellite images and/or aerial imagery. Based on ASEAN-ERAT's field call and with the BNPB team on the ground, some of the damages identified and verified on the ground included light damages; i.e. where the roof of a building remains, but with structural damages. The potential number of collapsed houses/buildings, at this point, was assessed to be more than 3,000, whereas damaged buildings (all severity levels) totaled more than 67,000 (BNPB). This is displayed in the following table.

Remote Assessment activities	Observed areas	Results
Aerial surveys by Government of Indonesia agencies (BNPB, BIG, BPPT, and PVMBG)	Regency: East Lombok District: Sambalia Village: Mentareng, Obel-obel	129 damaged buildings, out of total 287 (44.9%)
	Regency: East Lombok District: Sambalia Village: Pemadekan, Obel-obel	34 damaged buildings, out of total 165 (20.06%)
	Regency: East Lombok District: Sambalia Village: Obel-obel, Obel-obel	18 damaged buildings, out of total 116 buildings (15.5%)
Damaged assessment based on satellite-observation by UNITAR-UNOSAT	Regency: North Lombok District: Kagayan Villages: Gumantar and Dangiang	UNITAR-UNOSAT analysis identified 1,274 potentially damaged structures in the area
	Regency: North Lombok District: Pemenang Village: Gili Indah, Malaka, East Pemenang, West Pemenang	UNITAR-UNOSAT analysis identified 15 potentially damaged buildings and 6 potential gathering sites in Gili Indah village
	Regency: North Lombok District: Tanjung Village: Sigar Penjalin, Medana, Tanjung, Jenggala, and Tegal Maja.	Within the map, 49 settlements were categorised as destroyed, 57 as severely damaged, and 129 moderately damaged. Among the total, 235 damaged settlements were identified.
Government of France, Regional Service of Image Processing and Remote Sensing (SERTIT)	Regency: North Lombok District: Salangan Villages: Bagek Gembar, Lokok Sutrang	1,033 damaged buildings detected, with additional 268 buildings potentially damaged
	Regency: North Lombok District: Kayangan Villages: Salangan	Approximately 70 'very affected' buildings and 230 'affected' buildings. The imagery also managed to identify 'spontaneous gathering area' that may indicate an evacuation site
DigitalGlobe	Regency: North Lombok District: Bayan Villages: unknown	3 collapsed buildings and 55 houses identified from the imagery

Table 10.3 Aggregate of Remote Assessment Activities following Lombok Earthquake (AHA Centre, 2018)

The AHA Centre and ASEAN-ERAT on the ground used the Earth Observatory of Singapore (EOS)'s data package on the Advanced Rapid Imaging and Analysis damage proxy map, damage mapping, and surface displacement data, for their subsequent ground verification on building damages. The EOS made their data available through Sentinel Asia webGIS platform. As guided by BNPB, ASEAN-ERAT was tasked to support damage assessment in West Lombok Regency, together with its local disaster management agency (BPBD). Together with BNPB and BPBD West Lombok Regency personnel, ASEAN-ERAT analysed satellite imagery and identified 17 potentially damaged sites in Gunung Sari District which required on the ground verification, as can be seen in the figure below.

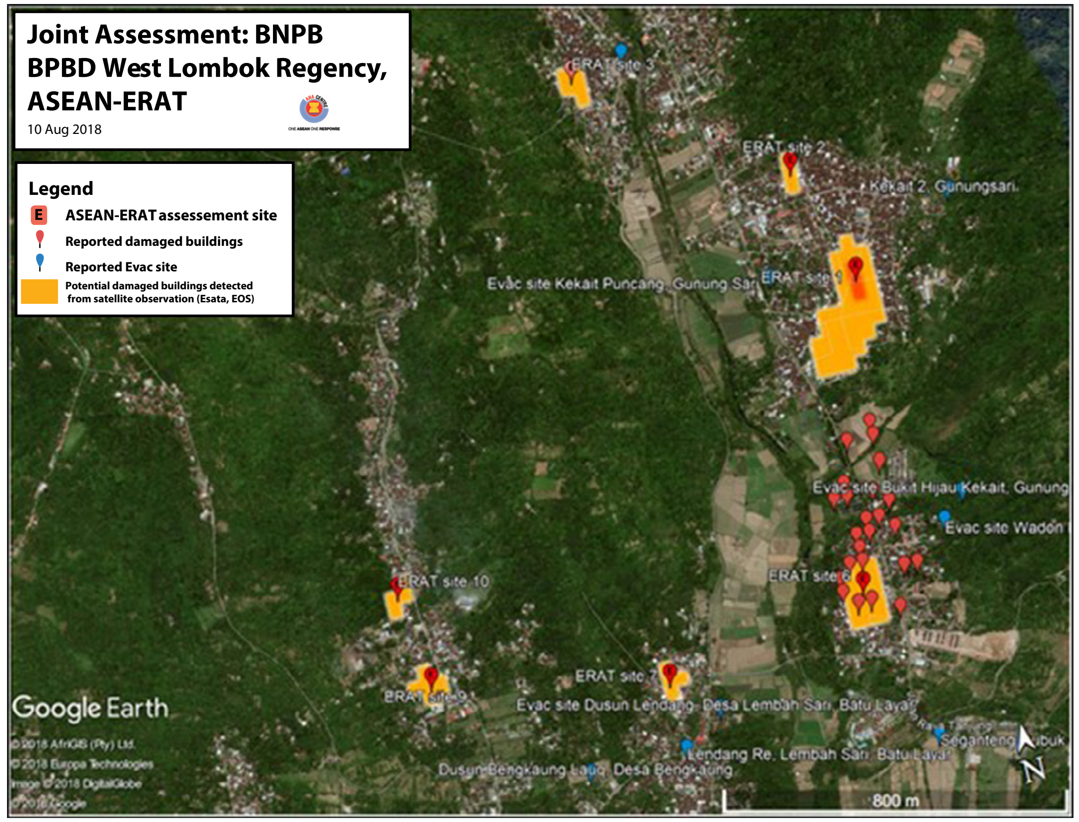

Figure 10.10 Joint Assessment Sites by ASEAN-ERAT, BNPB, and BPBD West Lombok

During emergency response operations, the AHA Centre and ASEAN-ERAT also utilised other humanitarian partner techniques of ground assessment, i.e. by combining available crowd-sourced reports, on-site verification of areas with potential damages as analysed through satellite observation, and ground verification by responders, with steps detailed below:

1. Verify location and situation of evacuation sites in both districts (blue points);
2. Verify reported damages (red points) already triangulated with satellite observations (orange/red areas);
3. Visit and conduct onsite verification of areas identified with potential damages (according to satellite imagery analysis); and contribute ground photos/observation

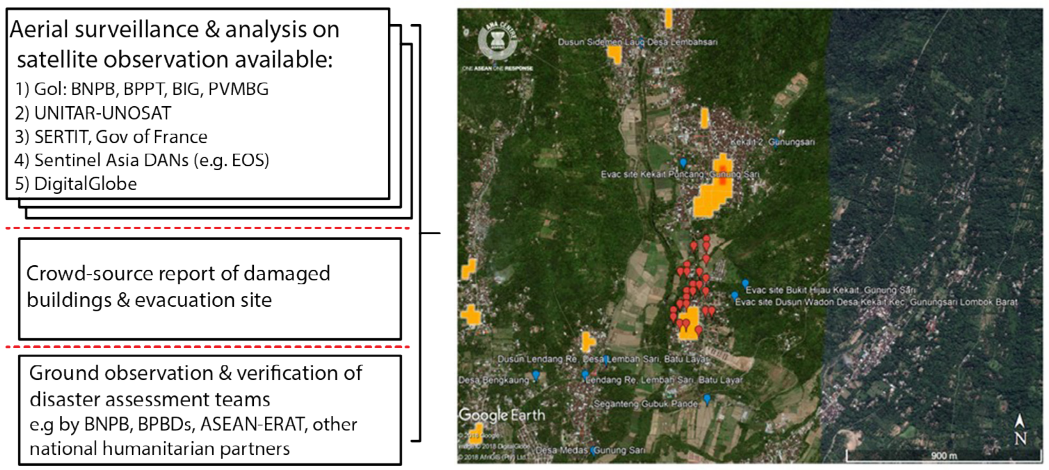

Figure 10.11 Recommendations on Ground Assessment guided by Satellite-based information
Source: AHA Centre, 2018

10.3.3 Yangon Fire Dump Site, Myanmar

A combination of extreme hot weather during the dry season, and exposure to an open dumping waste site, resulted in one of Myanmar's worst wildfires in Yangon, in April 2018. The open dumping practice caused methane, which had been gradually building up under the massive rubbish dump, to become 'fuel' for the fire triggered by extreme temperatures. The fire started in Hlaing Tharyar Township at the 17-year-old Htein Pin Landfill in Yangon's western outskirts, on Saturday, 21 April 2018. For nearly one week it affected more than 20 townships across Yangon city, with Tharyaw township being the most affected. Efforts to put out the fire were made on the first day using traditional methods, but once the fire had expanded to over 100 acres it became uncontrollable and released a massive amount of smoke.

On 25 April, the uncontrollable fire and smoke prompted the Public Health Department of Yangon Region to launch a 24-hour air-quality monitoring regime in the vicinity of the dump, as smoke from the site continued to pose a health risk. For instance, as of 25 April, 13 patients were treated at a local hospital after inhaling smoke from the blaze. According to the Department of Disaster Management of Myanmar (DDM), 15 people were hospitalised and 60 received health care assistance from a Mobile Health Care Facility. The Myanmar Times also reported that two men suffered from carbon monoxide poisoning, while two suffered acute severe bronchial asthma caused by smoke. For several days, the fire and smoke also disrupted flight operations to and from Yangon International Airport.

Contact was made by the DDM with the AHA Centre on Monday 23 April 2018, three days after the first fire broke out. According to the DDM, the Government of Myanmar explored potential support from ASEAN, in terms of assessment and public health recommendations. It was then decided, upon approval from the Governing Board, that ASEAN-ERAT with public health capabilities would be deployed. Meanwhile, EOC remote assessment and information management support was provided by the AHA Centre.

Up until 72 hours after the fire broke, a good understanding of the smoke's movement was still lacking, as was information on whether the heat source still persisted into the following week. Utilisation of space-based information was therefore critical in these matters. For this incident, the AHA Centre did not issue a request to Sentinel Asia, due to the amount of time which had elapsed after the main trigger point, and also because the European Space Agency (ESA)'s Satellite Sentinel-2A already had imagery of the location (although it was yet to be analysed). Accordingly, the AHA Centre used this source and provided the first situational map on 26 April 2018, as can be seen on the next page. The location of the Htain Bin Dump Site and an area with a 30 km radius (approximate area of 630 km^2) were produced and shared with Myanmar's DDM. The map shows that the heat source was in a wider area than the Htain Bin Dump Site area itself, and thus smoke could still be generated, meaning the danger was not over.

Figure 10.12 Situational Awareness Map processed by AHA Centre showing the heat source and the extent of smoke fume

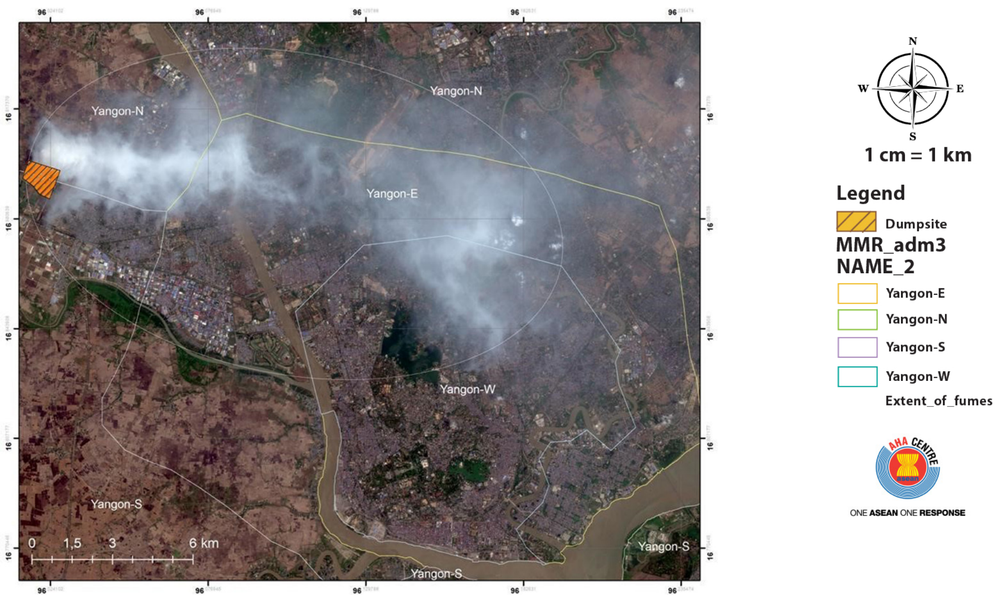

Figure 10.13 Situational Awareness Map processed by AHA Centre showing the extent of smoke fume across townships in Yangon

The AHA Centre also further utilised observations of the smoke-covered areas, by overlaying the population distribution of townships in Yangon, as can be seen in the figure below. Furthermore, calculations on vulnerable populations were also provided, for situational awareness of the health offices in Yangon. Based on the geospatial calculation, approximately 796,852 people were potentially exposed to the smoke, with 290,850 considered vulnerable. Vulnerable populations include those under 15 years of age (219,931 or 27.6% of total population) and 70,919 people aged 60 and above (8.89% of total population). A recommendation on the priority for potential health equipment and protection was generated based on this information.

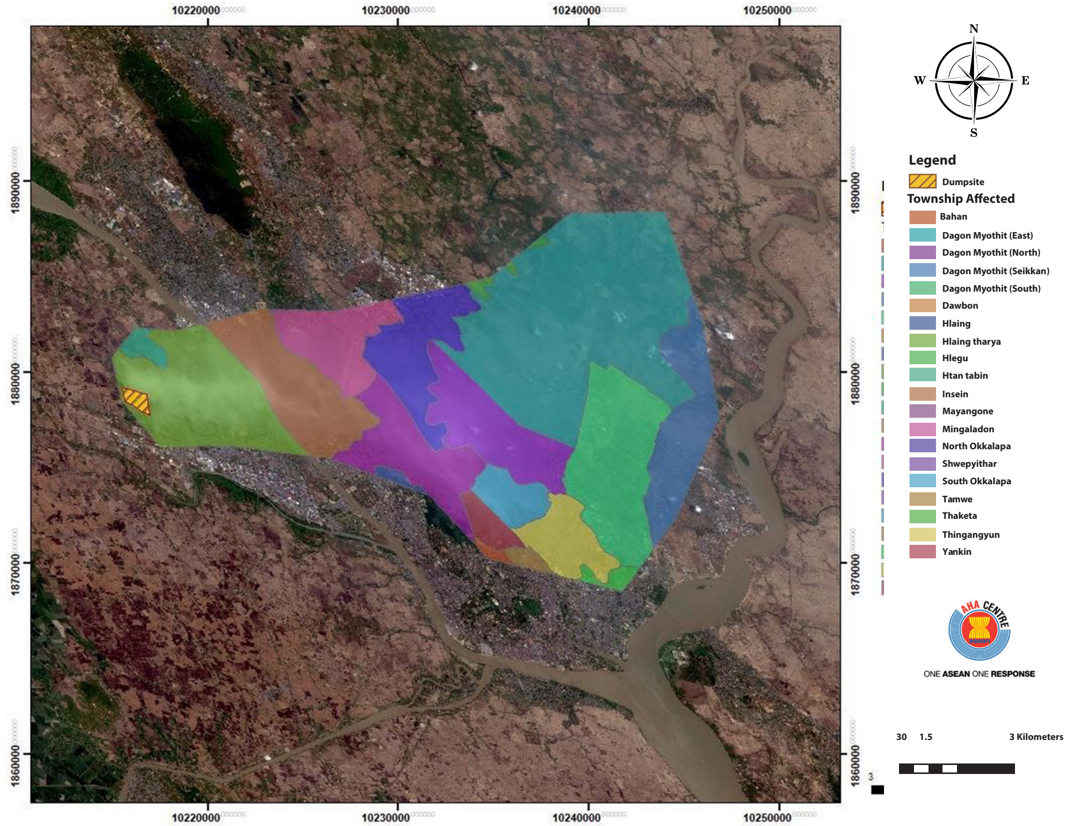

Figure 10.14 Exposure Map provided by AHA Centre showcasing the number of exposed populations by township in Yangon City

After ASEAN-ERAT was deployed it participated in the response, and provided the key situational information to authorities that about 80% of the fire was now under control, but also that "what we can't control is smoke", as stated by Yangon Region Chief Minister U Phyo Min Thein. ASEAN-ERAT also provided the recommendation, based on the heat source information, to apply the 'divide and separate' technique to the waste in the dump site. Furthermore, having received recommendations from both ASEAN-ERAT and a special team from Thailand, the Chief Minister of Myanmar decided to use bio-foam, a fire suppression detergent, to reduce the smoke. The statement also included the information that the Government would import 1,800 gallons (6.8 tonnes) of the foam from Thailand.

Conclusion & Recommendation

Based on the current arrangement between Sentinel Asia and the interrelated ASEAN Member States, along with recent experience from emergency response operations, these are the key recommendations:

1) Ensure all NDMOs of ASEAN countries are exposed to the Sentinel Asia platform and mechanism, through a dedicated capacity building and training exercise which covers the EOR process, WebGIS utilisation, outreach, and potential use of satellite-based observations for emergency response operations.

2) Establish a strategic coordination and communication forum between ASEAN countries' NDMOs and ASEAN-based DPNs and DANs, i.e. those in Thailand, Singapore, and Viet Nam. Thailand, through GISTDA, will have further involvement in designing the next stage of Sentinel Asia, and it hosts the ASEAN Research and Training Centre for Space Technology and Applications (ARTSA), therefore such a strategic event could be conducted in close collaboration with it. In the past the AHA Centre has coordinated with ARTSA on the potential development of a regional UAV network. A similar attempt can be made to further expose ASEAN countries and disaster-related stakeholders to Sentinel Asia.

3) During emergency response operations, conducting a teleconference between NDMOs, the AHA Centre, and DPNs and DANs may be useful for sharing information, including about the potential use of satellite-based data and observation as well as ground feedback from the responders.

Beyond engagement with the Sentinel Asia mechanism, this chapter has also demonstrated the means for space-based information provision through other agencies such as members from the International Charter. It is recommended that ASEAN Member States have multiple space-information networks. For instance, keeping tab to potential availability of data from EU's Copernicus Programme can also be another alternatives to immediately build situational awareness. Nevertheless, requests for space-based observation following disasters can always be escalated to the International Charter facilitated by Sentinel Asia, which is called "Sentinel Asia Escalation", as in the case with the 2018 Lombok Earthquake, Indonesia, coordinated by the AHA Centre and the Sentinel Asia community. Ultimately, the important action performed by the information management coordinator, i.e. the AHA Centre, is utilising various available data and space-based information for comprehensive situational awareness (as depicted in conceptual steps in Figure 10.11.

In addition, practitioners in both the space and disaster management communities need to be aware of and refer to the work of ESCAP and the AHA Centre, regarding recommendations for procedural guidelines for sharing space-based information in ASEAN countries' emergency responses (ESCAP, 2017). Its handbook provides such guidelines. While satellite-derived and geospatial information is often used for increasing situational awareness during the aftermath of disasters, many disaster managers are unfamiliar with the systematic approach necessary for properly utilising such innovative applications. There is a lack of standard processes and procedures across agencies, making it difficult to coordinate national activities as well as regional cooperation and support during emergencies. Free satellite data for emergency response is becoming increasingly available and accessible, but end-users are often unaware of such global and regional initiatives. Furthermore, the procedures for requesting space-based information from the growing number of data providers can vary, with no consolidated set of instructions, as there are multiple platforms for sharing information at national, regional and international levels, which can often create confusion.

Finally, rather than relying only on space-based information, disaster managers should take advantage of space-based information generated from satellite observation as well as information generated from aerial surveillance, for example from an Unmanned Aerial Vehicle (UAV) or drones. The table on the following page is provided for final takeaways for disaster managers in ASEAN to understand the characteristics of both types of observation.

Observation Parameter	Satellite Observation	UAV Observation
Scope	Can cover wide area of observation	Limited area of observation
Time turn around for observation	2-3 days after observation, requiring image processing	Observation can be made instantaneously, subject to humanitarian access of UAV and personnel in affected areas
Case of use	☐ Hazard observation in wide area (e.g. collapsed flank of Mount Anak Krakatau) ☐ Disaster damage observation	☐ Disaster damage observation (Lombok Earthquake, Palu Earthquake)
Advantage	☐ Precision for geospatial calculation	☐ Fast observation and data processing can be done at field command/ coordination post
Challenge of use	☐ Not all AMS have data analysis and processing capabilities for image processing ☐ Requiring stable environment with high spec PC capabilities for data processing	☐ Not all AMS have data analysis and processing capabilities for image processing, yet capacity building cost can be less than satellite
Existence of procedural reference in ASEAN	A document on Sharing Space-based Information: Procedural Guidelines for Disaster Emergency Response in ASEAN Countries is available	Reference document not yet available

Table 10.4 Comparison between satellite and UAV observation

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- **Yos Malole** is a disaster management practitioner with more than 11 years of working experience in the area of disaster preparedness, rehabilitation and recovery and emergency response. He was working with the Red Cross and Red Crescent Movement for the Indian Ocean Tsunami rehabilitation and reconstruction programme in Aceh. After which, he joined the AHA Centre as the Emergency Preparedness and Response Officer for five years. Mr. Malole has extensive experience in emergency response where he had been deployed to 10 response missions in the ASEAN region including as team leader role for the ASEAN-Emergency Response and Assessment Team (ERAT) during the Central Sulawesi Earthquake and Tsunami in September 2018. He currently serves as a Technical Consultant of the ASEAN-ERAT Transformation Project of the AHA Centre.

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