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Monographic issue

(Un)Natural Disasters in Southeast Asia

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Letter from the editors

The Emergency and Disaster Reports is a journal edited by the Unit for Research in Emergency and Disaster of the Department of Medicine of the University of Oviedo aimed to introduce research papers, monographic reviews and technical reports related to the fields of Medicine and Public Health in the contexts of emergency and disaster. Both situations are events that can deeply affect the health, the economy, the environment and the development of the affected populations.

The topics covered by the journal include a wide range of issues related to the different dimensions of the phenomena of emergency and disaster, ranging from the study of the risk factors, patterns of frequency and distribution, characteristics, impacts, prevention, preparedness, mitigation, response, humanitarian aid, standards of intervention, operative research, recovery, rehabilitation, resilience and policies, strategies and actions to address these phenomena from a risk reduction approach. In the last thirty years has been substantial progress in the above-mentioned areas in part thanks to a better scientific knowledge of the subject. The aim of the journal is to contribute to this progress facilitating the dissemination of the results of research in this field.

The objective of this monographic issue is to explore the risk profile on natural disasters of the Southeast Asia region aggregating relevant and updated information about the most common natural disasters (by frequency of events) that occurred over the last 50 years, between the period of 1971 to 2020 across the SEA region.

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ORIGINAL RESEARCH

(Un)Natural Disasters in Southeast Asia

Collins Santhanasamy

Table of Contents

Index of Figures 5
LIST OF ABBREVATIONS 6
INTRODUCTION, BACKGROUND AND CONTEXT 7
- Geography 7
- Demographic Information 8
- Economy 8
- Health 10

OBJECTIVES 11
METHODOLOGY 11
RESULTS 13
(UN)NATURAL DISASTERS 13
- Hydro-Meteorological Disasters 14
  - Tropical Cyclones 15
  - Floods 17
  - Landslides 19
- Geophysical 21
  - Earthquakes 22
  - Tsunamis 24
- Biological 25
  - Epidemics 25

HAZARDS, EXPOSURE & VULNERABILITIES 27
  - Natural Hazards 30
  - Floods 31
  - Cyclones 32
  - Landslides 32
  - Earthquakes 33
  - Climate Change 34
  - Pacific Ring of Fire 36

Preparation, Prevention and Mitigation Strategies 37
Community Resilience 38

DISASTER RISK REDUCTION 38
DISCUSSION 40
CONCLUSION 41
BIBLIOGRAPHY 42
- ANNEX I – SEA Seismic Zones 49
- ANNEX II – INFORM vs RVA Risk Score Comparison 50
- ANNEX III – ASEAN's Top 56 Cities Most-at-Risk 51

Index of Figures

Figure 1: Map of Southeast Asia 7
Figure 2: 2020 Southeast Asia population density for persons per square kilometre. 8
Figure 3: ASEAN GDP (PPP) per capita (Int$) 9
Figure 4: Top 8 natural disasters (by frequency) in Southeast Asia 13
Figure 5: Linear regression of cyclonic events v/s time (1971-2020). 16
Figure 6: Landslide reports and estimated fatalities for all years in the Global Landslide Catalogue (GLC) as a function of a region. 20
Figure 7: Collapsed slope on the day after the failure 21
Figure 8: Distribution of earthquakes of ≥ Moment magnitude (Mw) 7 with their associated casualties (1971-2020). 22
Figure 9: Distribution of tsunamis with their associated casualties (1971-2020). 24
Figure 10: Coverage of immunization against Measles among one-year old children (%) by ASEAN Member States, 2005-2018 26
Figure 11: Risk and the context of hazard, exposure and vulnerability. 27
Figure 12: Risk score of ASEAN countries 29
Figure 13: Distribution of disasters in ASEAN by country and hazards. 31
Figure 14: Climate change vulnerability: Most vulnerable areas in Southeast Asia 34
Figure 15: Pacific Ring of Fire. 36

LIST OF ABBREVATIONS

- AADMER – ASEAN Agreement on Disaster Management and Emergency Response
- AHA – ASEAN Coordinating Centre for Humanitarian Assistance on disaster management
- ADINet – ASEAN Disaster Information Network
- ASEAN – Association of Southeast Asian Nations
- CFR – Case Fatality Rate
- CRED – Centre for Research on the Epidemiology of Disasters
- DHF – Dengue Hemorrhagic Fever
- DRP – Disaster Prevention Programs
- DRR – Disaster Risk Reduction
- GAR – Global Assessment Report
- GLC – Global Landslide Catalogue
- GDP – Gross Domestic Product
- HFA – Hyogo Framework for Action
- IASC – Inter-Agency Standing Committee Task Team
- IFRC – International Federation of Red Cross and Red Crescent Societies
- INFORM – Index for Risk Management
- IOTWS – Indian-Ocean Tsunami Warning System
- IPCC – Intergovernmental Panel on Climate Change
- MLSEA – Mainland Southeast Asia
- NOAA – National Oceanic and Atmospheric Administration
- OCHA – UN Office for the Coordination of Humanitarian Affairs
- OFDA – Office of U.S. Foreign Disaster Assistance
- PDC – Pacific Disaster Center
- PTSD - Post-Traumatic Stress Disorder
- PTWS – Pacific Tsunami Warning System
- RVA – ASEAN Regional Risk and Vulnerability Assessment
- SARS – Severe Acute Respiratory Syndrome
- SDG – Sustainable Development Goals
- SEA – Southeast Asia
- SEDAC – Socioeconomic Data and Applications Center
- SNA – System of National Accounts
- SR15 – Special Report on Global Warming of 1.5°C
- UN – United Nations
- USD – United States Dollar
- WHO – World Health Organization

INTRODUCTION, BACKGROUND AND CONTEXT

Southeast Asia comprises of the ten (10) member states of the Association of Southeast Asian Nations (Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar (Burma), Philippines, Singapore, Thailand and Vietnam) and Timor-Leste. Despite the significant growth of ASEAN from its initial five (5) members to its ten (10) current member states, the region is still vulnerable to various natural hazards.

Geography

The region of Southeast Asia (SEA) extends across 11 countries and comprises of a total land area of 4,340,700 Km^2.(1) The geographical layout of this region comprises a wide range of characteristics and includes archipelagos and continental land masses with both low plains and mountainous terrain.(2)

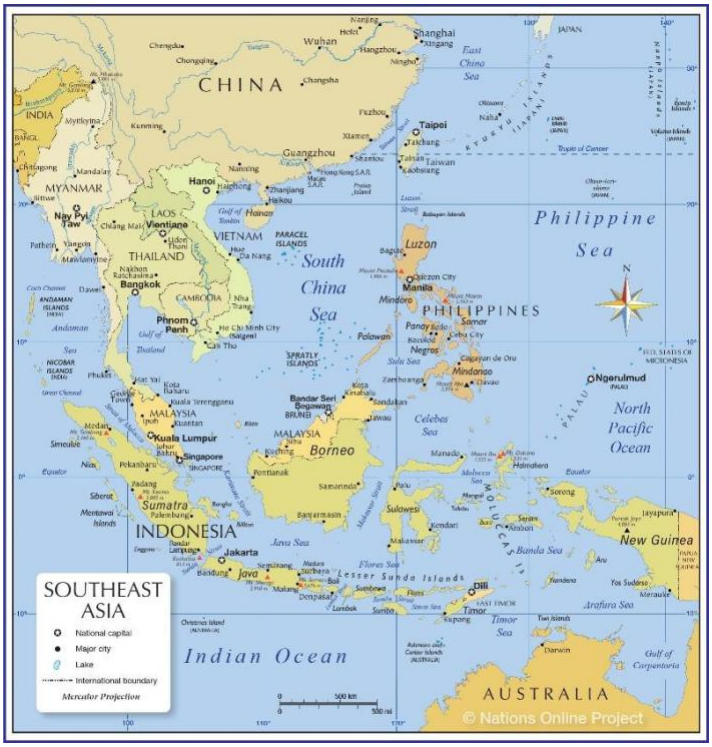


Figure 1: *Map of Southeast Asia*

Source: *Map obtained from The Nations Online Project.*(3)

SEA can be broadly divided into two geographic regions: The continental or mainland and a string of archipelagos that extend to the south and east of the mainland (insular Southeast Asia).(4) The continental projection is connected to India and China and extends south into what has been called the Indochina peninsula or Indochina, a name given to the region by France. This continental region is made up of the countries of Cambodia, Laos, Myanmar, Thailand and Vietnam. The insular region consists of the

islands of Southeast Asia: Brunei, Timor-Leste, Indonesia, Malaysia, the Philippines and Singapore.(5)

Demographic Information

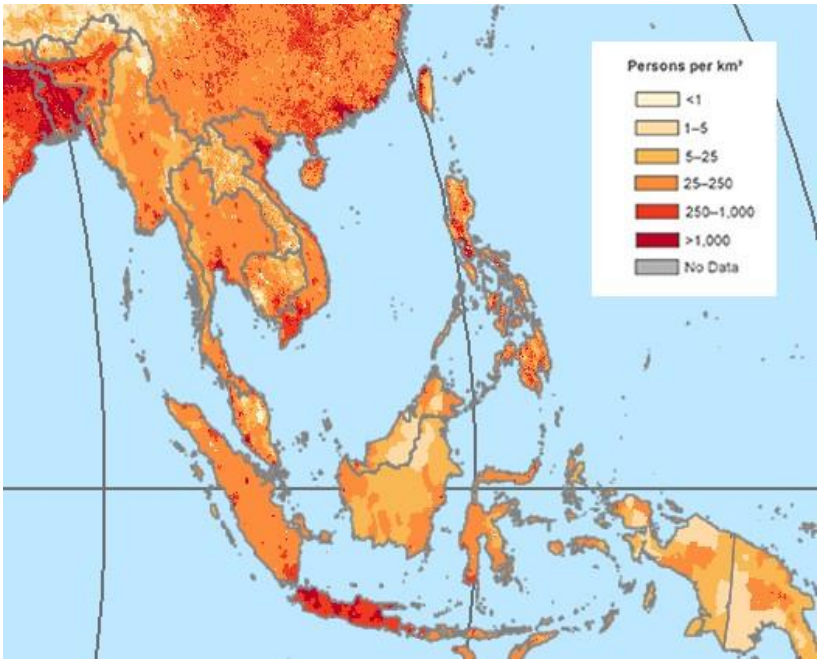


Figure 2: *2020 Southeast Asia population density for persons per square kilometre.*

Source: *Map obtained from SEDAC.*(6)

In 2019, Southeast Asia was home to a total population of 660,617,919 people of which 50 % of the population resided in urban areas.(7) The average population density in Southeast Asia is 154 per Km^2 with the median age being 30.2 years.(1) Indonesia has the highest population (270.6 mil) and Brunei the lowest (0.43 mil).

Economy

All countries across the SEA region depend on Agriculture as the main source of livelihood except for Brunei and Singapore. More than two-thirds of the workforce in Cambodia and Laos work in agriculture but however, agricultural employment has been declining across the region as the economies of the ASEAN countries restructure towards industries and services. A significant decline in the proportion of the Gross Domestic Product (GDP) from agriculture has been seen in Indonesia, Malaysia and Thailand.(8)

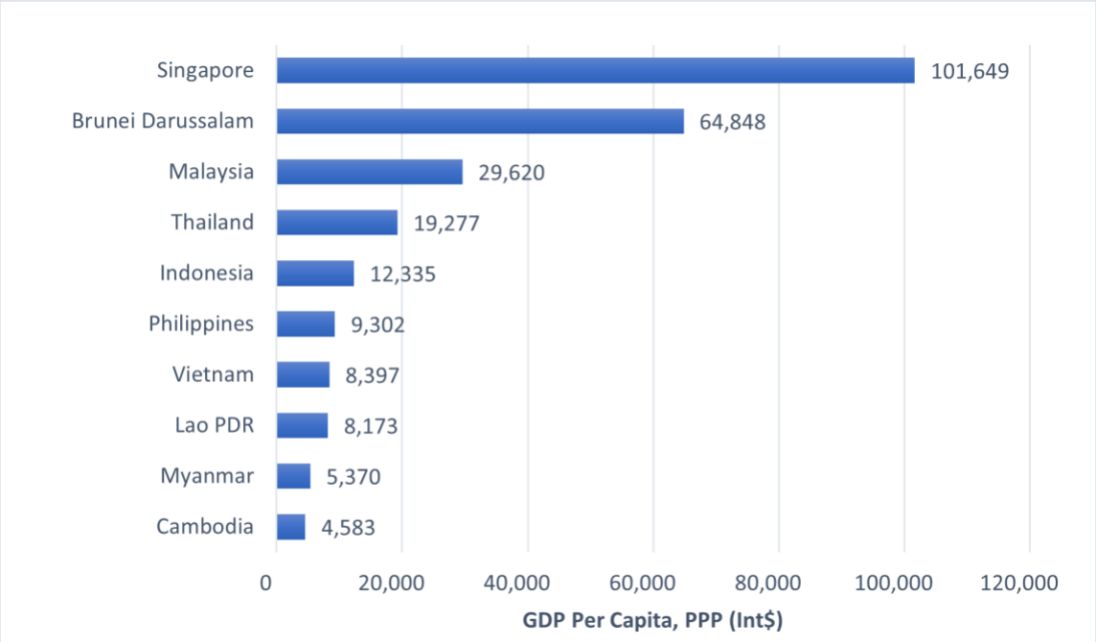


Figure 3: *ASEAN GDP (PPP) per capita (Int$)*

Source: *Figure prepared from data obtained from The World Bank.*(9)

The Gross Domestic Product (GDP) Purchasing Power Parity (PPP) per capita (Int$) is a commonly used measure in the System of National Accounts (SNA) for comparing the size, performance and prosperity of economies across countries. The GDP (PPP) per capita measures the sum of marketed goods and services produced within national boundaries averaged across the population that lives within the territory. It is calculated using a country's GDP (in the international dollar) which is then divided by the country's total midyear population.(10) Smaller and more technologically advanced nations tend to have a higher per capita GDP as seen in the case of Brunei and Singapore.

Even with the global economic crisis in 2008-2009, ASEAN's GDP has indeed seen a positive trend between 2000-2019. The total GDP of 3.2 trillion USD in 2019 has doubled from a decade ago (1.6 trillion USD in 2008) and almost five times more than its value in 2000 (0.6 trillion USD). Indonesia accounted for 35.4% of the region's GDP in 2019 followed by Thailand (17.2%), the Philippines (11.9%) and Singapore (11.8%).(11)

Southeast Asia's development in industrialization began in the early 1960s and is a considered a relatively recent phenomenon. The policies that facilitated industrialization were critical goals for the economies of the ASEAN countries. In all countries across the region, apart from Brunei, the contribution towards GDP from industries has grown considerably, the most significant of which, has been seen in Singapore, Thailand and the Philippines.

Regional trade from ASEAN is valued at approximately one-third that of the United States and most strikingly, there is almost total dominance of trade by market economies. Countries such as Singapore, Malaysia and Brunei have relatively large proportions of export trade whilst exports as a percentage of the GDP are moderate in Thailand, the Philippines and Indonesia and only account for a small percentage in Cambodia, Myanmar and Vietnam.(8)

Malaysia currently derives most of its export income from petroleum products but, in the past, its trade pattern was directed towards the exportation of palm oil, tropical hardwood and tin. Revenues generated from this trade have been used to build and improve the country's industrial base. Brunei also relies almost entirely on its petroleum exports.(12) Thailand on the other hand demonstrates a less diverse export structure, mainly focusing on food and manufactured goods. Singapore generated investments and expanded its manufacturing and service sectors by utilizing its unique geographical position and highly educated labour force to entice multinational corporations.(13)

All ASEAN countries have strong domestic air transport systems with Indonesia holding the most extensive network of over 673 airports which it utilizes as a critical link between its many islands.(14) The Indonesian government also subsidizes air services to smaller islands. The largest international air fleets from the region are maintained by Singapore, Malaysia and Thailand.

The most extensive communications capabilities and infrastructure can be found in Singapore whilst in other developed states, telephone services are mostly abundant in urban areas. Many rural areas of the Philippines, Indonesia and Thailand still suffer from deficient telecommunication however, Indonesia, through the deployment of satellites as part of its national infrastructure, has made significant improvements in its telephone and television transmissions to remote areas of the archipelago.(8)

Health

Healthcare systems across the region that have dominant tax funding are fairly stable however, crucial issues involving efficiency and quality of healthcare services, increasing operational costs, higher public expectations and sustainability still persist.(15)

Several advanced and innovative public-private partnerships for healthcare have been developed in the region. The 1985 restructuring / corporatization of public hospitals in Singapore and the government owned Swadana hospitals in Indonesia which are allowed to retain fees and funds for salary incentives, operations, and hiring of contract personnel are examples of this.(16)

The Philippines, Vietnam and Indonesia also radically decentralized their healthcare systems with the devolution of health services to local governments. This restructuring has affected several aspects of system performance and equity. Many governments passed laws to establish national health insurance systems and mandated universal coverage in order to ensure affordability and increased financial coverage however, challenges have been encountered in its implementation. Equity issues and poor infrastructure continue to plague the development of the healthcare sector in the region.(17)

OBJECTIVES

The objective of this risk profile on (un)natural disasters of the Southeast Asia region is to aggregate relevant and updated information about the most common natural disasters (by frequency of events) that occurred over the last 50 years, between the period of 1971 to 2020 across the SEA region. This disaster profile was developed with the following specific objectives:

A. To identify the frequency of natural disasters occurring in this region over the last five (5) decades.
B. To assess the impact of natural disasters on health, economy and services.
C. To analyse the major hazards and vulnerabilities present in the region.
D. To Identify disaster prevention and response strategies implemented across the region.
E. To identify the structure and characteristics of emergency and disaster response framework across the region.

METHODOLOGY

This Southeast Asia profile on natural disasters was developed through secondary data obtained from databases and review of literature. For the purpose of this disaster risk profile, disasters are defined as 'A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts'.(18)

The classification and statistics on disasters affecting the SEA region were adapted from EM-DAT, the OFDA/CRED international disaster database Version 2021-05-27. Data accessed for analysis was from the Southeast Asia region over a 50-year time period from 1971 to 2020, inclusive of both years. A crude cumulative total of 1,753 entry records from this database was extracted for study with the following key information: Year, disaster name, disaster group, disaster subgroup, disaster type,

disaster subtype, event name, country, location, latitude, longitude, total deaths, total affected, and total damages. Countries included Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar (Burma), Philippines, Singapore, Thailand, Vietnam and Timor-Leste. A descriptive analysis was conducted to understand the patterns, characteristics, and magnitude of natural disasters.

Reports from international organizations including the United Nations, the World Health Organization, The International Red Cross and Crescent, ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre), the Internal Displacement Monitoring Centre and the British Geological Survey were collected and reviewed.

Limitations of this study include a lack of quantitative data such as number of deaths, estimated economic damages and number of events. Certain events are not listed in the database which may be due to underreporting or inability to meet the entry criteria.(19)

A disaster is recorded in the EM-DAT database when it fulfils at least one of the following criteria: 1) 10 or more deaths, 2) 100 or more affected or a 3) declaration by the country of a state of emergency or 4) appeal for international assistance. Total estimated damage is quantified by different institutions and is expressed in ('000) US dollars. Total deaths refer to persons confirmed as dead and persons missing and presumed dead.(20)

In order to obtain more specific details related to events discussed in this report, other sources including OCHA, Relief Web, Prevention Web and UNISDR were utilized.

RESULTS

(UN)NATURAL DISASTERS

A disaster is defined as a "sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community's or society's ability to cope using its own resources. Though often caused by nature, disasters can have human origins."(21)

Recent, notable and high-impact and large-scale natural disasters in this region include the 2004 Indian Ocean Tsunami, the 2008 Cyclone Nargis and the 2013 Typhoon Haiyan (Yolanda). These 3 disasters alone cumulated a total death toll of 278,000 fatalities and combined economic damages amounting to USD 22.5 billion.(22)

Over the last 50 years, between the period from 1971 to 2020, there are total of 1,753 natural disasters recorded in EM-DAT, the international disaster database developed by the Centre for Research on the Epidemiology of Disasters (CRED).

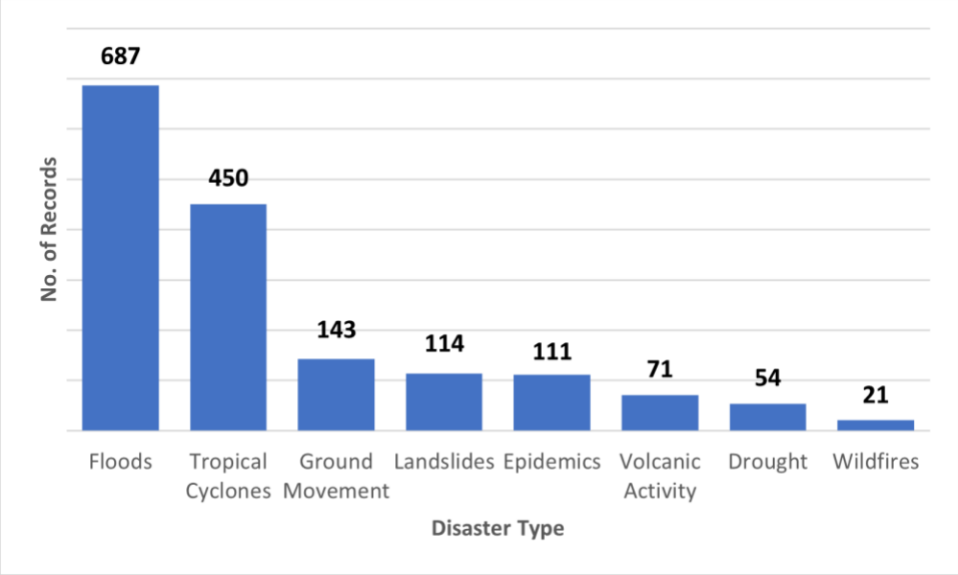


Figure 4: *Top 8 natural disasters (by frequency) in Southeast Asia*

Source: *Figure prepared from data obtained on 25th of May, 2021 from EM-DAT, CRED.*(20)

5 natural disasters having the highest frequency of occurrence in this this region include floods (Total – 687; Riverine – 300, Flash – 144, Coastal – 22, Uncategorized – 221), tropical cyclones (450), ground movement (143), landslides (114) and epidemics (111). There have also been 71 events related to volcanic activity, 54 incidences of drought, and 21 wildfires across the region.

The death toll of natural disasters in this region over the 50-year period amounts up to 439,791 fatalities. This represents 92.8% of deaths caused by all disasters in the region. Natural disasters not only cause fatalities and economic damages alone, but also induce massive population displacement.(23) Over 524 million people were affected by natural disasters in the SEA region alone.(20)

Interestingly, the term "natural disaster" is in fact a misnomer that is being recognized by a growing number of academicians in the risk community. The expression suggests that failures of development and the realities of the most vulnerable are to be blamed on nature, natural phenomena or even "acts of God".(24) Natural disasters are not so natural and such prevention failures cost many lives, mostly amongst the poorest populations. In 2018, UNISDR stated that this misnomer would no longer be used in their communications and this commitment is evident with the publication of the Global Assessment Report (GAR) in 2019.(25)

Natural disasters mentioned in this profile are broadly classified in to 3 groups: Hydro-meteorological, Geophysical and Biological. These disasters cost major economic losses across the globe. The cost of climate-related disasters far outweighs the direct economic impacts of earthquakes and other geophysical events. In total, EM-DAT recorded total losses of 2,600 billion USD in the period between 1994-2013. In the long-term, the loss of education and health infrastructure can slow economic and social development for generations to come.(26)

Hydro-Meteorological Disasters

Hydro-Meteorological disasters account for more than 75% of all damages caused by natural disasters. These damages include number of casualties, damage to infrastructure, economic losses and disruption to normal life. Disasters that fall into this category range from landslides and avalanches to heat and cold waves, from floods to droughts, cyclones and even debris flow.(20)

Water and wind are the primary causes of all hydro-meteorological disasters. Floods and wind storms account for the majority of disasters in this category and in comparison to other continents, the Asian continent suffers the most.(27)

Since the 1960s the number of weather-related natural disasters has tripled across the globe and every year these disasters result in over 60,000 deaths, the majority of which occur in developing countries.(28)

Storms are the most expensive type of natural disasters. Between 1994 and 2013 storms including cyclones killed more than 244,000 people and cost 936 billion USD in recorded damages across the globe. Scientific evidence also predicts that climate change will increase this upward trend in the number of floods and storms globally.(26)

Floods arising from extreme rainfall have been increasing in many regions across the world in recent years. Developed countries usually aim to mitigate flood disasters through strategies that involve the use of structural means, but these solutions are unaffordable in most developing countries which instead focus on cost-effective early warning systems that are in some cases the only option available.

Disasters affect communities across the region in many different ways. For example, cyclones that affect the SEA region usually last a few days but can cause extreme destruction in the form of crop failure, famines and disease outbreaks that can may continue for extended periods of time.

Tropical Cyclones

A tropical cyclone originates over tropical or subtropical waters. It is characterised by a warm-core, non-frontal synoptic-scale cyclone with a low-pressure centre, spiral rain bands and strong winds. Tropical cyclones are referred to as hurricanes if they arise from the Atlantic and Northeast Pacific oceans, typhoons from the Northwest Pacific ocean and Cyclones if they arise from the South Pacific and Indian Oceans.(29)

Of the 450 tropical cyclones recorded in the EMDAT database from this region between the time period of 1970-2020, 293 of these cyclones made landfall in the Philippines (65%), 100 in Vietnam (23%) and 26 in Thailand (6%). A total of 191,463 people were killed in these events making cyclones the deadliest category of natural disasters to affect the region with the highest death toll accounting for 43.5% of all deaths caused by natural disasters in the region during these 50 years.

Tropical cyclones also accounted for 39.68 billion USD in damages in the SEA region over the last 50 years with Philippines suffering from 58% of the economic impact (23.02b USD) followed by Vietnam (11.37b USD) and Myanmar (4.07b USD). (20)

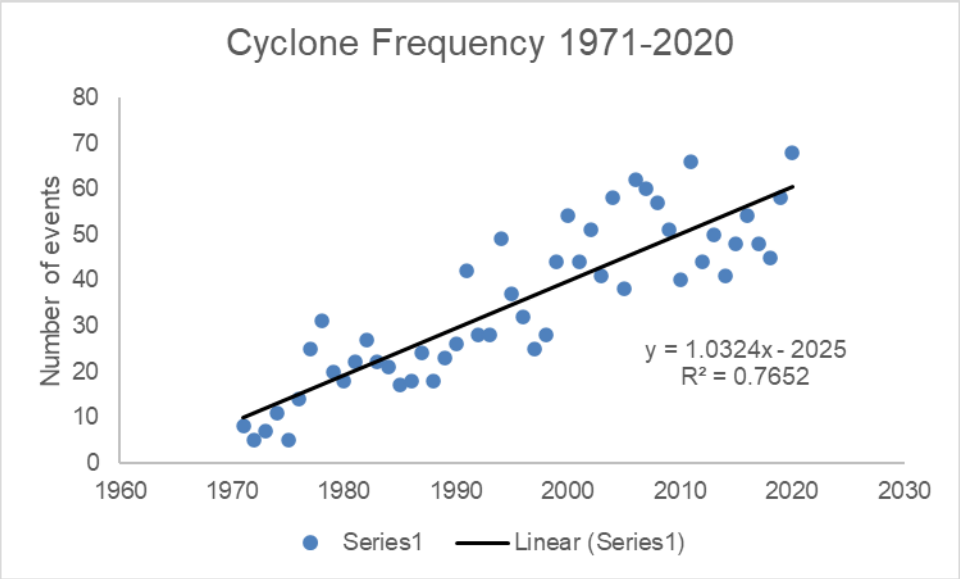


Figure 5: *Linear regression of cyclonic events v/s time (1971-2020).*

Source: *Figure prepared from data obtained on 25th of May, 2021 from EM-DAT, CRED.*(20)

An increasing trend of cyclonic events has been observed from 1971 to 2020. Linear regression done on cyclonic data by year with the number of events as the dependent variable showed a r-squared value of 0.77 which suggests that the progression of time is a suitable determinant for the frequency of cyclones.

The possibility of an increasing number of droughts and increased intensity of storms is most likely to occur with increasing global surface temperatures. As more water vapour is evaporated into the atmosphere, it acts as fuel for the development of more intense storms. Increased atmospheric heat and warmer ocean surface temperatures contribute towards a higher wind speed in tropical storm events. Rising sea levels also expose locations that were previously not subjected to the erosive forces of waves and currents.(30)

Historical Events

Cyclone Nargis: On the 2nd of May 2008, extremely severe cyclonic storm Nargis, originating from the Bay of Bengal, made landfall in the south of Myanmar. It caused estimated damages of 4 billion USD and killed 138,366 people making it the deadliest tropical cyclone in SEA's history.(20) In response to this disaster, the International Federation of Red Cross and Red Crescent Societies (IFRC) implemented actions aimed at disaster preparedness, risk reduction and capacity building at both the national and local levels. Over four (4) thousand people from 136 villages located in high-risk areas were trained in community-based disaster risk management and equipped with early warning tools such as loudspeakers, stretchers and educational materials. Assistance was also provided to vulnerable communities to secure clean

water sources, improve household shelters with disaster risk reduction techniques and the construction of schools which could serve as storm shelters during emergencies.(31)

This event highlighted the need for disaster risk management and the importance on focusing on community empowerment and risk awareness to ensure that a Nation remains prepared to face such events. After Cyclone Nargis, the IFRC took three years to rebuild more than 16,000 houses, 25 schools and 20 rural health centres.(26)

Typhoon Haiyan: On the 8th of November 2013, super typhoon Haiyan made landfall in the SEA region killing 7,354 people in the Philippines making it the second strongest landfalling tropical cyclone on record and one of the deadliest natural disasters in the country's history. With winds reaching speeds up to 270 km/h which completely flattened parts of low-lying islands, Sixteen (16) million people were affected by this disaster which caused over 10 billion USD in total estimated damages.(20)(32)

Typhoon Goni: Super typhoon Goni is the strongest storm at landfall in recorded history with 1-minute average sustained wind speeds of 315 km/h.(33) It struck the Philippines on the 1st of November 2020 and caused 503 million USD in total estimated damages. Although this cyclone was stronger than typhoon Haiyan, it only claimed the lives of 31 people.(20)

Floods

Flood is a general term that is used to describe the overflow of water onto dry land. Of all the natural disasters that occurred in the ASEAN region between 1971 and 2020, floods account for the highest total estimated damages. In this 50-year period, 45% (66.5b USD) of total estimated damages caused by natural disasters in the region were caused by floods.(20)

Data from EM-DAT shows a recorded number of 687 flooding events across the SEA region: 300 Riverine, 144 flash, 22 costal and 221 uncategorized floods. These floods account for 31.3% of all people affected by natural disasters and amount to a cumulative death toll of 22,937 in the Southeast Asia region over this 50-year period, making floods the 4th highest cause of deaths by natural disasters (5.2%).

As flash, acute riverine and coastal flooding events continue to increase in frequency, interventions are necessary to counter the rising average death tolls from floods in many parts of the world. Studies have shown that the health and livelihoods of communities, particularly those depending on agriculture for survival, suffer from severe long-term impacts when exposed to recurrent flooding events. Children that are in their first years of life who are exposed to floods were found to suffer from the

highest levels of chronic malnutrition due to flood related disruptions in agricultural production and interruption of food supplies.(34)

Globally, floods have caused more damages to housing, schools and hospitals that any other type of disaster. Many of the impacts caused by floods are preventable. Through the utilization of practical community education targeted at mothers, it has been shown that children can be protected from flood-related malnutrition. Affordable solutions such as dams and dykes have also proven effectiveness in primary prevention.(34)

Riverine Floods

The EMDAT database glossary defines riverine flooding as involving 'overflow of flood waters into the floodplain, a generally flat land that runs parallel to a river or stream.'

Analysis of data available from the EMDAT database over 50 years from 1971-2020 shows that the total estimated damages caused by riverine flooding accounts for 86% (57.31b USD) of damages caused by flooding. This makes riverine flooding the most economically damaging of all the natural disasters subtypes, affecting agriculture, housing, industry and transportation industries.

Coastal floods

When higher-than-normal water levels occur along the coast it causes flooding which can last for days to weeks. This is propagated by tidal changes or severe thunderstorms. What is characteristic of a coastal flood is that the water level rises and drops with the tide. When a sea defence such as a dune or dike is breached, a low tide is when repairs can be carried out.(35)

Most deaths due to coastal floods occur due to drowning in floodwaters. Other injuries are caused by debris and infections related to contaminated water. Hypothermia is of particular concern, especially for people at the extremities of age. Electrocution risk also increases if electrical equipment is in contact with floodwaters.

Over the 50-year period, between 1971 and 2020, there have been 22 records of coastal floods in the EM-DAT database resulting in a cumulative death toll of 1,005 persons and the displacement of 4,775,922 people. Over 750 million USD in estimated damages have resulted from these events.

Flash Floods

Flash floods are defined according to the EM-DAT glossary of terms as "Rapid inland floods due to intense rainfall A flash flood describes sudden flooding with short duration. In sloped terrain the water flows rapidly with a high destruction potential. In flat terrain the rainwater cannot infiltrate into the ground or run off (due to small slope) as quickly as it falls. Flash floods typically are associated with thunderstorms." (29)

Flash floods usually occur within 6 hours of heavy rainfall or other causes and because they occur so quickly as the name suggests, people in the affected areas are often caught off guard and the rapidly escalating situation quickly becomes dangerous, especially if fast-moving and high levels of water are encountered. Flash floods can occur virtually anywhere, from streets and underpasses in urban areas to creeks and even in small neighbourhoods.(36)

Historical Events

2011 Thailand floods: Total deaths 813, total affected 9,500,000, total estimated damages 40 billion USD.(20) 66 provinces were affected by record-high flooding in May and by November more than 5.5% of the total landmass in the country had been inundated. The manufacturing sector bore approximately 70 percent of the total damage and losses due to the flooding of six industrial estates in Ayuthaya and Pathum Thani.(37)

1999 Vietnamese floods: Total deaths 622, total affected 3,504,412, total estimated damages 2.4 billion USD.(20) 7 central provinces were affected with rainfall ranging between 300 – 1,200 mm. In the worst affected province of Thua Thien Hue, 2,500 mm of rain fell during this period. This was more than the average annual rainfall across the whole country. Over 11,560 hectares of paddy, 500 bridges and 3,000 km of roads were damaged. Over 41,000 houses collapsed or were swept away, and 500 hospital rooms and health centres were damaged.(38)

Landslides

Southeast Asia has the third highest number of reported landslides as compared to other regions. There have been 114 recorded incidences of landslides in the 50-year period making landslides the third most common natural disaster to affect the region. The majority of these events occur in Indonesia (61) and the Philippines (30) which regularly have some of the highest number of events on record.(39)

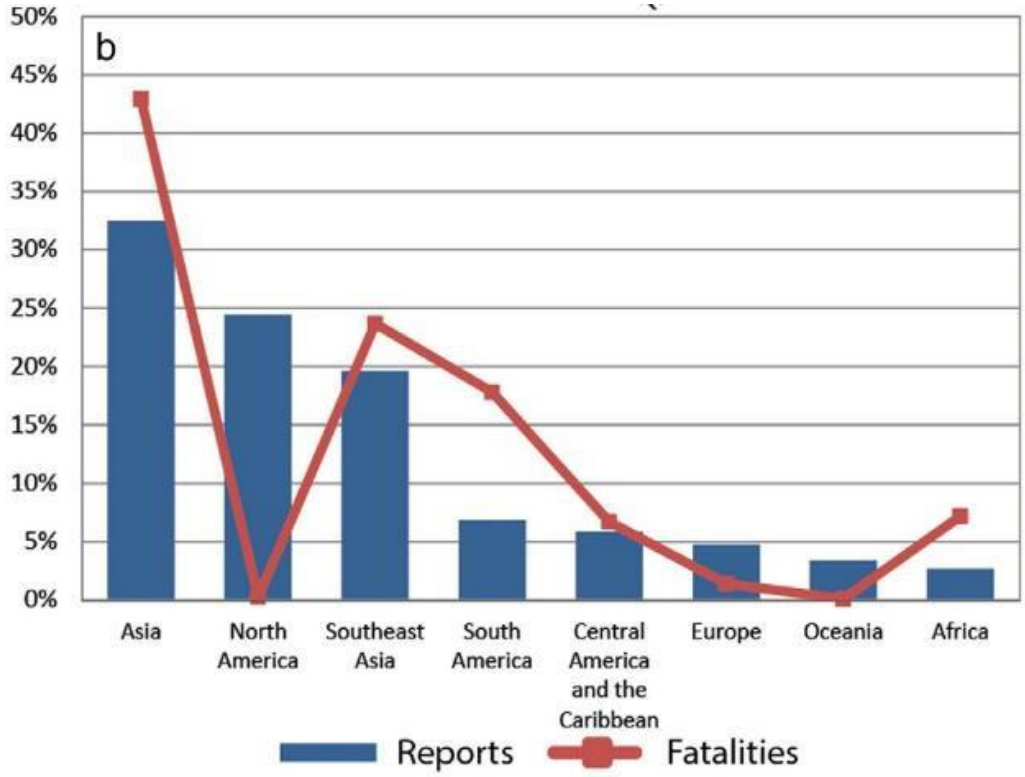


Figure 6: Landslide reports and estimated fatalities for all years in the Global Landslide Catalogue (GLC) as a function of a region.

Source: Spatial and temporal analysis of a global landslide catalogue.(39)

The total death toll caused by landslides in the SEA region is 5,572 accounting for approximately 1.3% of all deaths caused by natural disasters. The highest number of deaths were found in the Philippines (2,411) and in Indonesia (2,283). The Southeast Asian region is also ranked second highest for the number of fatalities due to landslides, only to be outranked by Asia which reported the highest number of fatalities.(39)

Historical Events

2006 Southern Leyte mudslide: On 17th February, a mudslide buried barangay (village) Guinsaugon in the Philippines, killing 1,126 people and displacing 19,000 making it known as the "deadliest single landslide disaster to occur worldwide in almost two decades". It took far longer than expected to source for suppliers.(40)

The residents of 26 villages in six municipalities of the province were evacuated and housed in temporary shelters as early as February 10 due to bad weather conditions and continuous rain that had fallen for two weeks. However, on the 16th of Feb, many residents had returned after seeing signs of better weather. The landslide buried the

whole village which had facilities such as an elementary school, barangay hall, covered auditorium, and a health centre.(41)

2000 Payatas landslide: In Metro-Manila, the capital of the Philippines, a huge municipal garbage dump located in the North-East, ironically named the "Promised Land" by locals, became a sodden, unstable mass which collapsed and burst into flames on July 10.(42) 287 people will killed and 2,838 people affected by the avalanche of mud and rubbish.(20)

Figure 7: *Collapsed slope on the day after the failure*

Source: *Image obtained from Stability problems of landfills – The Payatas landslide.*(43)

The official death toll remains uncertain as officials are not sure of the exact number of people living alongside the rubbish dump. The fire was caused by overturned stoves from the shanties and fallen power cables. (42)

Geophysical

Across the globe, between 1994 and 2013, nearly 750,000 lives were lost due to earthquakes and tsunamis. Tsunamis are the deadliest sub-type of earthquake, almost 20 times more deadly than ground movements with an average of 79 deaths for every 1,000 people affected as compared to only four (4) deaths per 1,000 for ground movements.(26)

Earthquakes

For the purposes of this profile, earthquakes will be used to describe ground movement. Tsunamis will be discussed separately in the subsequent section.

There are many factors that contribute towards making earthquakes one of the deadliest natural hazards. One important factor that plays a major role is that earthquakes strike without warning. In addition to this, many high-density population zones are also located within these earthquake zones and the consequences of a major earthquake occurring near such areas would be catastrophic with major loss of human life and a sizeable economic cost.(44) A large portion of the population of Malaysia, Myanmar and Thailand live on or near to active fault systems.(45)

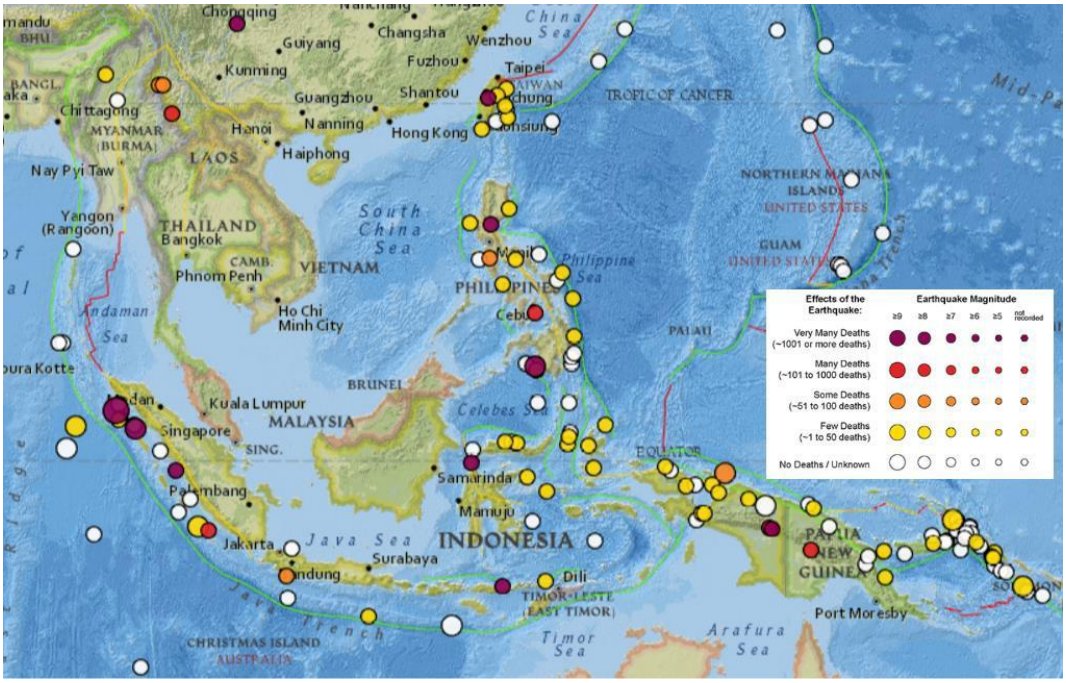


Figure 8: *Distribution of earthquakes of ≥ Moment magnitude (Mw) 7 with their associated casualties (1971-2020).*

Source: *Figure prepared from data obtained on 8th of June 2021 from the Natural Hazards Viewer of NOAA.*(46)

In the SEA region, over the 50-year period between 1971 to 2020, there were 143 events of ground movements recorded in the EM-DAT database. A total of 16,116,244 people were affected with a death toll of 23,702. Total economic damages amounted to nearly 9 billion USD from across the region.(20)

Historical Events

1976 Moro Gulf Earthquake and Tsunami (Mw 8): Historically one of the world's deadliest earthquakes. It occurred just a few minutes past midnight on the 17th of Aug near the West Coast of Mindanao, approximately 950 kilometers South of Manila. is estimated that the earthquake and tsunami caused over 6000 deaths, affected 181,348 people and caused massive destruction of properties.(20) The main shock was followed by a major aftershock 12 hours later which caused additional damage.(47)

2006 Yogyakarta earthquake (Mw 6.3): Destroyed more than 60,000 houses in the city, killed an estimated 6,234 people and caused 3.1 billion USD in damages on the 27th of May. This earthquake was unusual as it was centred about only 10 kilometres under the Earth's surface. Most earthquakes in Indonesia usually occur deep under the Earth's surface where the slab of the Earth's crust that carries the Australia Plate descends beneath the Sunda Plate.(48)

2009 Sumatra earthquakes: On the 30th of September a powerful earthquake struck off the western Sumatra coast in Indonesia, measuring 7.6 degrees on the Richter Scale. It was followed by a second quake 22 minutes later measuring 6.2 and a third measuring 6.8 which occurred inland, 225 km to the southeast of Padang the next morning. Total damages was estimated at 2.2 billion USD with 121,679 homes severely damaged, 52,206 moderately damaged, and another 57,510 lightly damaged. Over 250,000 families were rendered homeless, 3,108 classrooms and 118 health facilities were damaged with 50% of them extensively damaged.(49)

Tsunamis

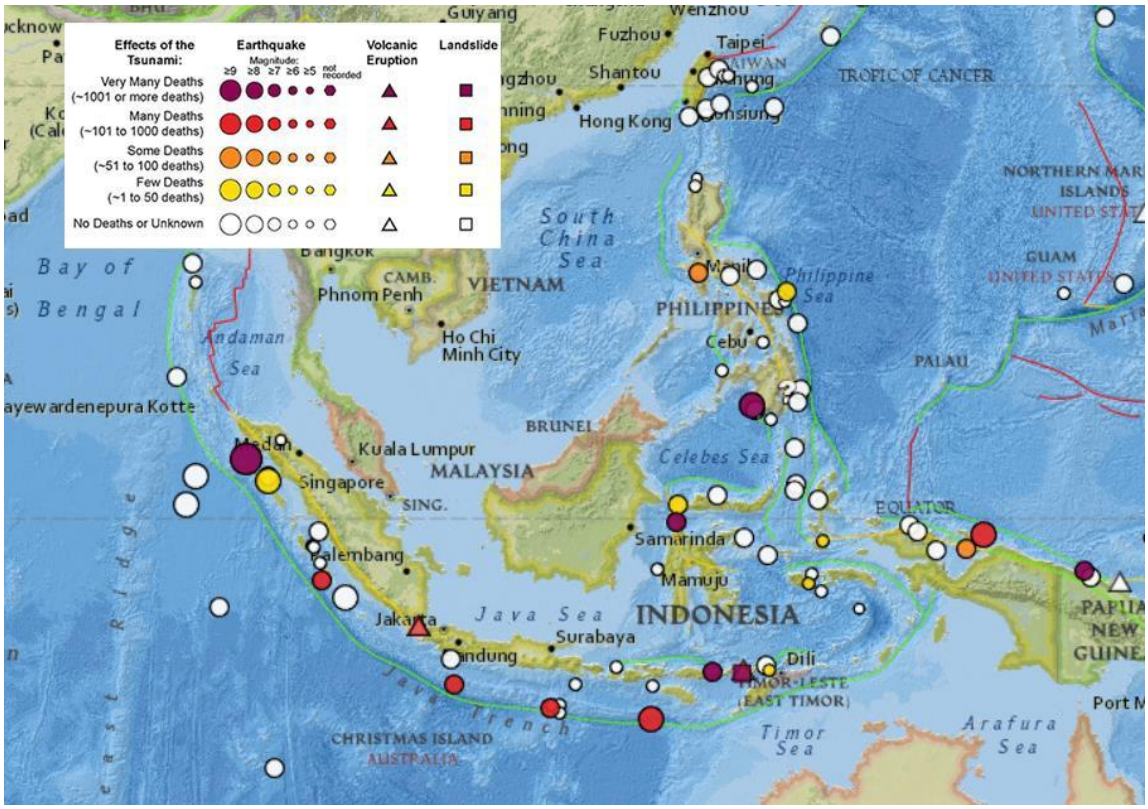


Figure 9: *Distribution of tsunamis with their associated casualties (1971-2020).*

Source: *Figure prepared from data obtained on 11th of June 2021 from the Natural Hazards Viewer of NOAA.*(46)

Most tsunamis occur in Indonesia and although there have only been 8 tsunamis recorded to have affected the region over the 50-year period from 1971-2020, the economic impact of these events are extremely high and have affected Malaysia, Myanmar and Thailand as well. Cumulatively these events have caused an estimated 8 billion USD in damages and resulted in a death toll of 180,427 whilst affecting 887,502 people across the region. This is a staggering average of 22,553 fatalities in the ASEAN region per event.

These seismic sea waves are in essence an enormous ocean wave caused by underwater disturbances such as earthquakes, landslides or volcanic eruptions. Tsunamis carry extremely strong currents and can persist for many hours due to the complex relationship and interactions with the seabed as well as the coast.

Tsunamis also tend to overwhelm coastal areas and cause extensive erosion sediment transport and deposition within minutes. Damage to agricultural land and property as week as loss of life are aggravated by flooding that is caused by waters that are pushed inland. Currently two tsunami warning systems cover the ASEAN region: the

Indian-Ocean Tsunami Warning System (IOTWS) and Pacific Tsunami Warning System (PTWS).(22)

Historical Events

2004 Indian Ocean earthquake and tsunami: The deadliest tsunami in recorded history was the 2004 Sumatra–Andaman earthquake which claimed the lives of 225,000 people across a dozen countries and 165,708 people in Indonesia alone. It caused a total estimated damages of 6.45 billion USD.(20)

The first wave hit Sumatra 25 minutes after the start of the quake on the 26th of December and was reported to be in excess of 100 feet in height.(50) In the days to follow, the list of casualties was further aggravated due to a lack of food, clean water, and medical treatment. It was also an enormous task for relief workers to ensure that supplies could reach remote areas where roads had been completely destroyed.(51)

2018 Sulawesi earthquake and tsunami: On 28th of September, a series of strong earthquakes struck Central Sulawesi in Indonesia. A tsunami was triggered by a 7.4 magnitude earthquake whose epicentre was located close to the provincial capital, Palu. The combination of the tsunami, earthquake, liquefaction and landslides caused significant damages and loss of life. Estimates showed that over 1,500 schools were impacted and at least 35,000 households were in need of immediate emergency shelter and basic household assistance.(52) 4,340 people lost their lives in this event and over 200,000 people were affected.(20)

2006 Pangandaran earthquake and tsunami: On 17th July, a 7.7 magnitude undersea earthquake with an epicentre about 180 km off the coast of Pangandaran triggered a tsunami that travelled as far as 400 meters inland according to reports from the UN Office for the Coordination of Humanitarian Affairs (OCHA).(53) 35,543 people were affected and 802 deaths were recorded in the EM-DAT database.

Biological

Epidemics

The recent global COVID-19 pandemic placed immense pressure on healthcare systems across the Southeast Asian bloc. In addition to COVID-19 related deaths and the increased demand for intensive care, the pandemic has highlighted the major repercussions on health outcomes of other diseases at a time when resources and personnel have to be diverted towards fighting the pandemic, especially the challenges faced by low and middle income countries.(54)

'Southeast Asia is a hotspot for emerging infectious diseases, including those with pandemic potential'.(55) Over the last 50 years between 1971-2020 there have been a total number of 111 epidemics recorded in the EMDAT database: 64 incidences of viral, 30 incidences of bacterial diseases and 6 incidences of parasitic epidemics in the

Southeast Asian bloc amounting to a total death toll of 9,688 and affecting over 1,284,780 people.

Of the 64 incidences of viral epidemics across the region, dengue and dengue haemorrhagic fever accounted for 34 of these events. There were also 6 events related to acute respiratory syndrome (SARS), 7 events related to the H5N1 avian influenza virus and 3 outbreaks of measles.

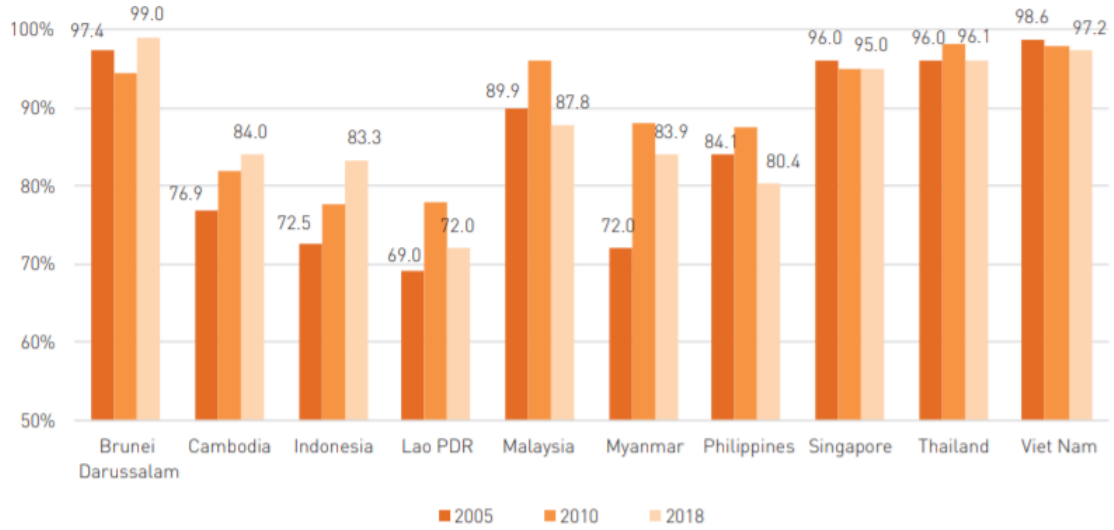


Figure 10: *Coverage of immunization against Measles among one-year old children (%) by ASEAN Member States, 2005-2018*

Source: *Figure obtained from ASEAN Key Figures 2020.*(11)

Immunization is amongst the most cost-effective public health interventions to reduce child mortality and morbidity associated with infectious diseases. Measles immunization has consistently covered over 90% of total children aged one year in Brunei, Singapore, Thailand and Vietnam. Significant progress was also recorded in other ASEAN member states such as Cambodia (76.9% in 2005 to 84.0 in 2018), in Indonesia (72.5% to 83.3%) and in Myanmar (72.0% to 83.9%). Similar trends were observed for DPT immunization.(11)

Historical Events

Dengue: There are approximately 100 million dengue cases that occur each year. The highest burden of disease occurs in Southeast Asia followed by Latin America.(56) During the 1998 dengue pandemic, more than 1.2 million cases of dengue fever and dengue haemorrhagic fever (DHF) were reported to The WHO from over 56 countries. Indonesia reported an annual outbreak of 72,133 cases and 1400 14 deaths with an overall case fatality rate (CFR) of 2.0%. In 2004 a dengue outbreak of similar magnitude was reported from Indonesia with a total of 58,301 cases causing 658 deaths with a lower case fatality ratio of 1.1%.(57)

Measles: In 2019, a measles outbreak in the Philippines caused 477 deaths amongst 34,950 cases with a case fatality rate of 1.37%. These cases were reported between the 1st of January and the 11th of May. This CFR was considered high when compared to a CFR of 0.87% from the same period in 2018. UNICEF facilitated the procurement of an additional 6 million doses of measles and polio vaccines and by the 8th of May 2019, over 5 million individuals had been vaccinated against measles and rubella. (58)

SARS: In 2002, Severe Acute Respiratory Syndrome (SARS) spread from southern China to Southeast Asia. Singapore and Vietnam stood out as 2 of the most severely threatened states. Other regional states such as Malaysia, the Philippines and Thailand were also affected but to a much lesser extent. Vietnam became the first Southeast Asian country to deal with the SARS epidemic as well as the first country in the world to contain this highly contagious disease. This was due to the rapid action of the Vietnamese Ministry of Health (MoH) in implementing strict quarantine measures and the establishment of a cross ministerial committee to monitor and respond to developments. It was this rapid response that limited the spread of the virus in Vietnam as well as internationally. By the time the outbreak was contained, Vietnam had registered 63 cases including 5 fatalities. (59)

HAZARDS, EXPOSURE & VULNERABILITIES

According to EM-DAT, a hazard is defined as a "Threatening event, or probability of occurrence of a potentially damaging phenomenon within a given time period and area". Natural hazards do not cause disasters by themselves but when combined with a vulnerable, exposed or ill-prepared community, a hazard may result in a disaster.(60)

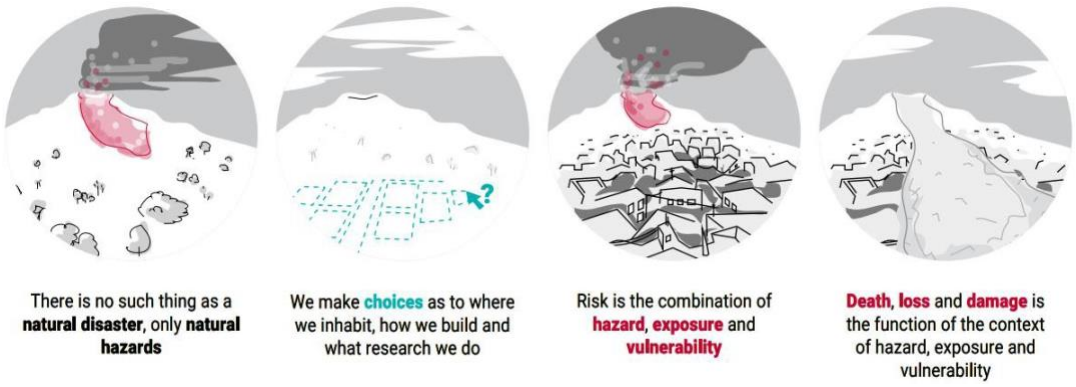


Figure 11: *Risk and the context of hazard, exposure and vulnerability.*

Source: *Figure obtained from UNDRR 2019.*(25)

An exposure on the other hand is defined as "the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected."(61)

Vulnerability refers to "the propensity or predisposition to be adversely affected". This includes a variety of elements and concepts that includes the susceptibility to harm and the lack of capacity to cope and adapt.(61) A small population size increases these vulnerabilities because if a high percentage of a population is killed or affected in a natural disaster, the overall economic activity and development of the country will suffer from devastating long-term impacts.(26)

In 2012, the Index for Risk Management (INFORM) began from a convergence of interest of UN agencies, NGOs, donors and research institutions. The aim was to establish a common base of evidence for global humanitarian risk analysis. The index supports a proactive crisis and disaster management framework and is a composite indicator that identifies countries at risk of humanitarian crisis and disasters that could overwhelm the national response capacity. INFORM is a joint initiative between the European Commission and the Inter-Agency Standing Committee Task Team (IASC) for preparedness and resilience in partnership with UN agencies, NGOs, donors and Member States.(62)

In April 2018, the Pacific Disaster Center (PDC) completed the development of the ASEAN Regional Risk and Vulnerability Assessment (RVA). Multiple drivers of risk were measured utilizing a composite risk approach which conceptualized the RVA as a function of multi-hazard exposure, coping capacity and vulnerability.

The methodology used in both indexes described above are similar. The main difference is that INFORM's scores are evaluated on an annual basis whilst RVA considers data from a 20-year period. In addition to this, RVA only calculates risk based on natural hazard exposure vulnerability and coping capacity to natural disasters and does not include conflict risk, vulnerability and coping capacity. INFORM's ranking scores between 1 to 10 while RVA ranges from 0 to 1.(22)

***Figure 12**: Risk score of ASEAN countries.*

***Source:** ASEAN Risk Monitor and Disaster Management Review (ARMOR) 2019.*(22)

The risk score above ranks the Philippines, Myanmar and Indonesia as the top 3 ASEAN states most at-risk to natural multi-hazards. Myanmar scored the top spot on the INFORM index and Philippines on the RVA index. This result indicates that the Philippines has the higher risk from a long-term perspective whilst on the other hand, the ongoing conflict in Myanmar ranks it as high risk on a yearly basis. Myanmar has also experienced numerous hazards including cyclones, floods, earthquakes, landslides, droughts and tsunamis. This risk score combines the multi hazard exposure, vulnerability and coping capacity. It also ranks the likelihood of disruption due to factors associated with the individual Member State's hazard exposure and ability to prepare, respond and recover from impact.(22)

In terms of vulnerability, both Cambodia and the Philippines have the highest vulnerability levels due to common challenges such as the impact of recent disasters, access to information, economic constraints, population pressures and access to clean and safe water.(22)

Vulnerability in the Philippines is driven primarily by disaster impacts, whilst in Cambodia, it is driven by challenges in access to information. Cambodia has the lowest adult literacy rate (82.5%) and second lowest net enrolment rate in secondary education (37.1%) of all the ASEAN nations and therefore, education remains a high priority for the country.(11)

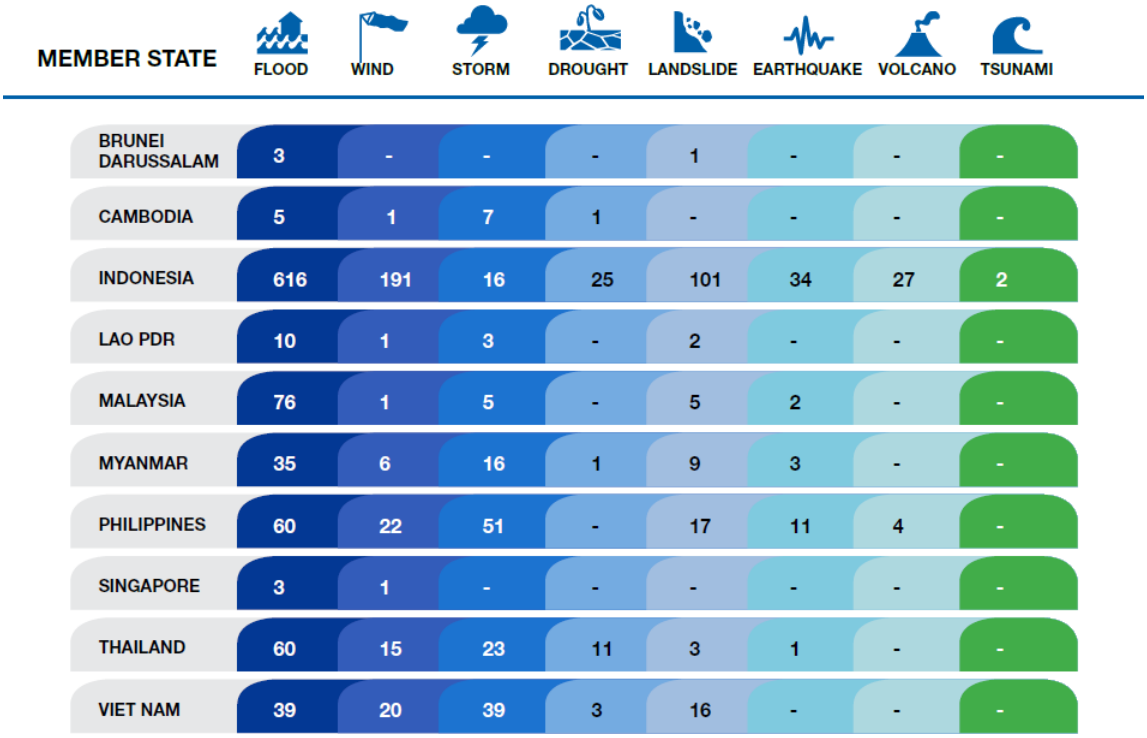
Natural Hazards

Natural hazards are defined as naturally occurring, physical phenomena, caused either by rapid or slow onset events which are broadly classified into geophysical, hydrological, climatological, metrological and biological hazards. Aggravating factors such as climate change, unplanned urbanization, poverty, underdevelopment and the threat of pandemics increases complexity, frequency and the severity of disasters.(63)

Heat waves arise when stationary regions of high pressure remain aloft in the atmosphere for up to several weeks, trapping heat instead of allowing it to lift. Cold waves on the other hand occur when cold and dense air from the high altitudes moves into the middle and lower altitudes.(26) An increase in the incidence of heat wave events will see an increase in the number of deaths of people at the extremities of age, the elderly and the very young. People who are chronically ill and those that are socially isolated are also especially vulnerable.(60)

Droughts are one of the most complex phenomenon of natural hazard events. A drought is an extended period characterized by deficiency in the region's water supply that results in a wide range of damage to local areas that range from land degradation and famines to agricultural losses, death of livestock, disruption of inland transportation and even impact to hydropower plants. Droughts are the result of not only atmospheric factors such as precipitation but also long-term geological conditions such as soil characteristics or water volume. Droughts also increase the risk of wildfires.(22)

A study conducted by the Asian Development Bank in 2016 projects that droughts and floods are likely to increase in Southeast Asia and could potentially affect water security. There is also a likelihood of underreporting of drought information due to the challenges faced in the acquisition of information and data from the current ground up model.(22)



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	-	-	-

Figure 13: *Distribution of disasters in ASEAN by country and hazards.*

Source: *ASEAN Risk Monitor and Disaster Management Review (ARMOR) 2019.*(22)

Data obtained from The ASEAN Disaster Information Network (ADINet) shows that of all the countries in the ASEAN region, Indonesia remains at highest risk to all types of hazards except for storms. The Philippines is at risk to storms of which, tropical cyclones are a major part of. Both floods and tropical cyclones have been identified as the 2 major hazards that plague a number of the member states.

Floods

When precipitation upstream is too high, it leads to flooding and when it is too low, it causes a drought.(26) The frequency and intensity of floods and extreme precipitation are increasing. Floods contaminate freshwater supplies, increase the risk of waterborne diseases and create breeding grounds for disease carrying insects such as mosquitoes. The direct impact of floods include drownings, physical injuries and damage to homes. Floods also severely disrupt the supply of medical and health services.(28)

It is estimated that 11% (69 million) of the total ASEAN population are exposed to floods and an estimated 897 billion USD worth of capital stock is vulnerable to damage by floods.(64) Most floods are caused by increasing rainfall during monsoons as well as cyclonic events. There are also increasing numbers of reported flash floods caused by erratic weather patterns. The production of staple foods in many of the

poorest regions are also likely to decrease due to rising temperatures and variable precipitation. This will likely increase the prevalence of malnutrition and undernutrition, which are currently responsible for 3.1 million deaths every year.(28)

Cyclones

Differential heating between the equator and the poles coupled with the Coriolis force leads to wind systems that in turn give rise to different forms of cyclones.(26)

The weather in the Philippines is largely influenced by the southwest and northeast monsoon events which give rise to the formation of tropical cyclones that originate from the Pacific Ocean which eventually result in heavy rain and destruction as cyclones make landfall.(22)

Based on records and reports available on tropical cyclones across the region including the ASEAN Risk and Vulnerability Assessment (RVA) conducted by the Pacific Disaster Center in 2018, populations residing in the northern regions of ASEAN are particularly exposed to tropical cyclones. It is estimated that 59% (379 million) of the total ASEAN population are exposed to a category 1 or greater tropical cyclone and that an estimated 3 trillion USD worth of capital stock is vulnerable to damaging wind occurrences. Should a catastrophic event occur, there is a high potential that the resiliency of these countries would be heavily tested.

Increases in the number and intensity of very strong cyclones (typhoons and hurricanes) will affect coastal regions, with the potential of large loss of lives, assets and disruption of services. Low-lying settlements may become unviable, which may result in increased potential for movement of population and loss of infrastructure. (60)

Landslides

A landslide is the movement of soil or rock that is controlled by gravity. They include any kind of moderate or rapid soil movement including lahars, mudslides and debris flow. Landslides can be superficial or deep, depending on the conditions however, the materials need to make up a mass that constitutes a portion of the slope or the entire slope itself. This movement has to be directed downward and outward and must have a free face.(29) Excessive snowfall can trigger avalanches and rainfall can trigger landslides and debris flows.(26)

landslides are caused by both internal factors such as the topography of the soil as well as external factors like extreme rainfall, earthquakes and soil erosion. Other external and artificial factors such as deforestation, the cutting of hills and complex

constructions further aggravate this risk. Steep slopes are the most important factor that makes a landscape susceptible to landslides.(65)

Across the globe, landslides that are triggered by heavy rains kill about 4,600 people each year.(66) Indonesia records the highest number of landslide events and has the highest percentage of population that is at landslide risk followed by the Philippines and Vietnam.(22)

The increasing intensity of monsoon rainfalls also contribute to the triggering of major landslide events. Although landslides only contributed to 9.6% of recorded disasters between 2012 and 2019, these incidents greatly affect humanitarian responses and emergency operations to affected communities and villages because of disruptions to road and transport services. It is estimated that about 3% of the ASEAN community is exposed to landslides and that communities living in remote and mountainous areas are particularly vulnerable.

Earthquakes

Earthquakes are defined as 'Sudden movement of a block of the Earth's crust along a geological fault and associated ground shaking.'(29)

Mainland Southeast Asia (MLSEA) has been recognized as one of the most seismically active regions in the world due to its location being close to the active tectonic plate boundary.(67) between 1962 and 2013 more than 45 major earthquakes have been reported within MLSEA.(68)

During a quake, the sudden release of energy results in waves that radiate outwards from the source through the earth's crust. The true point where the earthquake originates is known as the focus or hypocentre and this point may be located many kilometres deep within the ground. The surface point located directly above this hypocentre is termed as the earthquake epicentre. When these stresses exceed the strength of the rock in the earth's crust, it causes a break along a weakness line that is either new or a pre-existing fault plane.(69)

The ASEAN region sits between and along several tectonic plates, namely the Indian, Australian, Eurasian, Philippine and the Caroline Plate which form a part of the ring of fire within which there are numerous occurrences of earthquake activity as well as tsunamis that are induced by geophysical factors. Although volcanic eruptions and earthquakes only account for 5.1% of total recorded disasters over the 7-year period between 2013-2019, the risk associated with these hazards are much higher as compared to floods. Overall estimates show that 30% of the ASEAN population are exposed to earthquakes of intensity 7 and above with an estimated 35% of the full Asian population exposed to volcanic activity.(69)

Over recent years, urbanization within these highly seismic zones has increased significantly. This exacerbates the deadliness of such events. Slums and squatter dwellings frequently expand on areas that are of the highest risk, such as slopes and embankments. As a result of this, even small ground movements and landslides have the potential to dislodge friable land and can cause severe casualties.(26)

Climate Change

Climate change refers to both global warming and the resulting large-scale changes or shifts in weather patterns. The largest cause of global warming is through the natural greenhouse effect, where radiation from the earth's atmosphere further warms the surface of the earth by preventing heat from escaping into space. Greenhouse gases include carbon dioxide, methane, nitrous oxide, ozone, water vapor and some artificial chemicals such as chlorofluorocarbons.(70)

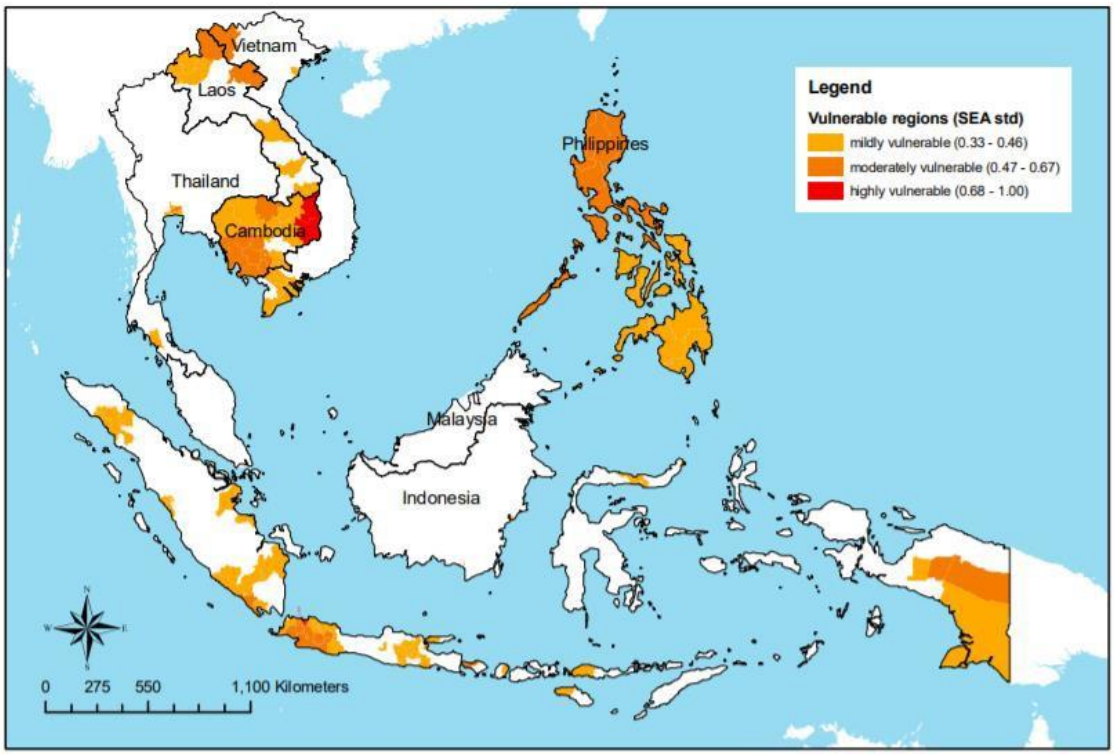


Figure 14: *Climate change vulnerability: Most vulnerable areas in Southeast Asia.*

Source: *Climate Change Vulnerability Mapping for Southeast Asia.(71)*

The most vulnerable regions in Southeast Asia to climate change include almost all regions of the Philippines and Cambodia, the northern and eastern regions of Laos as well as the Mekong river delta region in Vietnam, the Bangkok region in Thailand, the west and south regions of Sumatra and the western and eastern regions of Java in Indonesia.(71)

Over the last 130 years, the earth has warmed by approximately 0.85°C and each of the last 3 decades has been successively warmer than any preceding decade since 1850.(72) By 2100, the Intergovernmental Panel on Climate Change (IPCC) estimates that global sea levels will rise between 18 and 59 cm and that the oceans will become more acidic. In addition to this, heat waves and heavy precipitation will continue to increase in frequency and tropical cyclones will continue to increase in intensity.(60)

More than half of the world's population lives within 60 km of the sea. The rising ocean levels coupled with increasingly severe weather events will destroy homes, medical facilities and disrupt other essential services. People will be forced to migrate, further heightening the health impact, especially in terms of communicable diseases and mental health.(28)

Global warming is likely to rise to 1.5°C between 2030 and 2052 if it continues to increase at its current rate as indicated by the Special Report on Global Warming of 1.5°C (SR15). Climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and increase even further with 2°C.(73)

Vector borne diseases such as malaria and dengue fever will be impacted by warming from 1.5°C to 2°C. It is projected that incidences of such diseases will increase, and its patterns will shift in terms of geographical range.(73) Risk from food, energy and water sectors could also overlap spatially and temporarily, leading to exacerbation and even new hazards, exposures and vulnerabilities that work continued to affect increasing number of peoples and regions across the globe. Malnutrition and undernutrition currently cause 3.1 million deaths every year. This prevalence is expected to rise.(28)

Disasters, many of which are exacerbated by climate change and which are increasing in frequency and intensity, significantly impede progress towards sustainable development.(74) The impact of climate change and the responses to it are closely linked to sustainable development which balances economic prosperity with social wellbeing and environmental protection. The SDGs provide a framework for the assessment of the links between global warming of 1.5°C or 2°C and the development goals that include poverty eradication in reducing inequalities and climate action.(73)

Social and environmental determinants of health such as secure shelter, food, clean air and safe drinking water are affected by climate change. It is expected that 250,000 additional deaths caused by heat stress, malnutrition, malaria and diarrhoea will result from the effects of climate change between 2030 and 2050. It is also estimated that the direct damage costs to health will be between 2-4 billion USD per year by 2030.(28)

Pacific Ring of Fire

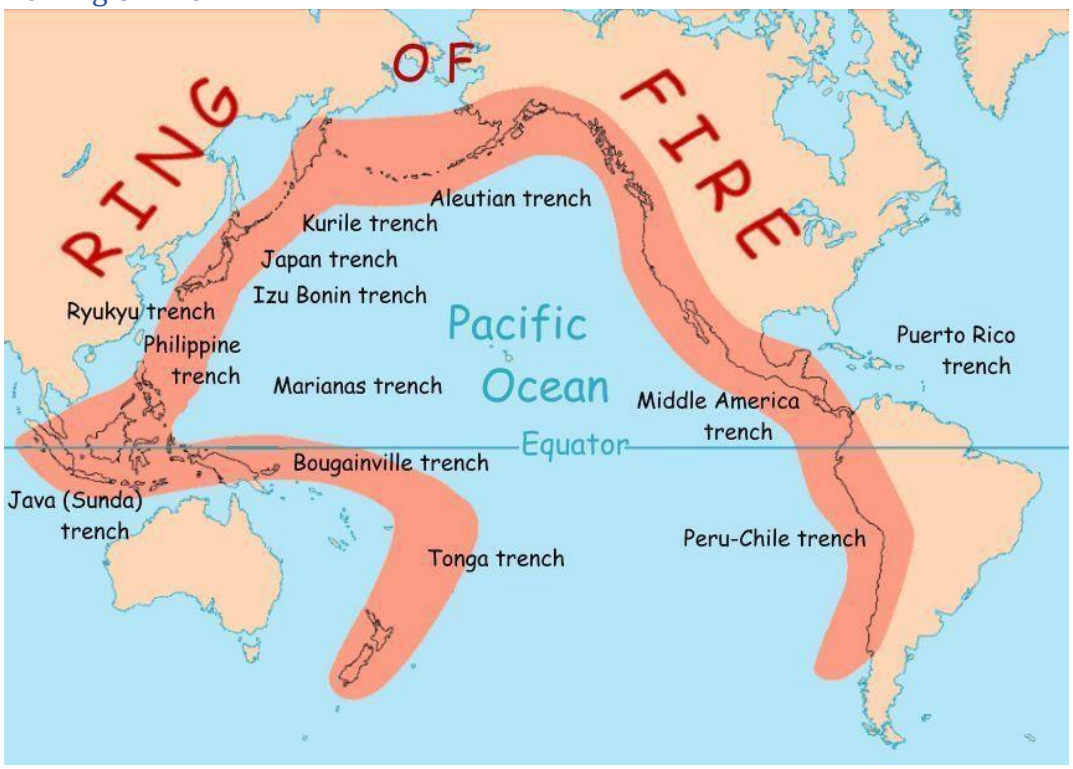


Figure 15: *Pacific Ring of Fire.*

Source: *National Geographic.*(75)

The Ring of Fire stretches for nearly 40,000 kilometres and is made up of more than 450 volcanoes. The majority of active volcanoes on earth are located underwater aptly called the Ring of Fire located in the Pacific Ocean. This Ring of Fire extends in a horseshoe shape from the southern tip of South America along the West Coast of North America down to Japan and through New Zealand. It is the result of plate tectonics and much of volcanic activity occurs along convergent plate boundaries, where the two tectonic plates meet. The heavier plate is subducted under the other plate and when this happens, the melting of these plates produces magma that rises up through the overlying plate, erupting to the surface as a volcano. The subduction zones are also where the deepest parts of the earth's oceans can be found and earthquakes can occur when two plates scrape against each other and as the subducting plate bends.(76)

Along the islands of Indonesia, the Australian plate is subducting the Eurasian plate and this resulted subduction zone west of the Indonesian island of Sumatra is an area of high seismic activity. It was in this zone that the 2004 earthquake and tsunami resulted from a massive undersea earthquake that was so powerful it even affected the rotation of the earth.(77)

Preparation, Prevention and Mitigation Strategies

In view of the disproportionate burden of natural hazards in lower-income countries, including the huge disparity in death rates between richer and poorer countries, mitigation measures in less developed countries require significant improvement.(26)

Poor communities that are at high risk of recurrent flooding require better flood control as an important step in the right direction. Building embankments, zoning of floodplains, afforestation, better warning systems and the restoration of wetlands are some examples of effective and low-cost solutions. Such prevention strategies carry development benefits as floods are one of the major causes of damages to schools, hospitals and clinics within lower income countries as recorded in EM-DAT.

It is also important that we conduct better research to understand how and why households and communities across the ASEAN region are affected by disasters so that our responses are based on evidence rather than assumptions. Without this micro level of research, future Disaster Risk Reduction (DRR) and Disaster Prevention Programs (DPP) will not be effective.

Considering predictions that suggest that climate change will increase the frequency of storms and other extreme weather events, it is imperative that better management, mitigation and deployment of storm warnings be utilized to save more lives in future events. Reducing the size of drought-vulnerable populations is also a global priority over the next decade.

Following the 2004 Indian Ocean tsunami one major advancement for the region was the establishment of the IOTWS which now provides tsunami alerts through three regional watch centres in India, Indonesia and Australia and 26 national tsunami information centres. It's efficiency was proven during the Banda Aceh earthquake in 2012 where early warnings were disseminated within 8 minutes of detection.(26)

In parallel to this, UNISDR is actively campaigning for safe schools and hospitals in earthquake and flood zones in order to reduce injuries, fatalities as well as physical damage. An example of this implementation can be seen in Turkey which committed to making all schools and hospitals earthquake proof by 2018.(78)

Weather forecasting has made extraordinary progress in recent years, with predictions now highly reliable within a 48-hour period. Better forecasting may be one reason behind the global decrease in deaths from storms identified by EM-DAT over the past 20 years. However, given that EM-DAT data also shows a rising number of people affected by storms and an increasing death toll in Asia coupled with huge financial losses, storm preparedness in the region needs strengthening.(26)

Community Resilience

Communities hold the key to early recovery, and it is vital that the potential to adapt and recover in the aftermath of disasters be facilitated through programs targeted at the grassroot level. The first responders who have immediate access to affected areas are often local civil society groups and organizations that are both formal and informal. the strength of local resources and talents should be acknowledged and empowered to respond in such times of emergencies.(79)

Community resilience is the process that links the network of adaptive capacities such as resources with dynamic attributes to the adaptation after a disturbance or adversity. This community adaptation manifests itself in population wellness which is characterized by high and non-disparate levels of mental and behavioural health, the ability to function and quality of life. This resilience arises from four sets of primary adaptive capacities: Economic Development, Social Capital, Information and Communication, and Community Competence which together provide a strategy for disaster readiness. The reduction of risk and resource inequalities, the engagement of local populations in mitigation and the linkage of organizations helps to build community resilience and boost social supports. Planning requires flexibility, trusted sources of information and skills for decision-making during times of uncertainty.(80)

DISASTER RISK REDUCTION

The Sendai Framework (2015-2030), adopted at the Third United Nations World Conference on Disaster Risk Reduction in in Sendai, Miyagi, Japan which was held from 14 to 18 March 2015 is the successor instrument to the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters.(74)

At the world conference, States reiterated their commitment, with a renewed sense of urgency, the importance of addressing disaster risk reduction and the building of resilience to disasters in the context of sustainable development and the eradication of poverty. The importance of the integration of both disaster risk reduction and the building of resilience into plans, policies, programmes and budgets at all levels is essential in this framework.(74)

The Sendai Framework articulated the need for countries to improve in understanding disaster risks from all dimensions of exposure, vulnerability and hazard characteristics. It also highlights the importance of strengthening disaster risk governance at the national level and the importance of accountability in disaster risk management.

In addition to the above mentioned, the Sendai Framework also focuses on preparedness to “Build Back Better”, the importance of health infrastructure

resilience and the mobilization of risk-sensitive investments to prevent the creation of new risks.

International cooperation and global partnerships including risk-informed donor policies and programs, financial support and loans from international financial institutions as well as a clear recognition of coherent agendas through the Global Platform for Disaster Risk Reduction and regional platforms are also outlined in this blueprint.

Disaster Risk Reduction is ultimately a cost-effective investment for resilience that prevents future losses. Effective disaster risk management plays a major role in sustainable development, and it is urgent as well as critical that countries work towards anticipating and planning towards reducing disaster risk in order to prevent loss of life, to protect communities and their ecosystems including livelihoods, cultural heritage and socioeconomic assets.

Seven different types of disasters have been prioritized for action by the ASEAN region: (i) drought, (ii) earthquakes, (iii) floods, (iv) landslides, (v) typhoons, (vi) volcanos and (vii) tsunamis.

Barely ten years after the adoption of the Hyogo Framework for Action, disasters continued to undermine efforts made towards achieving sustainable development. To support the assessment of global progress in achieving the outcomes and goals of the present Framework, seven global targets have been agreed upon. These targets, to be measured at the global level, will be complemented by work to develop appropriate indicators.

The seven global targets are: (a) Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020–2030 compared to the period 2005– 2015; (b) Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 in the decade 2020–2030 compared to the period 2005–2015;9 (c) Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030; (d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030; (e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020; (f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the present Framework by 2030; (g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.(74)

Six months after the 2004 Indian Ocean tsunami, the 10 Asian states gathered on the 26th of July 2005 in Laos to solidify their political commitment towards DRR and

disaster management by signing the ASEAN agreement on disaster management and emergency response (AADMER). This agreement came into force in 2009 and its purpose was to strengthen cooperation on disaster management across the region through political and legal commitments between the Member States.(81)

Two years later the AHA centre was established in Jakarta after the ASEAN summit in Bali which was held in November 2011. The ASEAN states also unveiled 'vision 2025' for disaster management with the declaration of 'One ASEAN, One Response: responding to disaster as one, in the region and outside.' in 2016. It is of importance that the momentum continues towards reaching ASEAN's stated aim of becoming a global leader in disaster management by the year 2025. It is a bold, ambitious and important vision that will transform ASEAN and ensure it stays relevant not only in the region but also in the world.(82)

DISCUSSION

Over the last 50 years, natural disasters such as floods, storms, earthquakes, tsunamis and landslides have placed a burden on the region, not only in terms of economic damage but also loss of life and displacement of populations. With scientific evidence pointing to an increasing number of natural disasters to occur in the near future due to climate change and other factors, it is essential that Member States across the ASEAN region invest in Disaster Risk Reduction as well as strategies that can help to prevent and mitigate disasters.

Because of the wide profile of natural hazards that affect the region coupled with a high number of populations concentrated in regions that are vulnerable, it is essential that further research be conducted so that risk can be analysed, problems detected, and innovative solutions be developed as interventions to reduce loss of life and secure livelihoods across the bloc.

Storms and floods are predictable to some degree and sufficient preparation can prevent population displacement and the health consequences that are associated with it. Earthquakes however remain a challenge and it is difficult to prevent population displacement as earthquakes tend to strike without warning. It is therefore essential that communities living in earthquake prone zones are equipped with tools and resources that strengthen community resilience.

Importance must be placed on food security and water sustainability protecting those who are most vulnerable. From the analysis of data, it appears that floods and storms account for the highest volume of deaths in countries such as Indonesia, the Philippines, Myanmar and Vietnam. This is primarily due to the high frequency of such events occurring over time.

Systematic review of literature also shows that populations displaced from homes due to natural disasters are more at risk to mental health challenges including post-traumatic stress disorder (PTSD), depression, anxiety and distress in addition to infectious diseases. The challenge lies in addressing the issues that surround mental health as well as non-communicable diseases especially during initial response phases where there is large displacement of people.

The recent COVID-19 pandemic and the associated lockdown has highlighted an urgent need for the upskilling of health care workers to handle a new era of digital healthcare technologies and to integrate these technologies into national healthcare systems. A majority of the ASEAN countries are suffering from shortages of trained medical personnel including doctors and nurses. Studies have found that human centred design plays a vital role in enabling healthcare operators to integrate such technologies into healthcare operations and it is of importance that these technologies are reliable and user friendly.(83)

CONCLUSION

Natural disasters have impacted Southeast Asia in diverse ways. The impact is indeed becoming more severe due to various factors including climate change. More studies and research are vital in identifying vulnerable populations and to further develop community centred, sustainable solutions that can serve to protect and strengthen the capacity of countries located in this bloc. It is essential that governments across the ASEAN region work with communities at the grassroot level on disaster preparedness and invest in build capacity for community resilience.

Disaster preparedness not only saves lives but is cost effective, sustainable and ensures that when disasters strike, the recovery period is short. This allows for countries to rebuild quickly and recover from natural calamities. Disaster risk reduction requires planning, and it is critical that actions be taken to anticipate the impact of hazards on communities, countries and their livelihoods.

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ANNEX I – SEA Seismic Zones

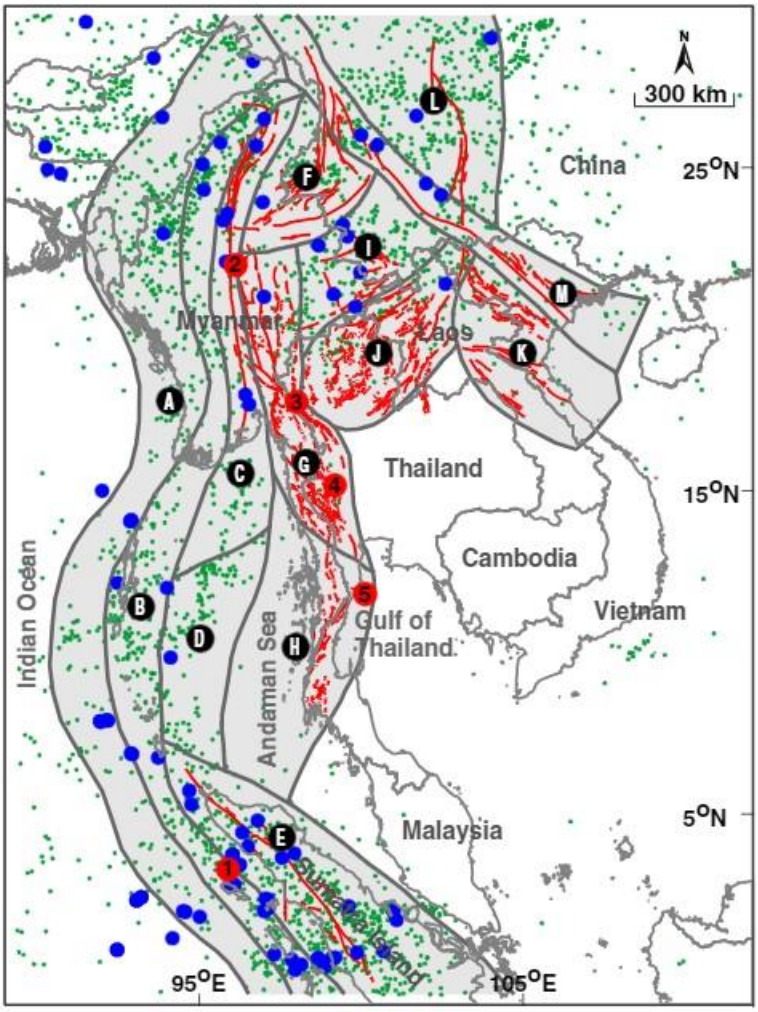
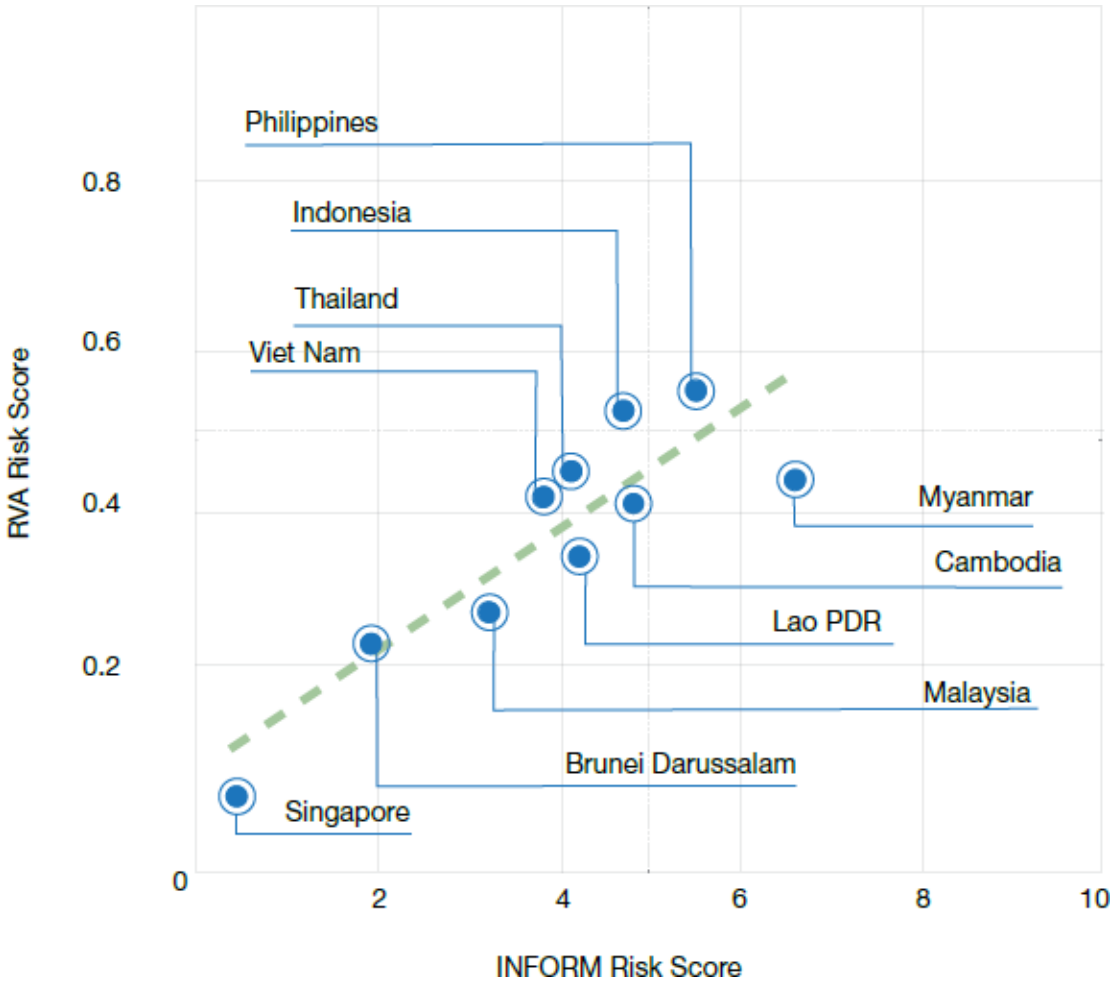


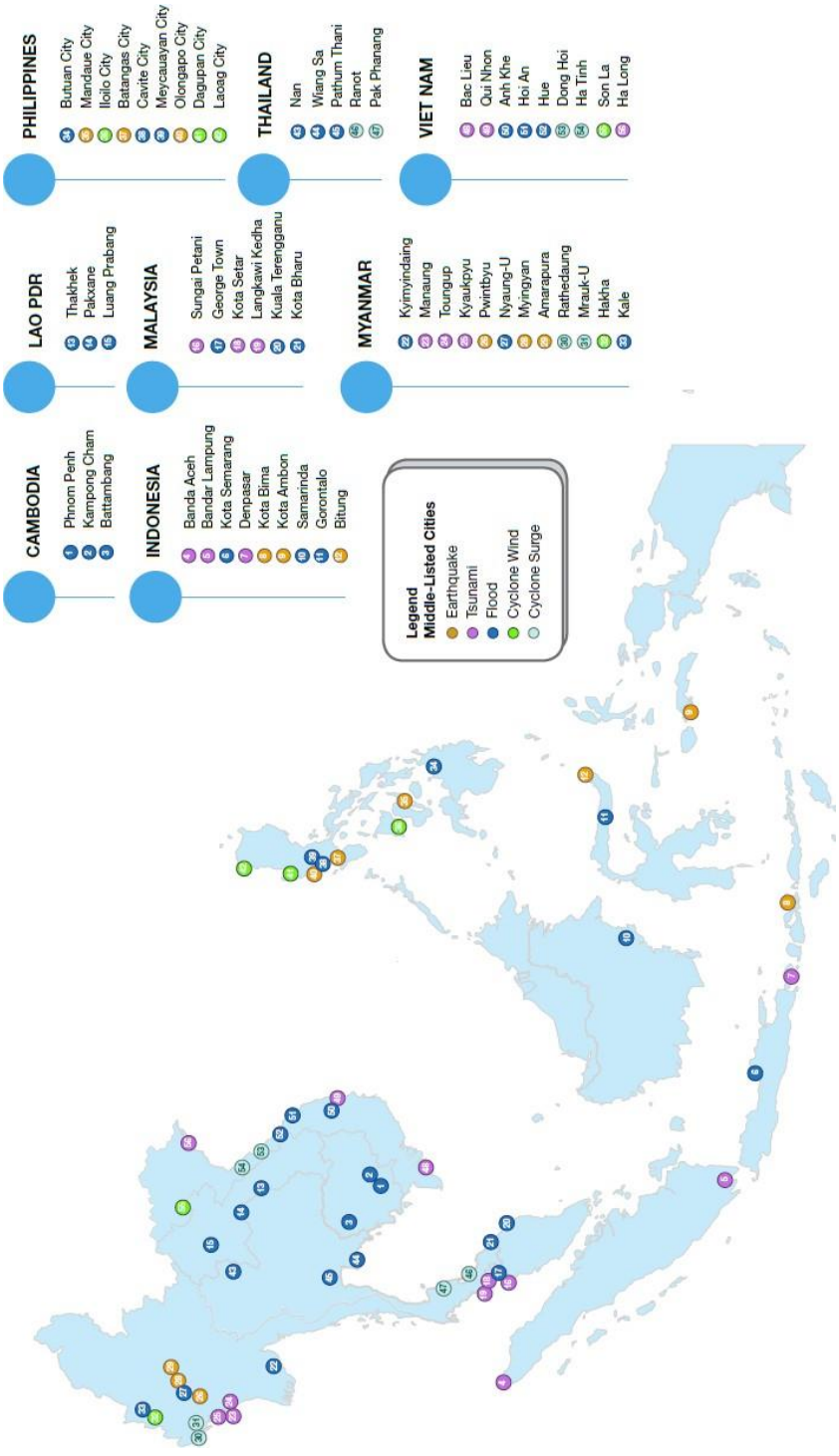
Figure 1 Map of mainland Southeast Asia (MLSEA) and the 13 designated seismic zones (A to M). The map shows epicentral distributions of completeness earthquakes with $m_b \geq 4.0$ reported during the period 1974 to 2010 (green circles), earthquakes with $m_b \geq 7.0$ (blue circles), and significant earthquakes mentioned in the text (red circles). Red lines depict the fault lines compiled by Pailoplee et al. (2009). Grey polygons indicate the geometry of the individual seismic source zones proposed by Pailoplee and Choowong (2013).

ANNEX II – INFORM vs RVA Risk Score Comparison



Source: ARMOR

ANNEX III – ASEAN's Top 56 Cities Most-at-Risk



Source: ARMOR