TARGETING TRANSFORMATIVE DISASTER RISK RESILIENCE IN SOUTH-EAST ASIA

Asia-Pacific Disaster Report 2024 for ESCAP Subregions

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Targeting Transformative Disaster Risk Resilience in South-East Asia

SUBREGIONAL REPORT

ESCAP/ 5-TR / 35

About the report

The Asia-Pacific Disaster Report 2023 demonstrates that the existing disaster risk hotspots are forecasted to face more frequent and intense disasters and new risk hotspots are expected to emerge. The full-length publication is available at https://www.unescap.org/kp/2023/seizing-moment-targeting-transformative-disaster-risk-resilience. Following the release of the APDR at the eighth session of the ESCAP inter-governmental Committee on Disaster Risk Reduction in July 2023, the report was customized for each of the five ESCAP subregions, namely East and North-East Asia, North and Central Asia, South-East Asia, South and South-West Asia and the Pacific. The current report highlights the key takeaways from South-East Asia.

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Executive Summary

Disaster and climate riskscape in South-East Asia

Climate change-induced disasters in South-East Asia pose an escalating threat, mirroring the broader trend across the Asia and the Pacific. Over the past five decades, these events have caused over 435,000 fatalities, affected over 580 million people and resulted in around $235 billion in damages.

The frequency and intensity of disasters in South-East Asia has intensified in the recent years, reflecting the impact of climate change. Droughts, floods, heatwaves, surface winds, and earthquakes have caused widespread damage, leading to loss of life, displacement of communities, and economic disruption. These events have disproportionately impacted the sub-region, exacerbating existing vulnerabilities and hindering capacity to cope.

The riskscape in South-East Asia is evolving rapidly, with emerging hotspots and intensifying hazards. The nations currently face medium-high risk levels, which increase in both frequence and intensity with global warming. At 1.5°C, the risk levels in South-East Asia such as Thailand, Viet Nam, Cambodia and Timor-Leste become more pronounced, risking to medium high to high risk level under 2°C. This region is especially vulnerable to drought, floods, heatwaves, and surface winds and areas like the Mekong River Basin consistently emerge as hotspot for intensifying multihazard across all climates scenarios. This will further strain the region's resilience and require enhanced disaster preparedness measures.

Climate change also poses a significant threat to the biodiversity in South-East Asia. The subregion's biodiversity hotspots, which play a crucial role in mitigating climate change and supporting ecosystems, are facing increasing pressure from climate-induced hazards. Species loss, habitat destruction, and ecosystem disruption are becoming more prevalent, with potential long-term consequences for both human and natural systems.

Mangroves in South-East Asia face escalating threats from multi-hazard zones, highlighting the growing vulnerability of coastal ecosystems. Over 10,741 km² of inland mangroves across South-East Asia, including Indonesia, the Philippines, and Myanmar, are exposed to tsunamis, tropical cyclones, and other cascading hazards. This widespread exposure threatens the resilience of coastal communities and ecosystems, emphasizing the critical role of mangroves in disaster mitigation and climate adaptation.

Protecting people and development gains

South-East Asia faces a pressing need to enhance its resilience against climate change. The subregion is characterized by high exposure to floods with close to 99 per cent of the population exposed to the hazard. Critical sectors, such as agriculture and energy, are also at risk from climate-related impacts.

Towards the disaster and climate related SDGs the subregion has made considerable progress on Sustainable Development Goals (SDG) , however, SDG 13 is regressing.
Addressing these challenges requires a comprehensive approach that prioritizes climate adaptation, disaster risk reduction, and sustainable development. Strengthening social protection for vulnerable groups, investing in resilient infrastructure, and promoting sustainable agriculture and energy are essential for protecting people and safeguarding development gains in South-East Asia**.**

Targeting Transformative adaptation in South-East Asia

South-East Asia faces significant climate-related hazard risks, requiring transformative adaptation strategies to enhance resilience. These strategies must integrate risk-informed investments, policies, and actions across various sectors to protect vulnerable communities and infrastructure. Under a 2°C warming scenario, Cambodia and Myanmar have the highest share of adaptation cost as a per centage of GDP , these costs remain far lower than the annual economic losses expected from climate change.

Effective adaptation in South-East Asia hinges on technology-driven innovative solutions, including science-based, data science and geospatial approaches. These technologies can facilitate fair transitions, address risks, and build resilience. Examples from Viet Nam and Thailand demonstrate the successful application of such technologies in enhancing climate adaptation and disaster risk reduction.

While the subregion has made progress in implementing adaptation measures, significant challenges remain. Addressing these challenges requires a comprehensive approach which combines financial investments, policy reforms, and technological innovation. By adopting transformative adaptation strategies, South-East Asia can build a more resilient and sustainable future.

Early Warning System: the critical component of Transformative Adaptation

Early warning systems (EWS) play a crucial role in building resilience to climate change - induced disasters in South-East Asia. By providing timely warnings, EWS can reduce disaster-related losses and protect vulnerable populations. To enhance EWS effectiveness, investments in technology, data collection, and human capacity are necessary.

Effective EWS requires a comprehensive approach encompassing four key pillars: disaster risk knowledge, detection and forecasting, warning dissemination, and preparedness. Strengthening capabilities in these areas involves addressing data gaps, improving technology, enhancing communication channels, and building response capacities. Regional cooperation is also vital for effective EWS implementation, as disasters often transcend national borders.

Implementing EWS can yield significant economic benefits. By reducing loss and damage, EWS can contribute to safeguarding economic stability and promoting sustainable development. In South-East Asia, early warning systems have the potential to prevent $8.7 billion to $ 13.1 billion annually.

To achieve the full potential of early warning systems, the subregion must prioritize investments in technology, data collection, and human capacity within the context pertinent to South-East Asia. By strengthening early warning infrastructure and fostering regional cooperation, the subregion can enhance its resilience to disasters and mitigate the impacts of climate change.

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Part 1 :
Disaster and Climate Riskscape in South-East Asia

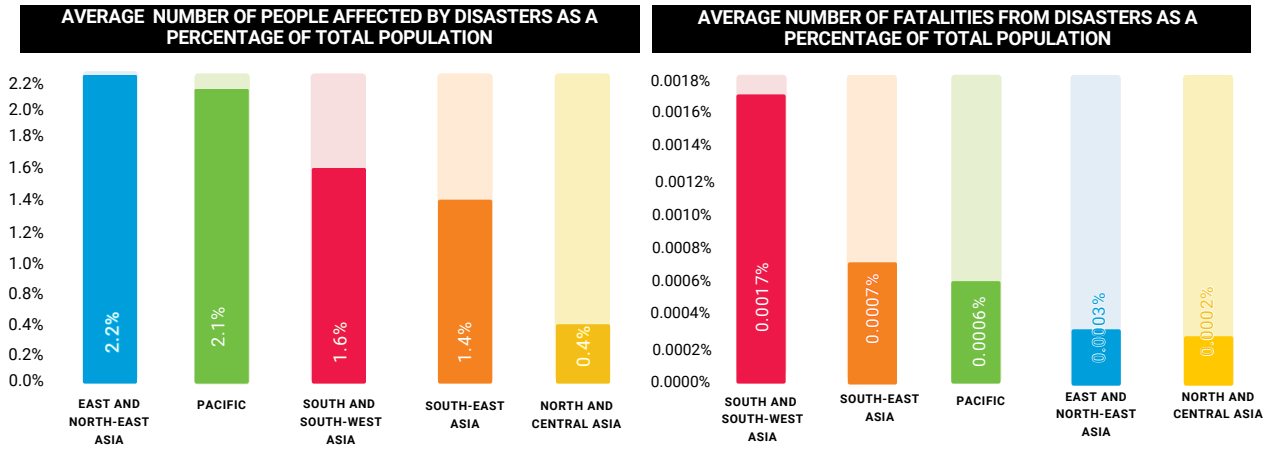
Key highlights

- **Increasing Disaster Impacts:** From 1970 to 2024, disasters have caused over 435,000 fatalities, affected 580 million people and caused an estimated damage of around $235 billion[1] in South-East Asia, which is close to 8 per cent of the total economic damages in the Asia Pacific region.
- **Escalating Climate Hazards:** Climate change is heightening multi-hazard risk across South-East Asia, particularly under 1.5°C and 2°C warming scenarios. Drought, flooding, heatwaves, and surface winds are set to intensify in the subregion. Flood and drought risks are rising, particularly vulnerable at 2°C. Heatwaves are expected to intensify while surface winds may escalate with stronger tropical cyclone activity.
- **Biodiversity at Risk:** Biodiversity hotspots of South-East Asai include Philippines and Indo-Myanmar face significant threats from climate change, leading to species loss, ecosystem disruption, and potential habitat loss by 2030.
- **Threatened Mangroves:** Over 10,741 km2 of inland mangroves across South-East Asia, including hotspots in Indonesia, Philippines and Myanmar, are exposed to multi-hazard zones, posing threats to their role in coastal protection and ecosystem stability.

Disaster riskscape of the South-East subregion

Over the past five decades, disasters in South-East Asia have affected over 580 million people and resulted in over 435,000[2] fatalities. South-East Asia has high proportion of affected population in the Asia-Pacific region with 1.4 percent of the subregion's total population impacted by disasters annually (Figure 1-1). Indonesia recorded the highest cumulative number of fatalities in the subregion, with over 200,000[3] deaths, followed by Myanmar with over 140,000 deaths.

Figure 1-1: Average Number of People Affected and Fatalities from Disasters as Percentage of Population in Asia and the Pacific



Source: ESCAP calculations based on EM-DAT, accessed on 1 July, 2024.
Note: 1. The percentage of disaster-related fatalities and people affected was calculated by dividing the total number of deaths/affected from 1970 to 2024 by the number of years (1970-2024) to obtain the average annual deaths, which was then divided by the 2024 total population. 2. EM-DAT does not have data available for Singapore and Nauru

1 Reference to dollars ($) are the United States dollars, unless otherwise stated ESCAP calculations based on EM-DAT, accessed on 1 July, 2024.

2 ESCAP calculations based on EM-DAT, accessed on 1 July, 2024.

3 Historical disaster events from EM-DAT include flood, drought, tropical cyclone, heatwave, earthquake,landslide and tsunami. Some disaster events, including cold wave, severe winter conditions, and glacial lake outbursts are grouped together under "other" category. Note: some disaster event types, such as animal accidents, epidemics, and insect infestation are not included as disaster events for this analysis.

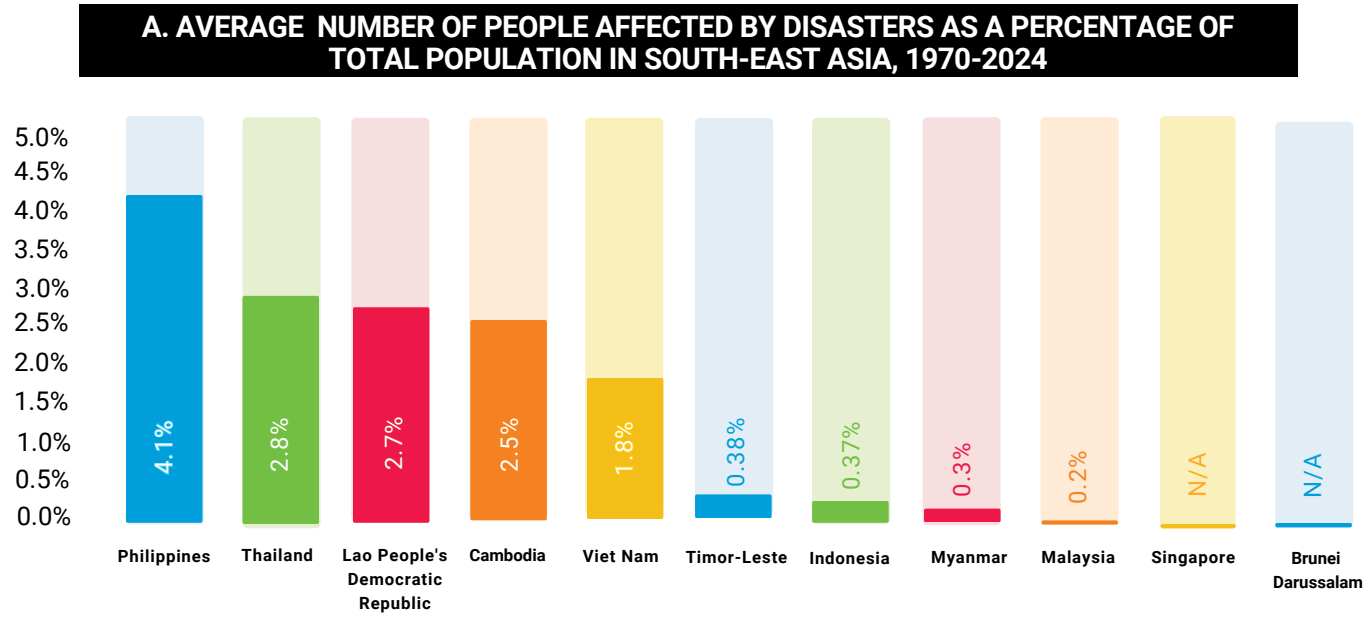
According to ESCAP's analysis of EM-DAT data from 1970 to 2024, an average of around five million people in Philippines are affected by disasters each year. This is followed by Thailand, where close to two million people are affected annually on average and Viet Nam, with over one million impacted. Figure 1-2A shows that Philippines has the highest percentage of its population affected by disasters at an average of 4.1 percent, followed by Thailand at 2.8 percent and Lao People's Democratic Republic at 2.7 per cent.

In terms of average number of fatalities, Indonesia loses over 3500 people to disasters each year followed by Myanmar with an average of over 2500 fatalities annually. However, when considering these figures as a percentage of the population, Myanmar has the second highest rate in the subregion (Figure 1-2B).

Storms had the greatest impact, affecting around 280[4] million people, mainly in Philippines. Flood affected over 170 million, and droughts impacted over 95 million, particularly in Thailand and the Indonesia. Earthquakes affected 23 million people, mainly in Indonesia and Philippines, causing death toll of over 26,000 in South-East Asia, with most fatalities in Indonesia. Storms have claimed around 200,000 lives, despite improvements in early warning systems and disaster management (Figure 1-2 C).

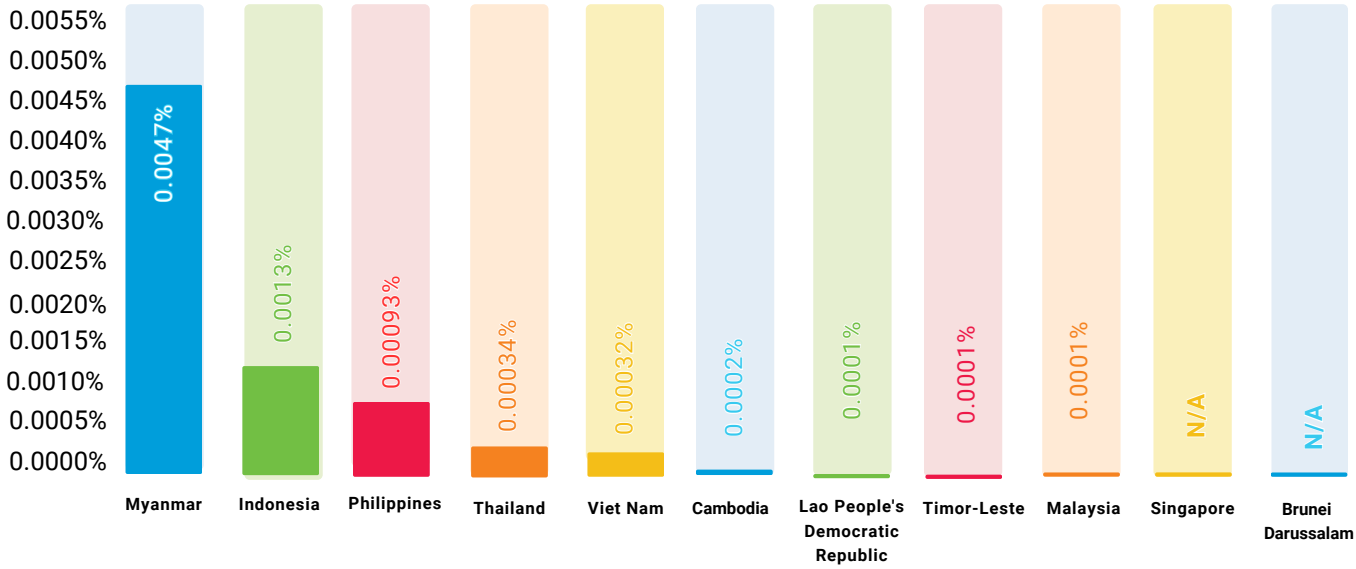
These disasters have caused around $235 billion in damages (Figure 1-2D) which is close to 8 per cent of the total disaster damages in the Asia Pacific region. Thailand suffered the highest losses at over $77 billion, of which close to 90 per cent were associated with floods. Earthquakes have caused around $17 billion in damages, of which an estimated 85 per cent were accounted for in Indonesia.

Figure 1-2: Average Number of People Affected, Fatalities, and Economic Losses from Disasters in South-East Asia

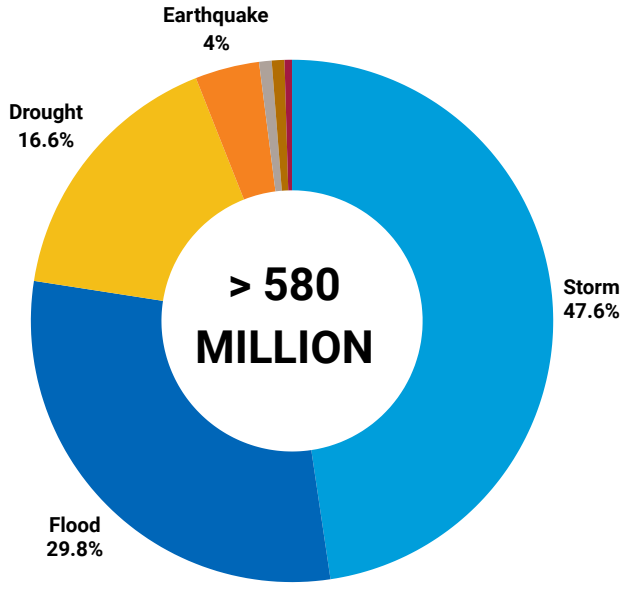


[4] Ibid

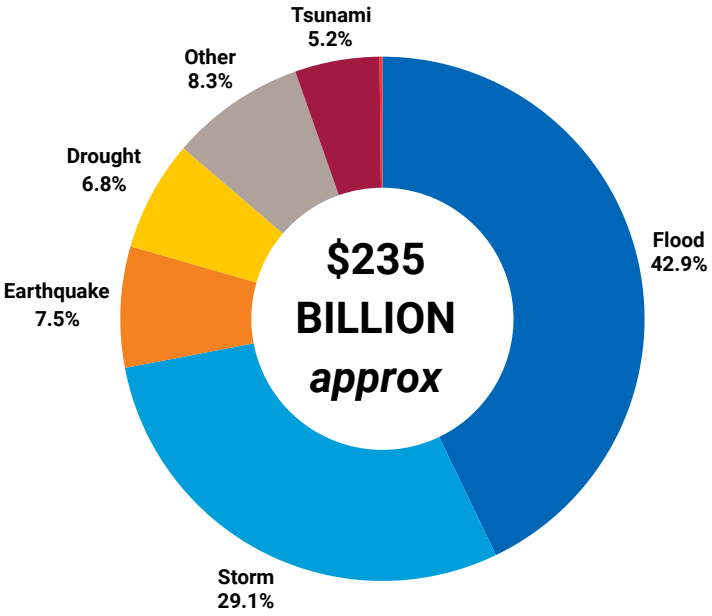
B. AVERAGE NUMBER OF FATALITIES AS A PERCENTAGE OF TOTAL POPULATION IN SOUTH-EAST ASIA, 1970-2024



C. TOTAL AFFECTED FROM DISASTERS IN SOUTH-EAST ASIA , 1970-2024



D: TOTAL DAMAGES FROM DISASTERS IN SOUTH-EAST ASIA , 1970- 2024



Source: ESCAP calculations based on EM-DAT, accessed on 1 July 2024

Note:

1. The percentage of disaster-related fatalities was calculated by dividing the total number of deaths from 1970 to 2024 by the number of years (1970-2024) to obtain the average annual deaths, which was then divided by the total population
2. EMDAT has no data on Singapore
3. No data is collected from EMDAT for heatwaves

Box 1: Exposure of Population to Heatwaves from 1983 to 2016

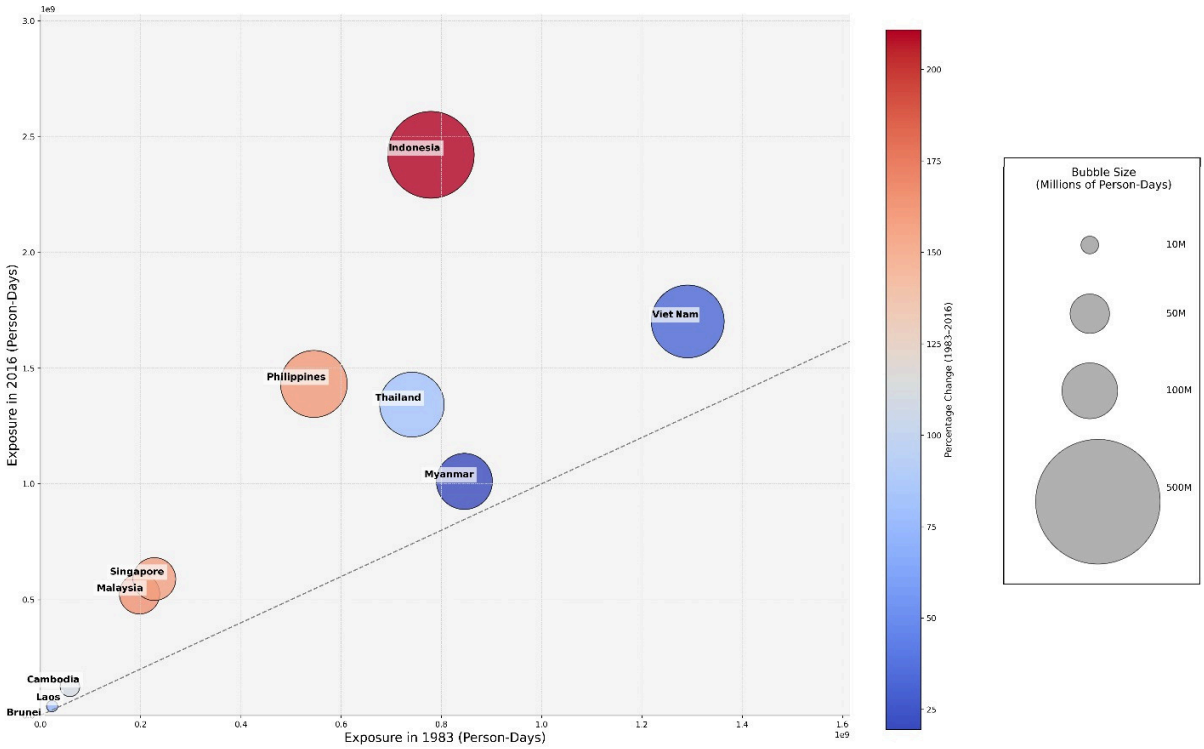
Figure 1-3 highlights the trends in heatwave exposure across Southeast Asia between 1983 and 2016, focusing on events where the Heat Index (HI) exceeded 40.6°C for two or more consecutive days. It captures the varying degrees of impact and growth in exposure among countries in the region. Countries like Indonesia and Vietnam experienced the most significant increases in heatwave exposure. Vietnam also shows a steep upward trend, signifying a substantial growth in the number of people-days exposed to prolonged heatwave conditions.

Countries such as the Philippines, Thailand, and Myanmar also exhibit moderate increases in heatwave exposure. Although their growth rates are less steep, the analysis suggests a notable absolute burden, with millions of people affected by prolonged heatwave events.

A subregional perspective reveals an upward shift of all bubbles relative to the diagonal trend line, emphasizing a consistent increase in heatwave exposure across Southeast Asia. However, the rates and magnitudes of change vary significantly, with some countries experiencing much sharper growth than others.

This analysis underscores the escalating threat of heatwaves across the region and the need for targeted interventions and regional cooperation to manage the growing risks, particularly in highly impacted countries such as Indonesia and Vietnam.

Figure 1-3: Exposure of Population to Heatwaves (Temperature Above40.6°C, 2-day events) in South-East Asia: Per cent Change from 1983 to 2016



Note:

1. Bubble Size represent exposure in millions of person-days
2. The dotted diagonal line represents a "No Change Line." Countries above this line experienced an increase in exposure, while those below would have experienced a decrease

Source: ESCAP calculations based on The UHE-Daily Dataset (1983-2016), developed by CIESIN, Columbia University.

Disaster Events in South East Asia: 2023-2024

TYPHOON: YAGI: VIET NAM

Super Typhoon Yagi, one of the strongest storms to hit Vietnam in three decades, has left a trail of destruction and continues to threaten the lives of millions across northern and central parts of the country. (IFRC, 2024) Government reports confirm 318 dead, 26 missing, and 1,976 injured. Around 220,000 children under five and 70,000 pregnant or lactating women face malnutrition risks due to disrupted services and lack of clean water. An estimated 365,000 families urgently need cash support for basic needs due to lost livelihoods and displacement. (UNICEF, 2024).

RAINFALL: INDONESIA

Since August 25, heavy rainfall in central-eastern Indonesia, especially in the Maluku islands, has caused flash floods, resulting in 18 deaths, one missing person, 15 injuries, 25 damaged houses, and around 600 affected people. (European Civil Protection and Humanitarian Aid Operations, 2024)

WILDFIRES: INDONESIA

In 2023, Indonesia saw a dramatic increase in wildfires, burning 1.16 million hectares—five times more than in 2022. The El Niño phenomenon intensified the fires, which were largely due to human activities like land clearing for agriculture, primarily in South and Central Kalimantan and South Sumatra. These fires, particularly on peatlands, emitted extensive smoke across Southeast Asia, severely impacting air quality and public health. Prolonged exposure led to significant health risks, including elevated PM2.5 levels in Jakarta (UNDRR, 2023).

STORM: MYANMAR

Extremely Severe Cyclonic Storm Mocha made landfall in May 2023, in Myanmar, near the border with Bangladesh, with extreme winds, heavy rain, and significant flooding. Damage assessments indicate extensive needs among vulnerable populations, particularly displaced communities, though early warnings limited fatalities" (WMO, 2023).

HEATWAVE: MALAYSIA

In March 2024, Malaysia experienced a severe heatwave as temperatures soared above 37°C across various regions, impacting over 29 areas. The Malaysian Meteorological Department reported 27 cases of heat-related illnesses, resulting in one fatality due to heat stroke. Additionally, critical water levels were noted at two major dams, while over 650 fire hotspots were monitored nationwide, exacerbating the ongoing dry conditions (Malaysian IFRC, 2024).

Climate riskscape of South-East Asia: Multi-hazard risk hotspots under climate change: 1.5°C and 2°C degree, SSP3 scenarios [5]

Climate change, particularly in South-East Asia, is escalating potential disaster risks under 1.5°C and 2°C warming scenarios. Currently, this subregion faces 'medium-high' risk levels, which become more pronounced at 1.5°C warming. At 2°C, risk levels rise to 'medium-high to high' in densely populated areas such Thailand, Viet Nam, Cambodia and Timor-Leste highlighting increased vulnerability to climate hazards (Figure 1-4 and Figure 1-5). Table 1-1 shows regions where multi-hazard risks are emerging and intensifying.

The Shared Socioeconomic Pathways (SSPs) are scenarios that explore how global socio-economic trends influence future climate outcomes. **SSP3**, "Regional Rivalry," projects a world with high population growth and a focus on regional security, resulting in slow economic and technological progress. This scenario anticipates significant challenges for adaptation and high vulnerability to climate impacts due to limited cooperation and resource competition.

i. Hausfather. Z. (2018). Carbon Brief. *How shared socioeconomic pathways explore future climate change.* Available at: https://www.carbonbrief.org/explainer-how-shared-socioeconomic-pathways-explore-future-climate-change/

The table indicates that several regions in Southeast Asia are at increasing risk from multiple climate-related hazards as temperatures rise under 1.5°C and 2°C warming scenarios. Areas such as Lao People's Democratic Republic , Myanmar, Thailand, Cambodia, Timor-Leste and Viet Nam are particularly vulnerable, with significant risks emerging or intensifying.

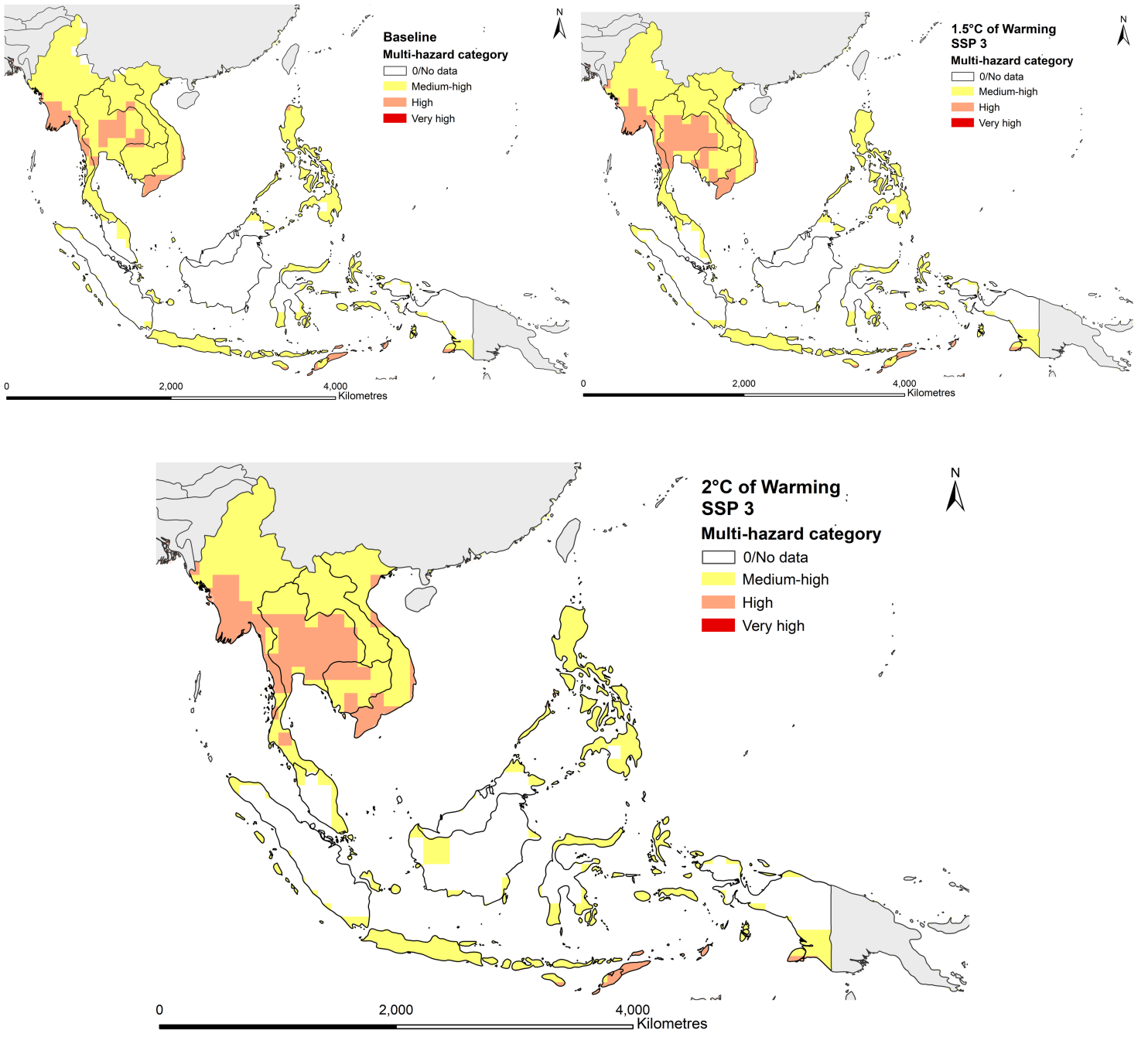
In terms of **drought risk**, Indonesia, Cambodia, and Myanmar are already experiencing severe conditions, with these areas expected to intensify under both 1.5°C and 2°C scenarios. Droughts will also emerge as a significant risk in Thailand, especially under 2°C warming. Cambodia, Myanmar, Lao People's Democratic Republic, Viet Nam, and Thailand are current hotspots for **flood risks,** with existing high risks that will continue to increase under both warming scenarios. In Cambodia, the Mekong Delta region is particularly at risk of intensified flooding, especially as warming approaches 2°C.

Heatwave risks are set to intensify across the region, with parts of Lao People's Democratic Republic , Myanmar, and Thailand identified as areas where heatwaves will become more frequent and extreme. Heatwaves in Southeast Asia have become more frequent and intense in recent decades due to global warming, particularly since the 1990s (WMO, 2024). The frequency of heatwave days has increased by 1–10 days per decade, with major El Niño years like 1983, 1998, and 2016 intensifying these events. Prolonged heatwaves and rising nighttime temperatures heighten mortality risks as the human body struggles to recover during hot nights. (Xian Xiang Li, 2020).

5 Details on the methodology to calculate Multi-hazard hotspot available from Beginner's handbook: landuse/ landcover mapping and climate risk assessment for Maldives using geospatial techniques (2024).

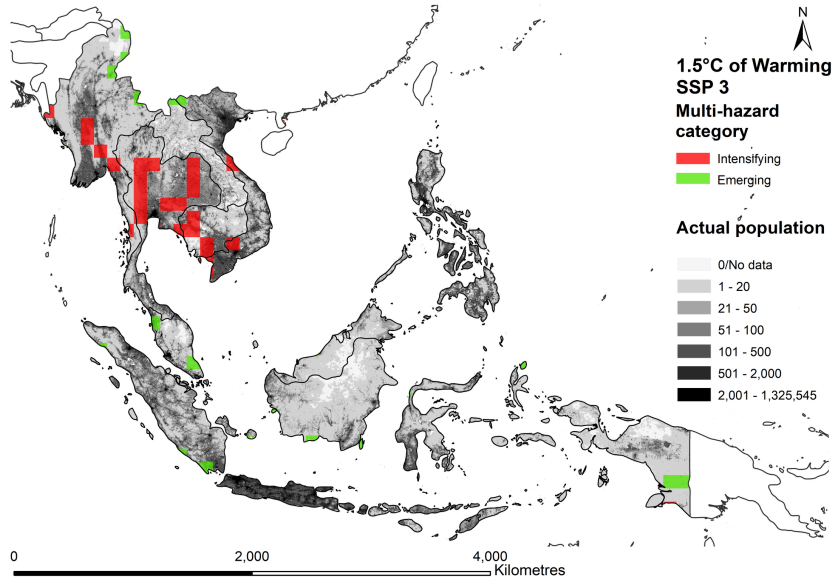
The El Niño- Southern Oscillation (ENSO) significantly influences heatwave patterns, with strong El Niño years, such as 1998 and 2016, driving severe heatwaves Dong et al., 2021) These countries, already grappling with rising temperatures, will see these risks exacerbate further under 2°C warming, especially in Myanmar, which will face increasingly hazardous heat conditions. Finally, surface wind risks are an emerging concern for Thailand, where high wind speeds, possibly linked to tropical cyclone activity, are expected to escalate under 2°C warming scenarios.

Figure 1-4: Hotspots of Climate-Related Multi-Hazard - Recent baseline and climate projects under 1.5°C and 2°C, SSP3 scenarios.

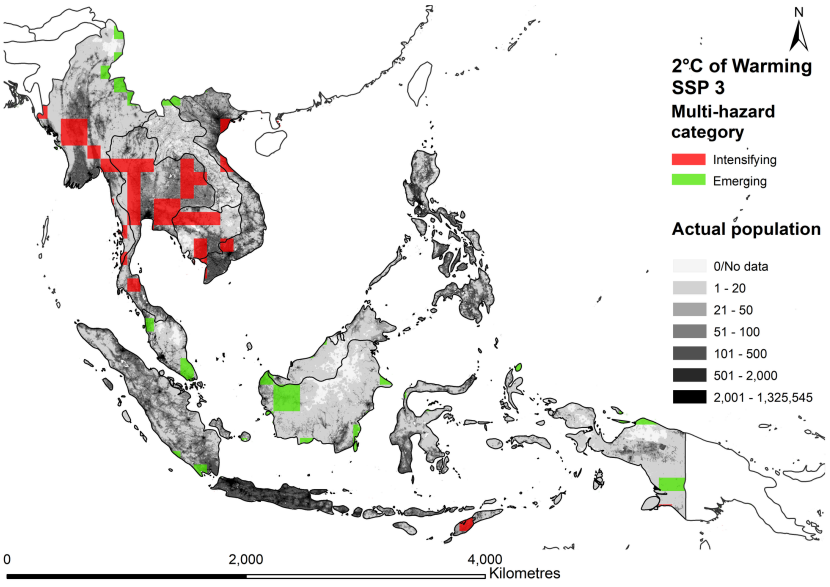


Sources: ESCAP calculations based on IPCC WGI Interactive Atlas- Coupled Model Intercomparison Project Phase 6 (CMIP6) 2021 and UN Geospatial.
Disclaimer: The boundaries and names shown and the designation used on this map do not imply official endorsement or acceptance by the United Nations

Figure 1-5: Hotspots of Emerging and Intensifying Multi-Hazard Risk Hotspots under 1.5°C and 2°C, SSP3 scenarios.



Sources : ESCAP calculations based on IPCC WGI Interactive Atlas - Coupled Model Intercomparison Project Phase 6 (CMIP6) 2021, WorldPop 2020 Population Estimates, and UN Geospatial.
Disclaimer: The boundaries and names shown and the designations used on this map do not imply fficial endorsement or acceptance by the United Nations.



Sources : ESCAP calculations based on IPCC WGI Interactive Atlas - Coupled Model Intercomparison Project Phase 6 (CMIP6) 2021, WorldPop 2020 Population Estimates, and UN Geospatial.
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Table 1-1: Existing, Intensifying, and Emerging Hotspots of Multi-Hazard Risk, Drought, Flood, and Heatwave Risks

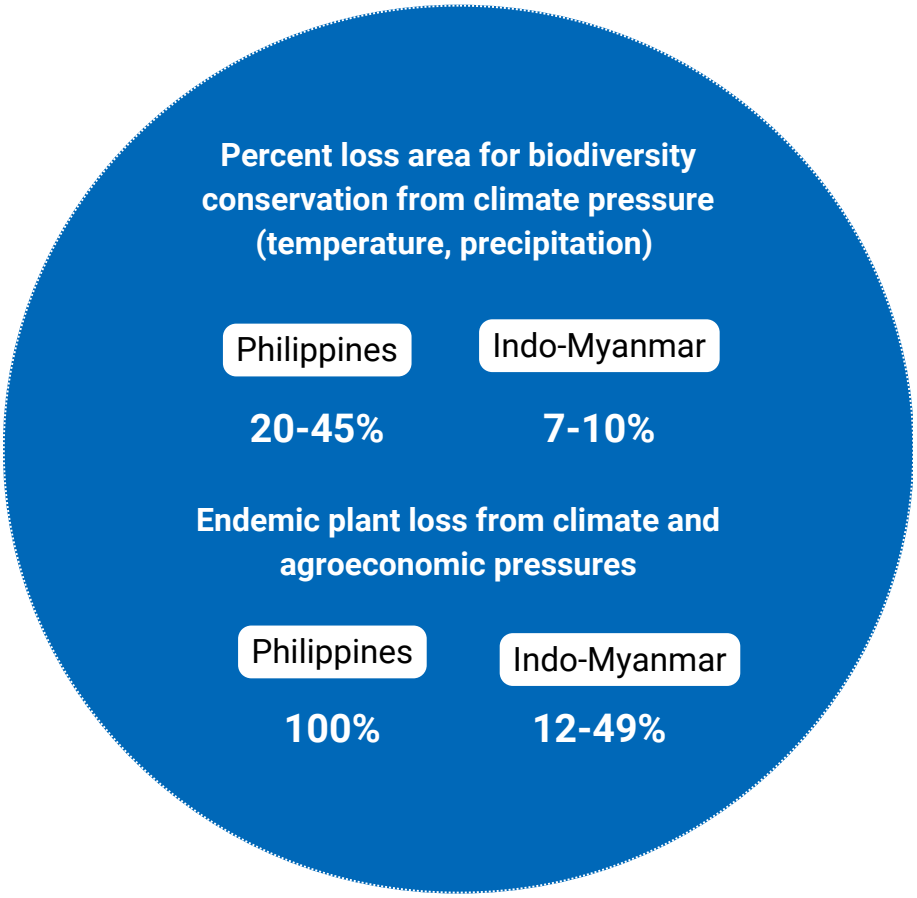
MULTI-HAZARD RISK				
Existing hotspots (Baseline Scenario)	Hotspots of intensifying risk (1.5°C)	Hotspots of intensifying risk (2°C)	Hotspots of emerging risk (1.5°C)	Hotspots of emerging risk (2°C)
Medium to high risk in Mekong River Basin, parts of Indonesia and Timor-Leste	Mekong river basin	Mekong river basin, Indonesia	Ring of Fire; Indonesia	Ring of Fire; Indonesia, Malaysia, Singapore
DROUGHT RISK				
Medium risk to drought in most of SEA including the Mekong River Basin		Southern Myanmar	Northern Myanmar, parts of Thailand, Indonesia, and Cambodia	More emerging in Northern Myanmar, parts of Thailand, Indonesia, and Cambodia than under 1.5 Degrees
FLOOD RISK				
High to very high risk in most of SEA including the Mekong River Basin	Mekong Basin (Myanmar, Thailand, LaoPeople's Democratic Republic , Cambodia, Viet Nam), parts of Indonesia, Malaysia, and Singapore	More intensification in Mekong Basin (Myanmar, Thailand, Lao People's Democratic Republic, Cambodia, Viet Nam), parts of Indonesia, Malaysia, and Singapore than under 1.5 Degrees		
HEATWAVE RISK				
Medium to high risk in Myanmar, Thailand, Cambodia and parts of Lao People's Democratic Republic	Myanmar, Thailand	More intensification in Myanmar and Thailand than under 1.5 Degree warming, parts of Cambodia	Myanmar, Lao People's Democratic Republic, Viet Nam, Cambodia	More expansion in Myanmar, Lao People's Democratic Republic, Viet Nam, Cambodia than under 1.5 Degrees; some parts of Indonesia
SURFACE WIND RISK				
Medium risk in parts of Thailand, Lao People's Democratic Republic, Cambodia; high risk in parts of Viet Nam, Philippines, Indonesia, Timor Leste			Indonesia	Thailand

Biodiversity risk in South-East Asia

Thirty-six per cent of the world's biodiversity hotspots are located in the Asia-Pacific region (Habel and others, 2019). Southeast Asia, home to four global biodiversity hotspots, faces severe biodiversity threats due to high rates of deforestation and land- use changes for agriculture, particularly for oil palm and rubber plantations. This trend is predicted to persist as global demand for commodities rises, intensifying habitat loss. Projections suggest up to 1.6% of species could be lost by 2100 under unsustainable development paths, with countries like Cambodia potentially losing over 4% of species due to extensive forest exploitation. Yet, potential for biodiversity recovery, as demonstrated by the Philippines, where forest restoration yields a 7.1% recovery by 2100.

Neighboring countries like Thailand and Viet Nam also offer hope, showing positive impacts from recent reforestation. Critical to this future are conservation policies focused on protecting primary-forest and implementing sustainable land-use practices, especially as ongoing deforestation threatens to limit habitat connectivity and species' ability to recover naturally (Botterill-James, Yates, Buettel & Brook, 2024).

Figure 1-6: Biodiversity Loss Hotspots Projections by 2030 in South-East Asia



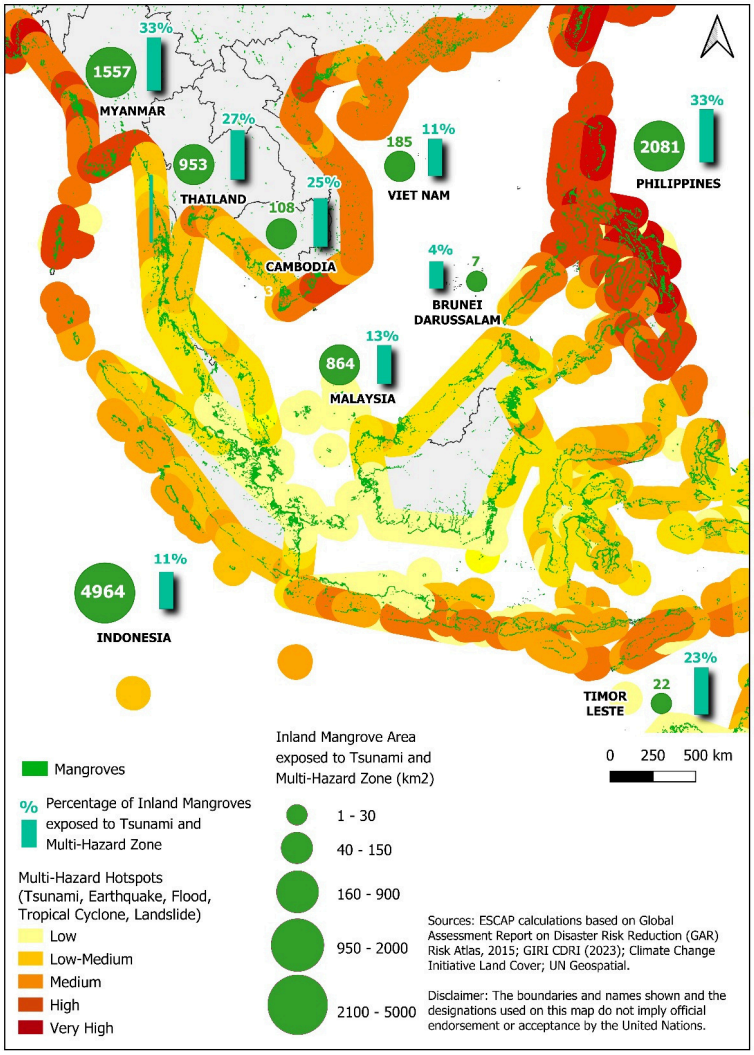
Source: ESCAP, based on Jan C. Habel, and others, "Final countdown for biodiversity hotspots", Conservation Letters (July 2019). Available at https://conbio. onlinelibrary.wiley.com/doi/epdf/10.1111/conl.12668

Mangroves loss in South-East Asia

More than 10,741 km of inland mangroves across South-East Asia are exposed to tsunamis and other cascading hazards[6]. Figure 1-7 illustrates the inland mangrove areas in South-East Asia exposed to multi-hazard zones, including tsunamis, earthquakes, floods, tropical cyclones, and landslides. Mangroves, represented in green, serve as a critical natural barriers, protecting coastal regions from these hazards. Indonesia has the largest inland mangrove area exposed, spanning 4,964 km² (11per cent of its mangroves), reflecting its vast coastline and frequent disasters. The Philippines follows with 2,081 km² exposed (33 per cent). Myanmar also faces significant exposure, with 1,557 km² (33 per cent) of its mangroves at risk. Countries such as Timor-Leste (22 km², 23 per cent), Brunei (7 km², 4 per cent), and Cambodia (108 km², 25 per cent) have smaller mangrove areas exposed but remain vulnerable.

The intensity of hazards varies across the region, with low to medium hazard zones dominating parts of Malaysia and Vietnam, while high to very high hazard zones are concentrated along the coasts of Indonesia, the Philippines, and Myanmar. Regions in the "very high" hazard category face compounded risks, underscoring the importance of mangroves for coastal protection. While Indonesia has the largest absolute exposure, Myanmar and the Philippines have the highest proportional exposure of their mangroves (33%), indicating greater relative risk.

Figure 1-7: Inland Mangrove Exposed to Tsunami in South-East Asia



6 The exposure numbers and percentages reflect inland mangroves' vulnerability to tsunami inundation. However, since these mangroves are crucial for mitigating tsunami impacts, their exposure to other hazards, such as floods and cyclones, is also concerning. The buffer zone accounts for these additional climate- related risks to give a fuller picture of their vulnerability.

Part 2 :
Protecting People and Development Gains

Key highlights

- **Widespread Exposure to Climate Hazards:** The South-East region is characterized by high exposure to floods and surface winds with close to 99 per cent of the population exposed to the hazards.
- **Agriculture and Energy sectors at Risk:** Under 2°C warming, around 76 per cent of agriculture production value and over 55 per cent of power plants capacity in the energy sector will be exposed to multi-hazard risks.
- **Protecting Vulnerable Populations:** The elderly and people with disabilities are particularly vulnerable, with disasters also causing internal displacements. Strong social protection for these groups is crucial before, during, and after disasters.
- **SDG 13 regression**: While the subregion has had good progress on Sustainable Developmental Goals (SDG), SDG 13 is notably regressing.

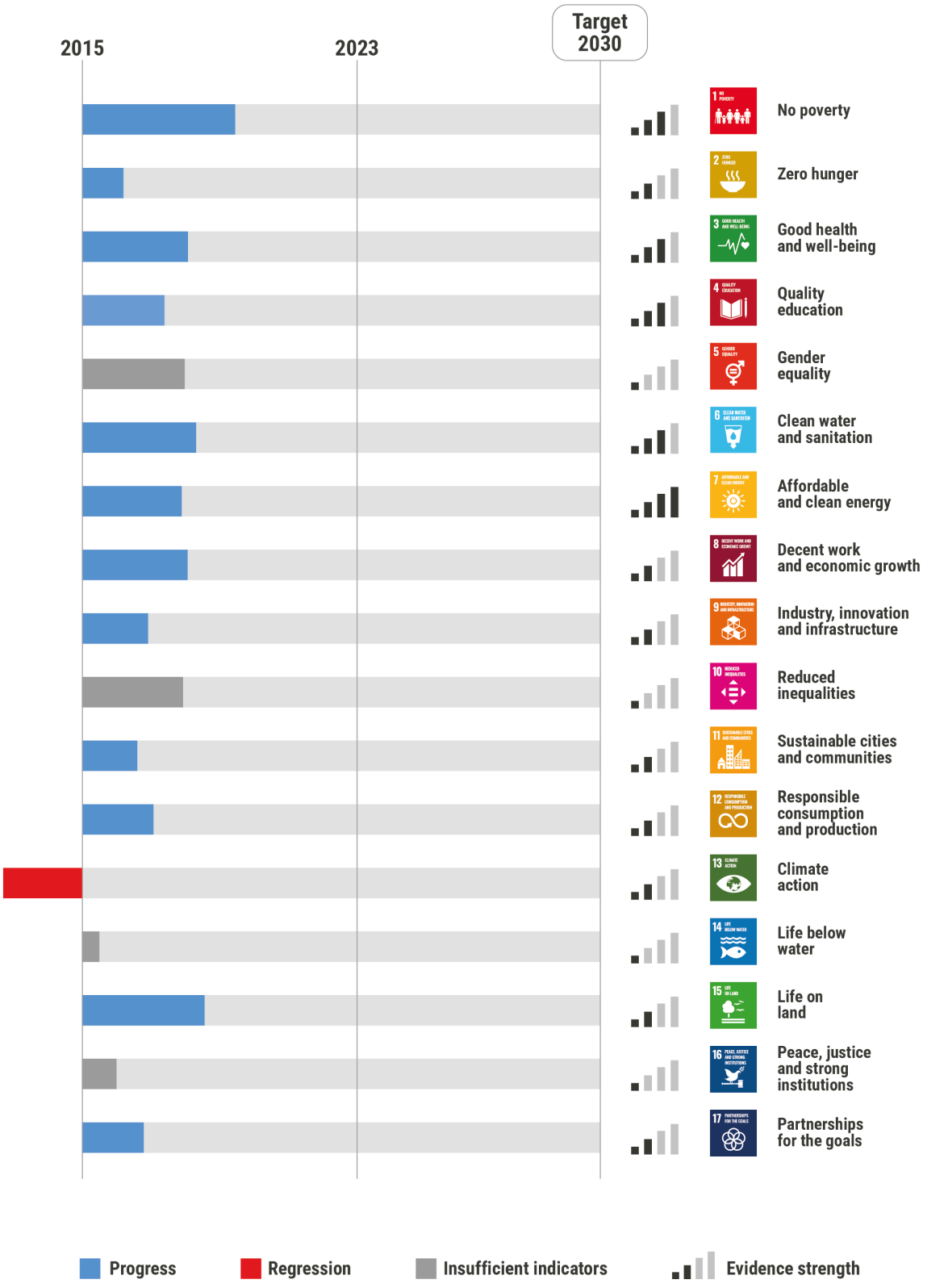
Disaster and climate related SDG progress in South-East Asia

Disaster risk reduction is crucial to achieving the Sustainable Development Goals (SDGs), especially in South East Asia. Viewing these goals through a resilience-building lens reveals key areas where efforts must be intensified to reverse negative trends and foster sustainable development outcomes (Figure 2-1). There is a concerning reversal under Goal 13 for Climate Action for this sub-region, particularly those under Target 13.1(Resilience and adaptative capacity) and Target 13.2 (Climate change policies). Under Goal 1 and 11, there is a reversal in Target 1.5 (Resilience to disasters) and Target 11.5 (Resilience to disasters). Additionally, under Goal 15, Target 15.1 (Terrestrial and freshwater ecosystems) and Target 15.5 (Halting Biodiversity loss) are also reversing. These trends highlight the urgency of climate action and ecosystem protection to build resilience in the region (Figure 2-2). In addition, hazards like heatwaves are severely impacting progress on SDG Goal 3 (Good health and wellbeing) (Box 2). The ESCAP Risk and Resilience Portal SDG Action Tracker continues to monitor progress toward disaster and climate-related SDG targets.

The ESCAP Risk and Resilience Portal's SDG Action Tracker monitors and evaluates countries' progress on disaster and climate-related SDGs. It offers a comprehensive overview of progress on SDG targets, helping policymakers identify areas for improvement and assess the impact of policies. This tool is essential for guiding decisions and ensuring accountability in achieving sustainable development goals.

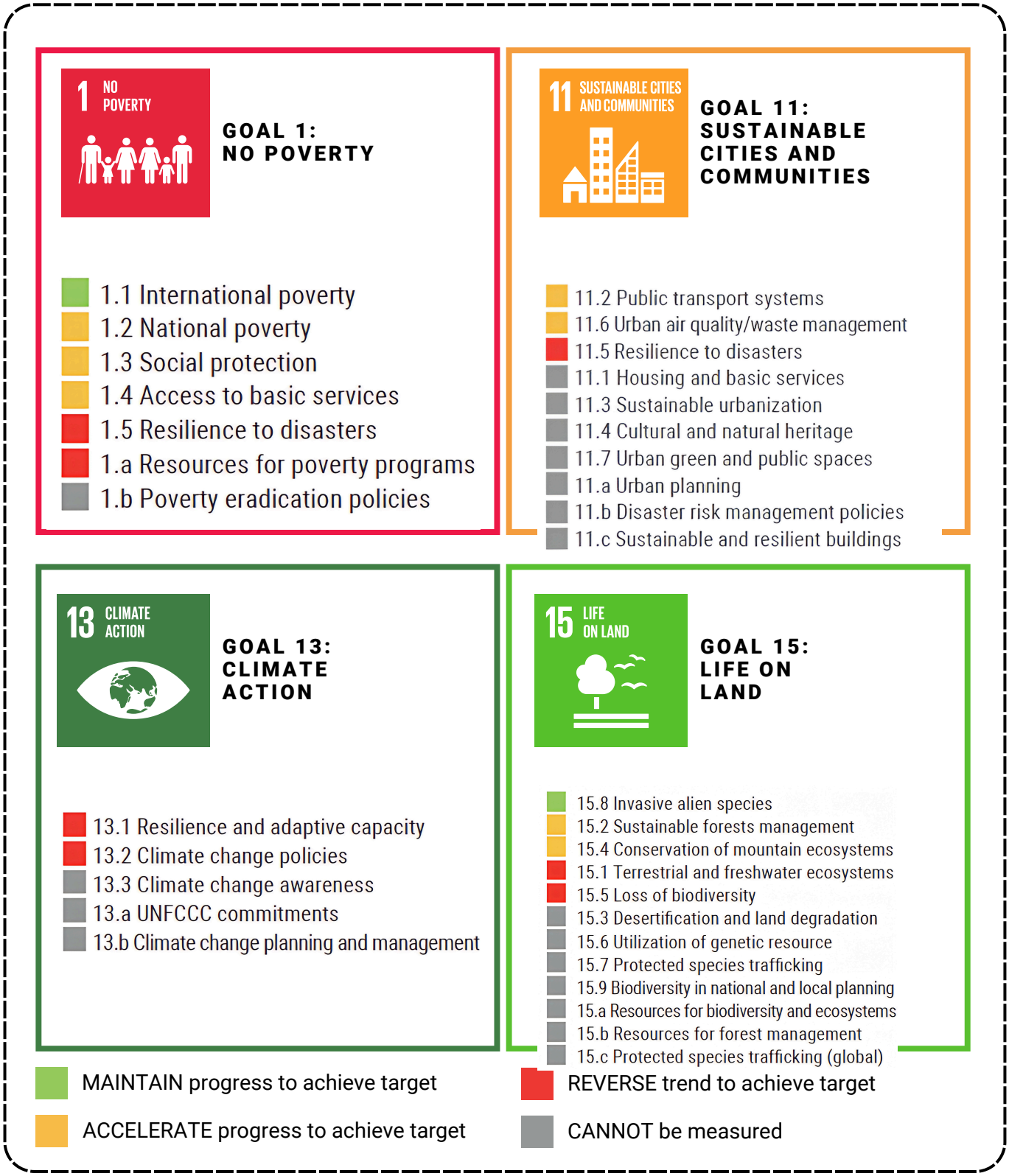
URL: https://rrp.unescap.org/sdg-stimulator#/

Figure 2-1: Snapshot of SDG Progress in South-East Asia



Source: ESCAP

Figure 2-2: Dashboard of Expected Achievements for Pacific



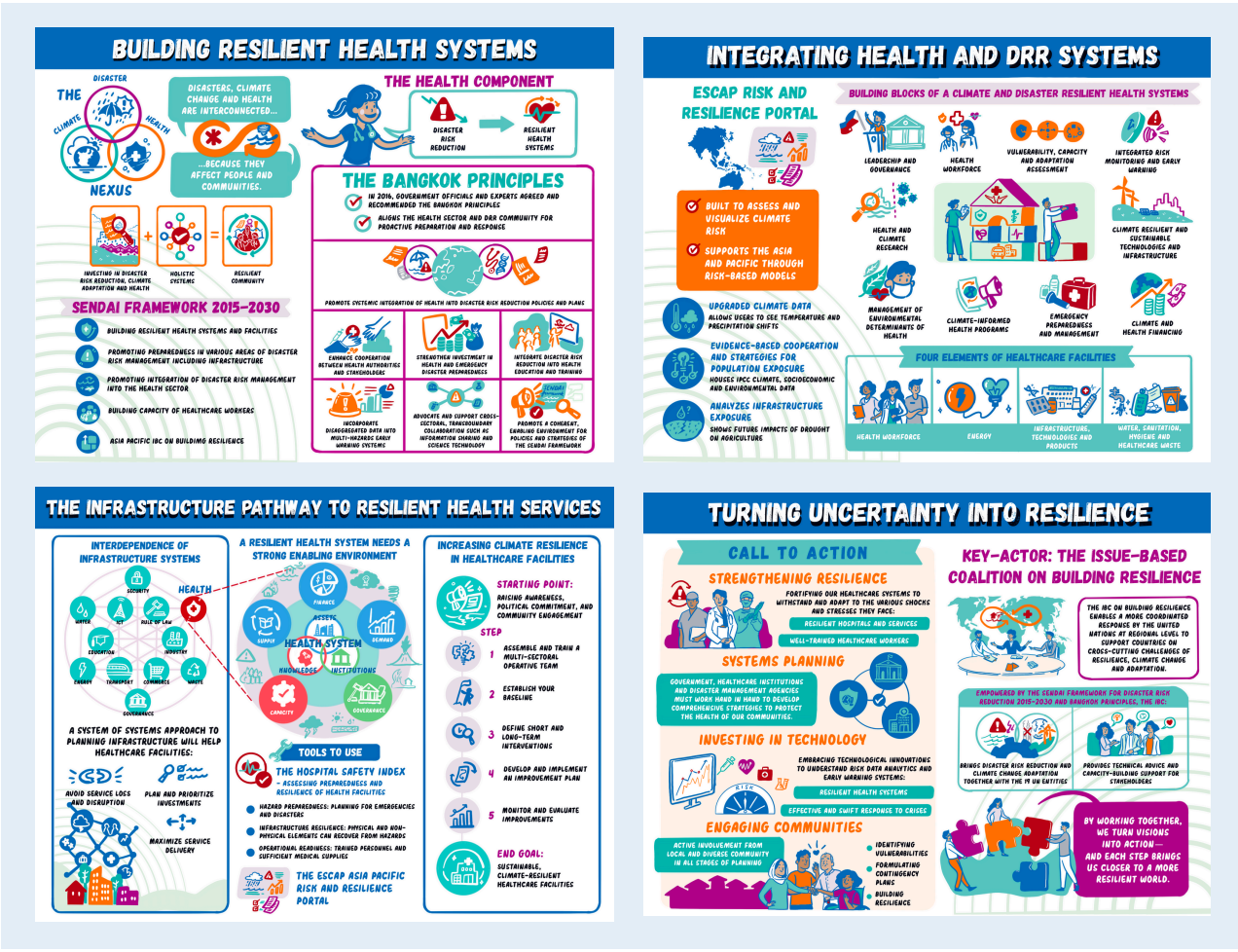
Source: Asia and the Pacific SDG Progress Report Showcasing Transformative Actions, 2023

Box 2: Advancing SDG3: Educational Tools to Strengthen Health System Resilience Against Disasters and Climate Challenges in Asia-Pacific

Goal 3 of the Sustainable Development Goals emphasizes ensuring healthy lives and promoting well-being for all, with Target 3.d focusing on strengthening the capacity of countries, particularly developing nations, to effectively manage health risks through early warning, risk reduction, and disaster response . Central to this effort is the promotion of a “Build Back Better” approach, which prioritizes recovery, rehabilitation, and reconstruction aligned with the health-related components of the Sendai Framework for Disaster Risk Reduction (2015–2030) and the Bangkok Principles. This approach fosters systematic cooperation, coherence, and integration between disaster and health risk management to build resilience against future challenges (TWG-DR3, 2017).

To further enhance health systems' capacity to withstand disasters and climate-related challenges, the Asia-Pacific Issue-Based Coalition on Building Resilience, supported by UNDRR ROAP, UNFPA, ESCAP, and UNOPS, has developed a comprehensive set of educational materials. These include four user-friendly infographics designed to provide valuable insights for a wide audience, including newcomers, specialists, and practitioners in health and disaster risk reduction. By simplifying complex concepts, these resources aim to strengthen the understanding and application of strategies that link disaster preparedness and health system resilience, paving the way for more robust, integrated responses to emerging risks.

Figure 2-3: Health and Disaster Risk Resilience Made Accessible: A Set of Infographics for Practitioners and Newcomers Alike



Source: Asia-Pacific Knowledge Management Hub, “Disaster and Climate Resilient Health Systems,”2024. Available at https://knowledge.unasiapacific.org/our-work/knowledge-resources/disaster-and-climate-resilient-health-systems

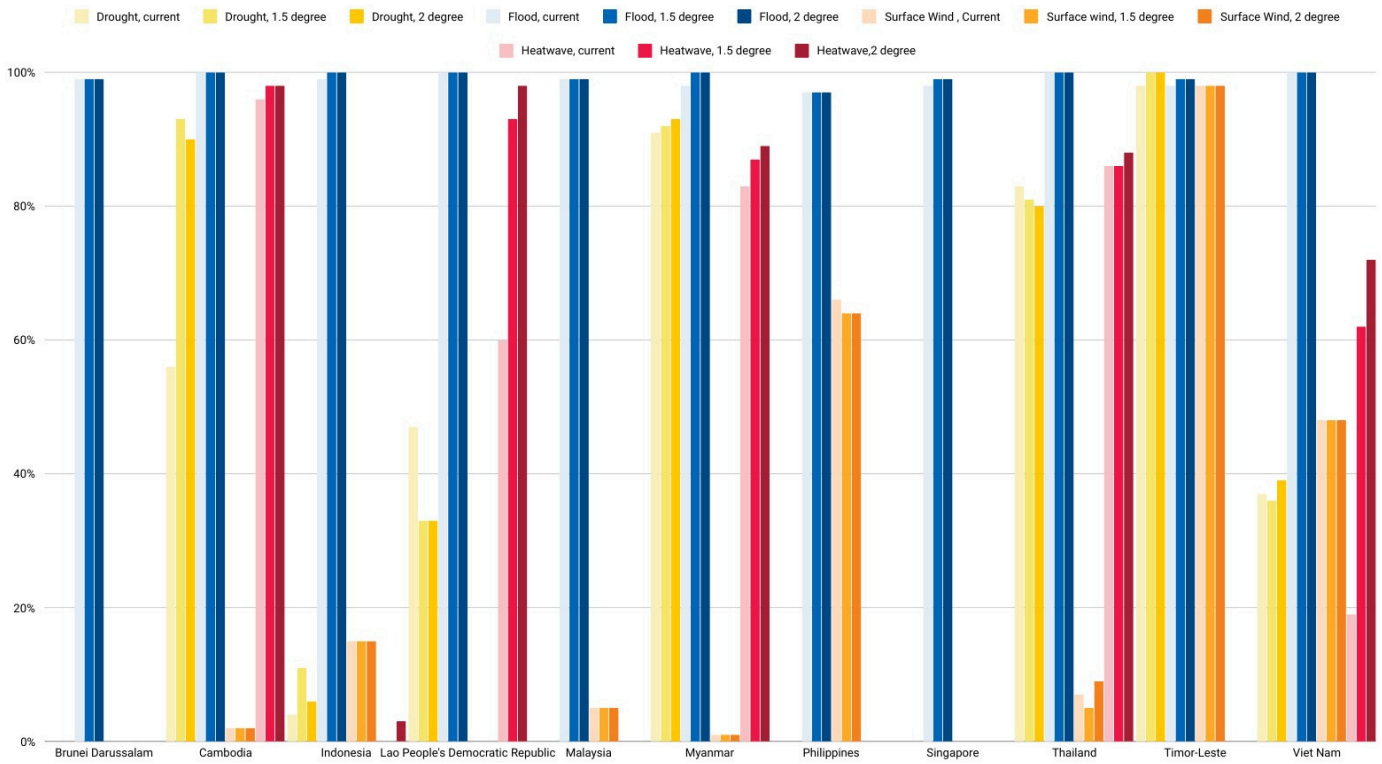
Impacts of climate on critical sector

Vulnerability in South-East Asia is intensifying as climate risk intensifies. Under 1.5°C warming, almost 71 per cent of the region's population is expected to face multi-hazard risks, which can further rise to 80 per cent under the 2°C warming scenario. Food and energy systems are increasingly at risk of severe shocks. Understanding the linkages between the different climate projection scenarios, population hotspots, and vulnerabilities can help build resilience to projected loss and damage from disasters.

POPULATION

South-East Asia is characterized by high exposure to floods with close to 99 per cent of the population exposed to the hazard. Floods pose a significant threat in Cambodia, Lao People's Democratic Republic, Thailand and Viet Nam, with almost the entire population exposed under both scenarios. Timor-Leste, Cambodia, and Myanmar have high exposure to drought with increasing exposure under both 1.5°C and 2°C warming scenarios. In Cambodia and Lao People's Democratic Republic, there is increasing population exposure to heatwaves under both scenarios.

Figure 2-4: Population Exposure of South-East Asia for Droughts, Floods, Heatwaves, Surface Winds under Current ,1.5°C and 2°C (SSP3 scenarios)

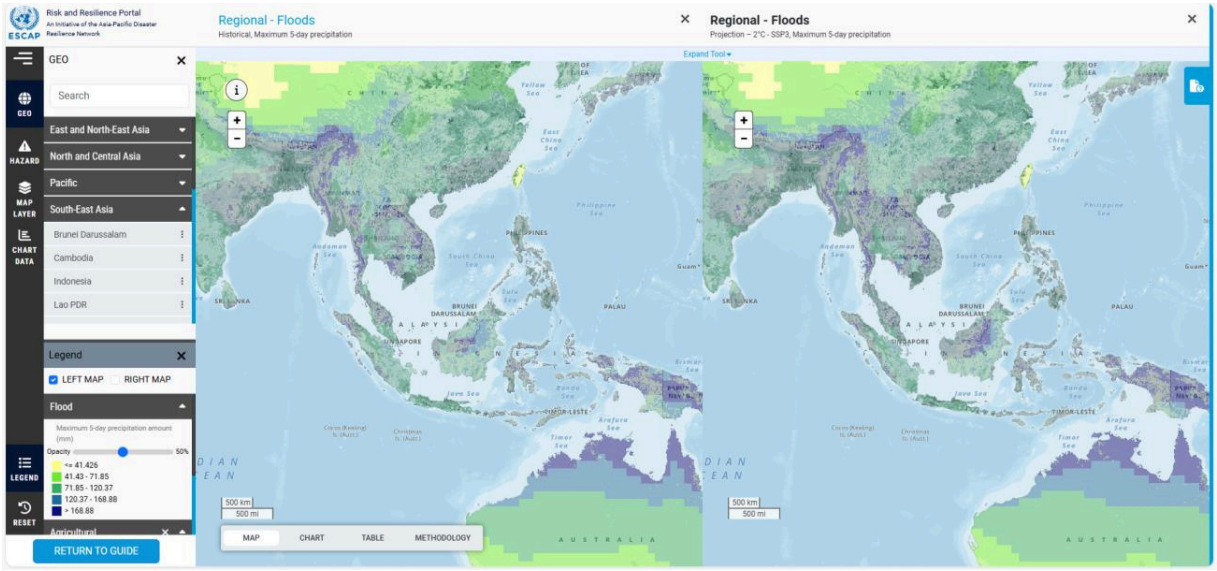


Source: ESCAP

AGRICULTURE AND FOOD SECURITY

Climate change poses threat to agriculture in South-East Asia, with rising temperatures, shifting precipitation patterns, and more frequent extreme weather events, leading to loss of agricultural land, intrusion of sea water, lower crop yields and reduced quality- all of which threatens food security. Under 2°C climate scenario, over 76 per cent of agriculture value in South-East Asia will be exposed to multi-hazard risk (ESCAP, n.d). Under a 2°C climate scenario, around 100 per cent of agricultural value in Singapore, Lao People's Democratic Republic, and Cambodia is at a high flood risk. Viet Nam, Myanmar and Thailand also face significant exposure, with Viet Nam showing nearly 99 per cent at extremely high risk while Myanmar and Thailand showing over 98 per cent at extremely high risk (figure 2-5).

Figure 2-5: Exposure of Agricultural Production Value to Flood Risks under the Current and 2°C degree Climate Change Scenarios



Source: ESCAP Asia-Pacific Risk and Resilience Portal

Climate Impacts on Agriculture

VIET NAM

Climate change in Vietnam threatens agriculture through rising temperatures, increased heat stress on labor, and altered rainfall patterns, leading to greater risks of drought and saline intrusion, particularly in rice-producing regions like the Mekong Delta. Sea-level rise and more frequent extreme weather events, including floods and storms, further endanger crop yields and infrastructure. These impacts could disrupt food production and security, especially for rice, Vietnam's staple crop, underscoring the need for adaptive strategies to protect agricultural productivity and rural livelihoods. (Asia Development Bank, 2019)

INDONESIA

Indonesia's agriculture faces significant climate risks due to rising temperatures, shifting rainfall patterns, and increased frequency of extreme events like droughts, floods, and sea-level rise. These changes threaten crop yields, particularly for rice, as higher temperatures and erratic precipitation alter growing conditions and increase vulnerability to pests and diseases. Drought, driven by climate variability and El Niño events, can intensify, impacting water resources and agricultural productivity. These factors pose challenges to Indonesia's food security and rural livelihoods, highlighting the need for climate-resilient agricultural practices and adaptation strategies. (World Bank, 2021a)

LAO PDR

Agriculture in Lao PDR faces climate-related risks from rising temperatures, irregular rainfall, and more frequent extreme events, including droughts and floods. These changes can disrupt crop yields, especially for rice, the country's main staple, and strain water resources critical for irrigation. Increased temperatures and erratic precipitation elevate the risk of pest infestations and soil degradation, further threatening productivity. As most of the rural population relies on agriculture for subsistence, these climate impacts raise concerns for food security and emphasize the need for adaptation strategies to build climate resilience in the agricultural sector. (World Bank, 2021b)

THAILAND

Climate change poses significant risks to Thailand's agriculture through rising temperatures, increased droughts, unpredictable rainfall, and frequent flooding. These changes threaten crop yields, especially rice, which is highly water-dependent. More intense wet season rainfall and frequent flooding risk waterlogging fields and eroding soil, while droughts strain irrigation and water resources. Additionally, the increased risk of cyclones and storm surges impacts coastal agriculture, complicating planting schedules and reducing productivity. (World Bank, 2021c)

MALAYSIA

Climate change is impacting Malaysia's agriculture sector through rising temperatures, increased droughts, and more frequent and intense floods. Projected temperature increases of up to 3.11°C by the 2090s and changes in rainfall patterns threaten crop yields, especially rice, rubber, palm oil, and cocoa. Floods, already a major source of damage, are expected to become more severe, disrupting agricultural production and infrastructure. The growing risk of drought in key agricultural regions also poses further challenges. (World Bank, 2021d)

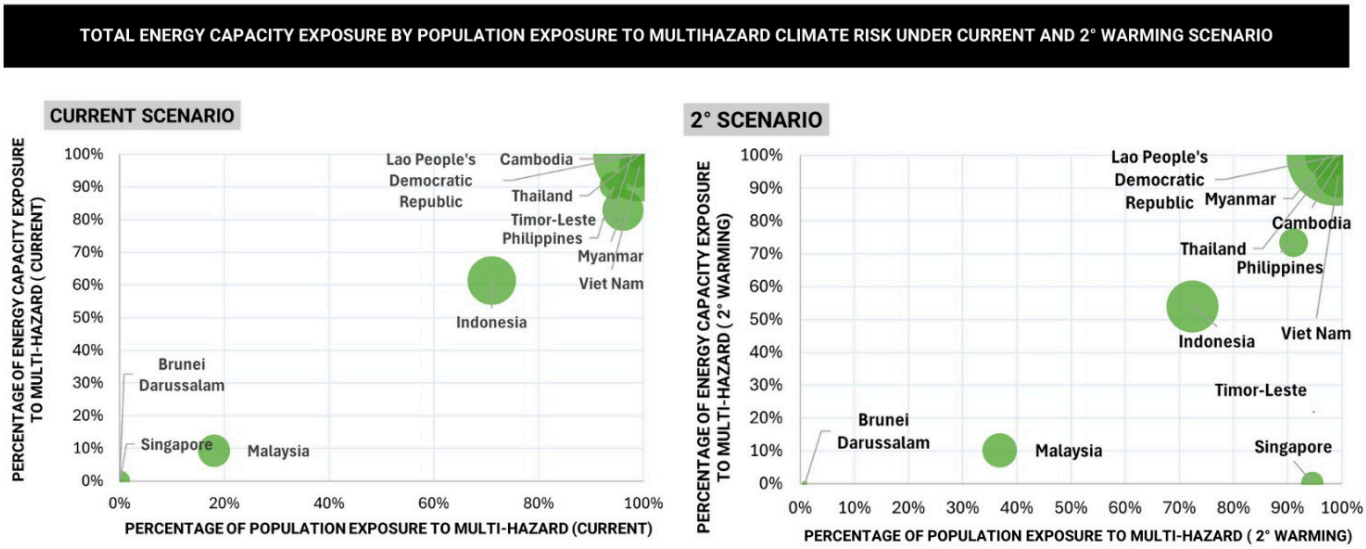
PHILIPPINES

The agriculture sector in the Philippines faces significant risks from climate change, including increased temperatures, more intense and unpredictable rainfall, and frequent extreme weather events like droughts and typhoons. Rising temperatures could reduce crop productivity, particularly for rice, the staple crop. Intense rainfall and flooding are projected to increase, damaging crops and infrastructure and exacerbating soil erosion. Droughts, especially during El Niño events, threaten water availability and crop yields. Typhoons, which are growing in frequency and intensity, bring destructive winds and flooding, disrupting agricultural activities and causing significant losses. (World Bank, 2021e)

ENERGY SECURITY

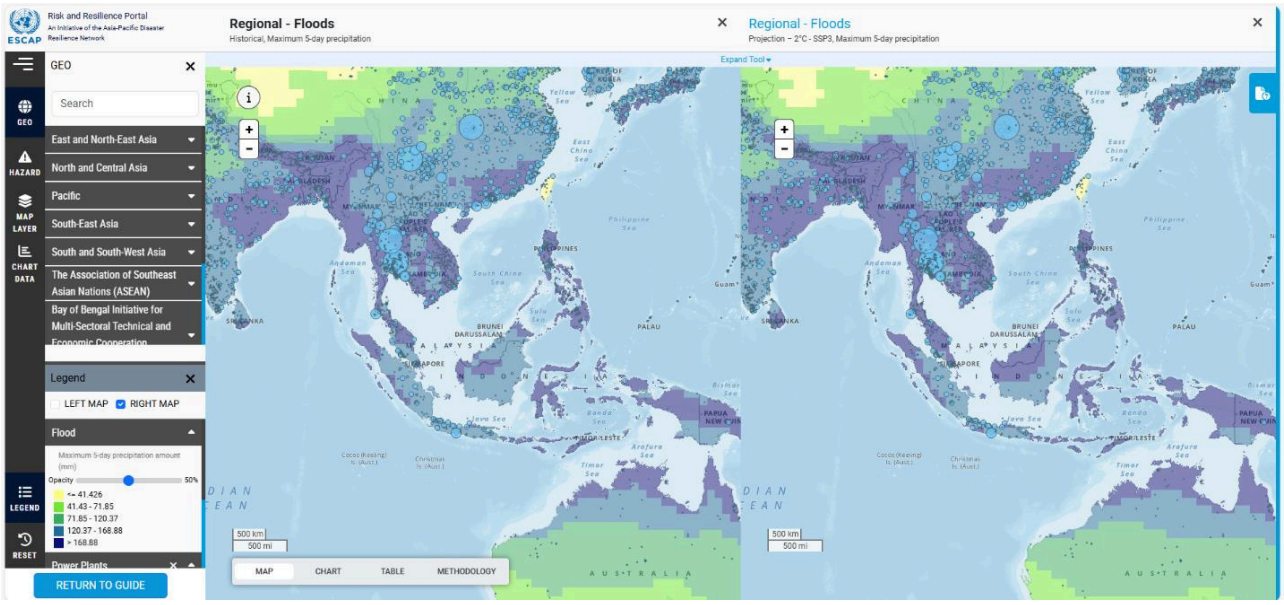
Climate change and extreme events significantly threaten critical infrastructure, particularly the energy systems. Under the 2°C climate scenario, multi-hazard risk for both energy infrastructure and population served by the energy systems significantly escalates across South-East Asia, with countries like Cambodia, Myanmar and the Lao People's Democratic Republic facing nearly total exposure. In Myanmar, Timor-Leste and Brunei Darussalm, almost 100 per cent of the country's total powerplant capacity will be exposed to flood risk under a 2°C climate scenario (Figure 2-7).

Figure 2-6 : Total Energy Capacity Exposure by Population Exposure to Multi-Hazard under Current and 2°C Climate Scenarios



Source: ESCAP

Figure 2-7: Exposure of Power Plant Capacity to Flood Risks under Current and 2°C degree Climate Scenarios

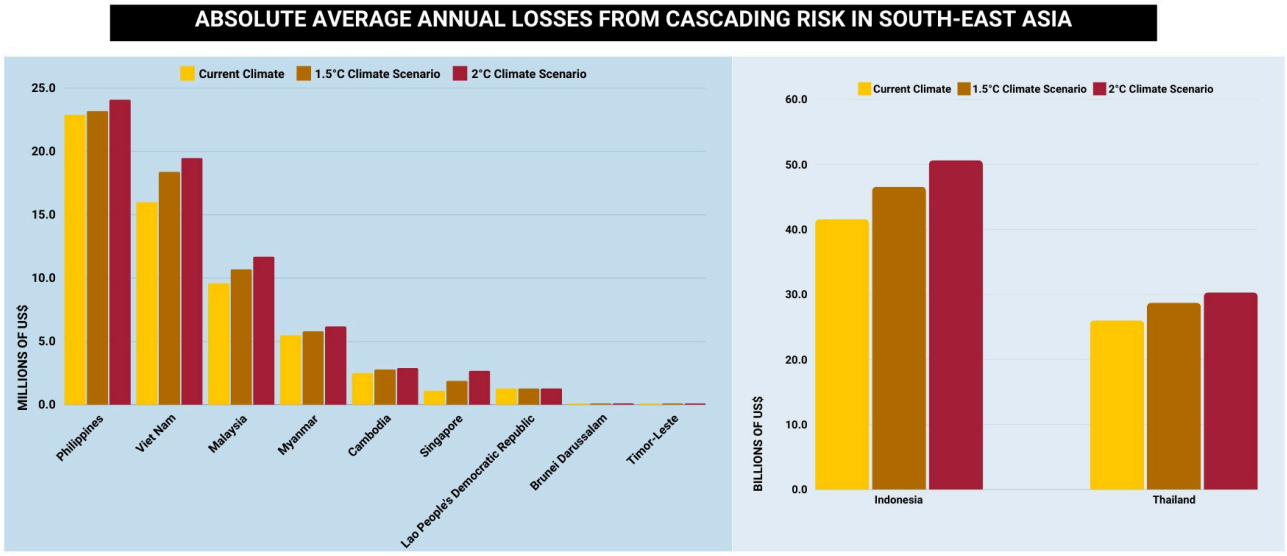


Source: ESCAP Asia-Pacific Risk and Resilience Portal

Average Annual Loss in South-East Asia[7]

ESCAP estimated the total average annual loss (AAL) in South-East Asia at around $150 billion under 2° C Climate Scenario. Among the South-East Asia, in absolute terms, Indonesia accounts for more than 34 per cent of the absolute AAL, followed by Thailand and Myanmar (Figure 2-8). However, as a percentage of GDP, Cambodia will be the most affected among South-East Asia, with AAL representing over 13 per cent of its GDP under 2° C Climate Scenario. Myanmar and Lao People's Democratic Republic follow as the second and third most impacted countries in terms of AAL as a percentage of GDP (Figure 2-9). Box 3 further highlights how climate change is impacting losses in the infrastructure and financial sectors.

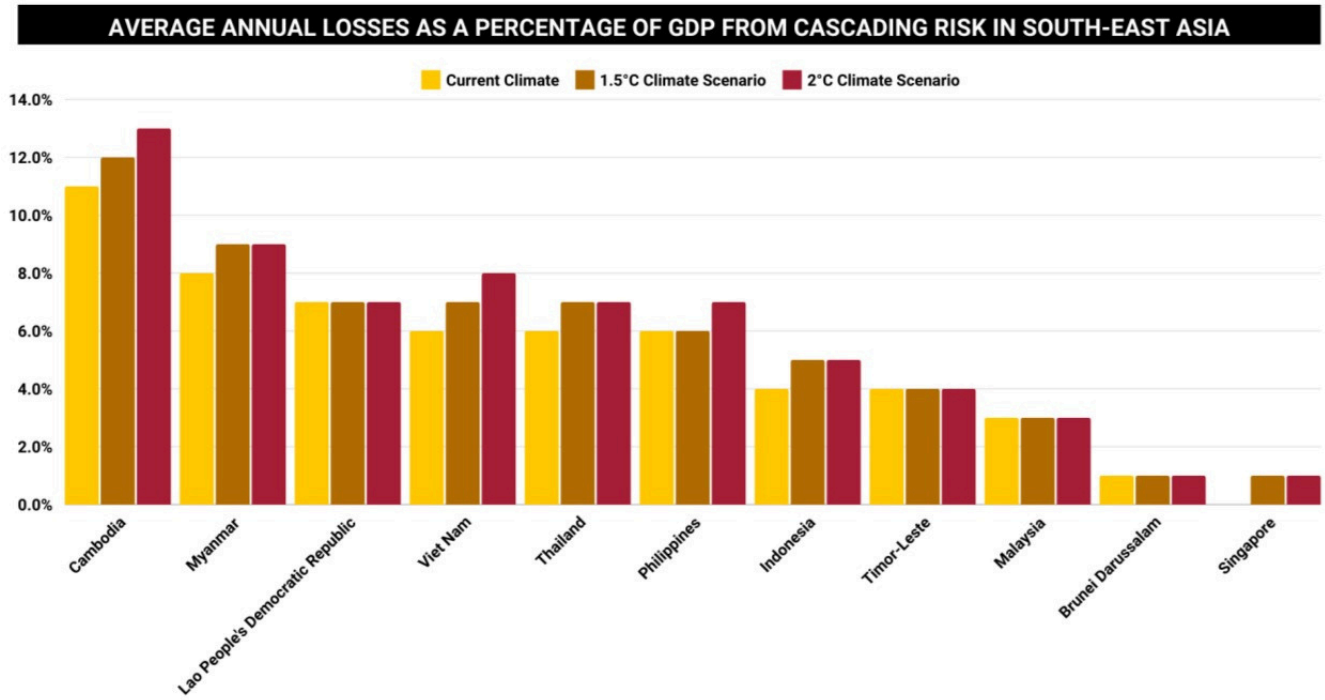
Figure 2-8: Absolute Average Annual Losses from Cascading Risk in South- East Asia, in billions of US dollars



Source: ESCAP

[7] Full report for details on the methodology used for calculating Average Annual Losses from Disasters available at the Global Assessment Report on Disaster Risk Reduction (2013).

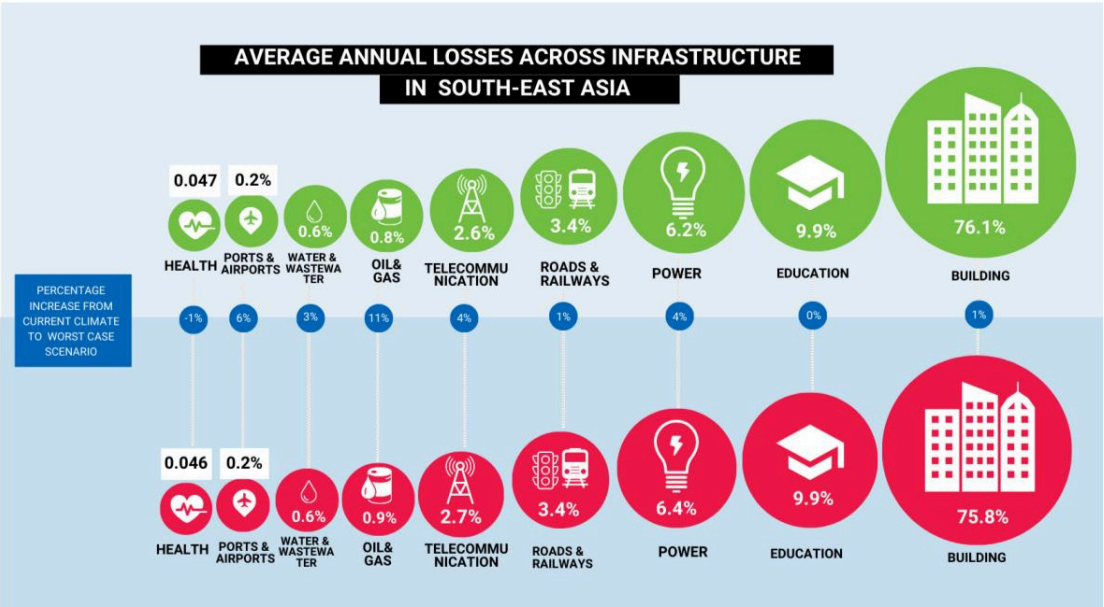
Figure 2-9: Average Annual Losses as a Percentage of GDP from Cascading Risk in South – East Asia



Box 3: Annual Average Losses in Infrastructure; Estimates From the Global Infrastructure Risk Model and Resilience Index;

The Global Infrastructure Risk Model and Resilience Index (GIRI) further indicates the AAL in in the infrastructure sectors (Figure 2-9) where the climate impacts on the building sector is projected to account for the highest infrastructure losses (75.8 per cent) with Indonesia, Thailand, and Viet Nam facing the highest losses. This is followed by the education sector (9.9 per cent) and power sector (6.2 per cent).

Figure 2-9: Annual Average Losses in Infrastructure Across South-East Asia



Source: Global Infrastructure Risk Model and Resilience Index (GIRI), Coalition for Disaster Resilient Infrastructure

Part 3 :
Targeting Transformative Adaptation in South-East Asia

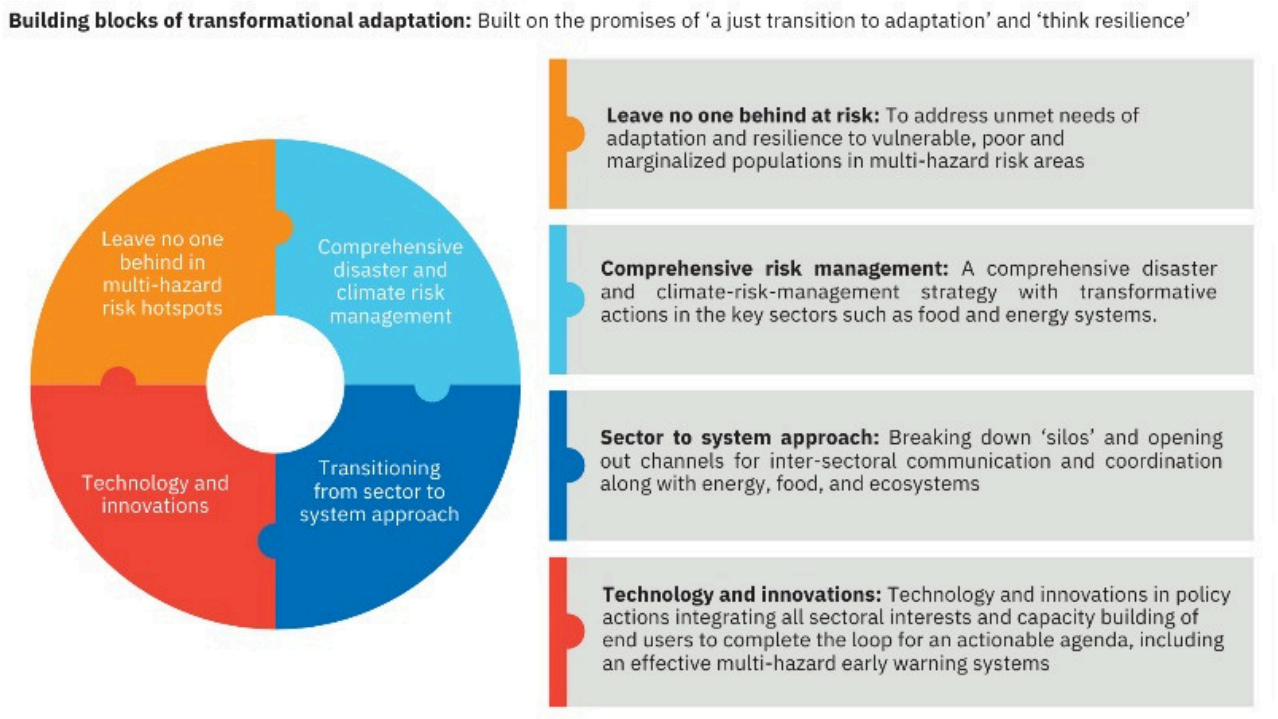
Key Highlights

- **Resilience through Transformative Adaptation:** Strengthening resilience by integrating risk-informed investments, policies, and actions to protect vulnerable communities and infrastructure.[1]
- **Financial Commitment:** Under a 2°C climate scenario, Cambodia and Myanmar have the highest share of adaptation cost as a per centage of GDP under 2°C climate scenario, these costs remain far lower than the annual economic losses expected from climate change.
- **Technology-Driven Strategies:** Effective adaptation hinges on science-based, innovative technologies, and data-driven risk analytics to enhance resilience.

Building Blocks of Transformative Adaptation

Climate change disproportionately affects the most vulnerable.[8] A just transition aims to protect these populations (Adaptation Without Borders, 2021). In the subregion, transformative adaptation can enhance resilience by encouraging risk-informed investments, policies, and actions that strengthen communities, infrastructure, services, and systems (Figure 3-1).

Figure 3-1: Four Pillars of Transformative Adaptation



Source: ESCAP

8 The "Seven principles for a just transition for mitigation", developed by Atteridge and Strambo in 2020, serves as a useful starting point of defining a just adaptation: 1) Actively encourage adaptation; 2) Avoid the creation of adaptation "losers" or redistributing climate risk; 3) Provide international support for vulnerable regions and communities; 4) Support people and communities who are negatively affected by adaptation measures; 5) Reduce climate risk and distribute the burdens of adaptation fairly, ensuring that risk is not transferred from the private to the public sector; 6) Address existing global inequalities, including the distribution of climate risk; and 7) Ensure that a planning process is both inclusive and transparent. See, A. Atteridge and C. Strambo, "Seven principles to realize a just transition to a low-carbon economy", SEI policy report, Stockholm Environment Institute, Stockholm, 2020. Available at https://www.sei.org/publications/seven-principles-to-realize-a-just-transition-to-a-low-carbon-economy/

Leave No One At Risk Behind: Transformative Adaptation Examples

Transformative adaptation must prioritize the most vulnerable, poor, and marginalized populations, particularly in areas prone to multiple hazards. Ensuring inclusivity and equity is crucial for building resilience. The National Adaptation Plans (NAP) emphasize transformative adaptation as a crucial strategy to effectively address the unique challenges posed by climate change in South-East Asia countries. Thailand, the Philippines, and Viet Nam are integrating transformative adaptation strategies into their NAPs to address climate vulnerabilities at scale.

Thailand's NAP emphasizes Ecosystem- based Adaptation (EbA) and community-based approaches, focusing on building resilience in agriculture, water resources, and health sectors through innovative water management systems and public health measures that anticipate climate change impacts (Thailand National Adaptation Plan, 2023). In the Philippines, transformative adaptation includes strategies to enhance coastal resilience, such as extensive mangrove reforestation to protect shorelines and communities from storm surges, alongside policies aimed at sustainable urban development that incorporate climate resilience into infrastructure (Philippines National Adaptation Plan, 2024). These examples underscore Southeast Asia's commitment to transformative adaptation, aiming to create lasting changes that not only mitigate immediate climate risks but also build systems capable of adapting to long-term environmental shifts.

Comprehensive Disaster and Climate Risk Management

Aligning with Global Frameworks: Integrating Comprehensive Disaster and Climate Risk Management (CRM) is essential to align with Target E of the Sendai Framework, which aims to enhance disaster risk reduction and climate adaptation efforts. National Adaptation Plans (NAPs), Nationally Determined Contributions (NDCs), and development strategies should be designed in accordance with CRM principles.

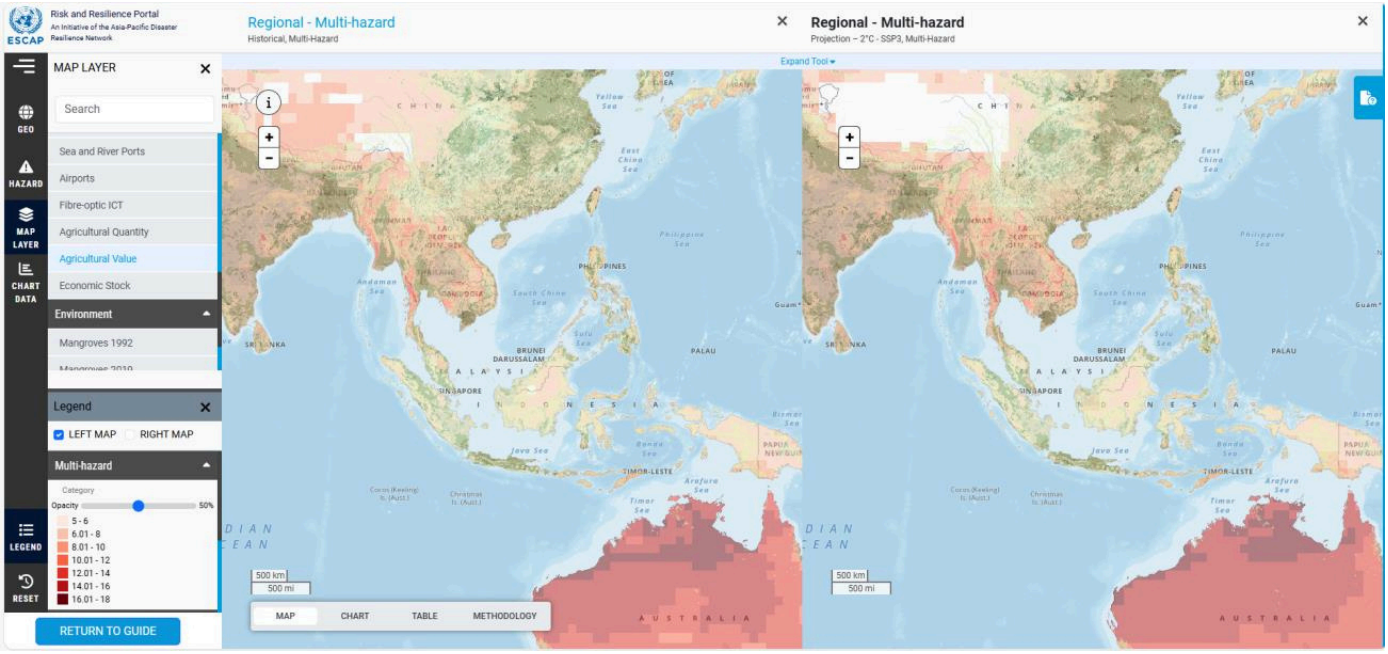
Responding to Shifting Risk Hotspots: Part 1 highlights the shifting risk hotspots in the South-East Asia under 1.5°C and 2°C global warming scenarios. These findings underscore the urgent need to incorporate climate projections into medium- and long- term adaptation plans to ensure responsiveness to evolving risks.

Transitioning from Sector to System

A. FOOD SYSTEM RESILIENCE

The increasing frequency of climate-related disasters, including cyclones, droughts, floods, and heatwaves, has severe consequences for agricultural production and food security. Under a 2°C warming scenario, countries such as Myanmar, Thailand, Viet Nam, the Philippines, Malaysia, and Indonesia face increased risks to agricultural production due to intensified climate hazards like flooding, droughts, and sea-level rise (Figure 3-2). Critical areas like Viet Nam's Mekong Delta and the coastal regions of the Philippines are particularly vulnerable, which could impact food security. This underscores the urgency for adaptation strategies to build agricultural resilience across the region.

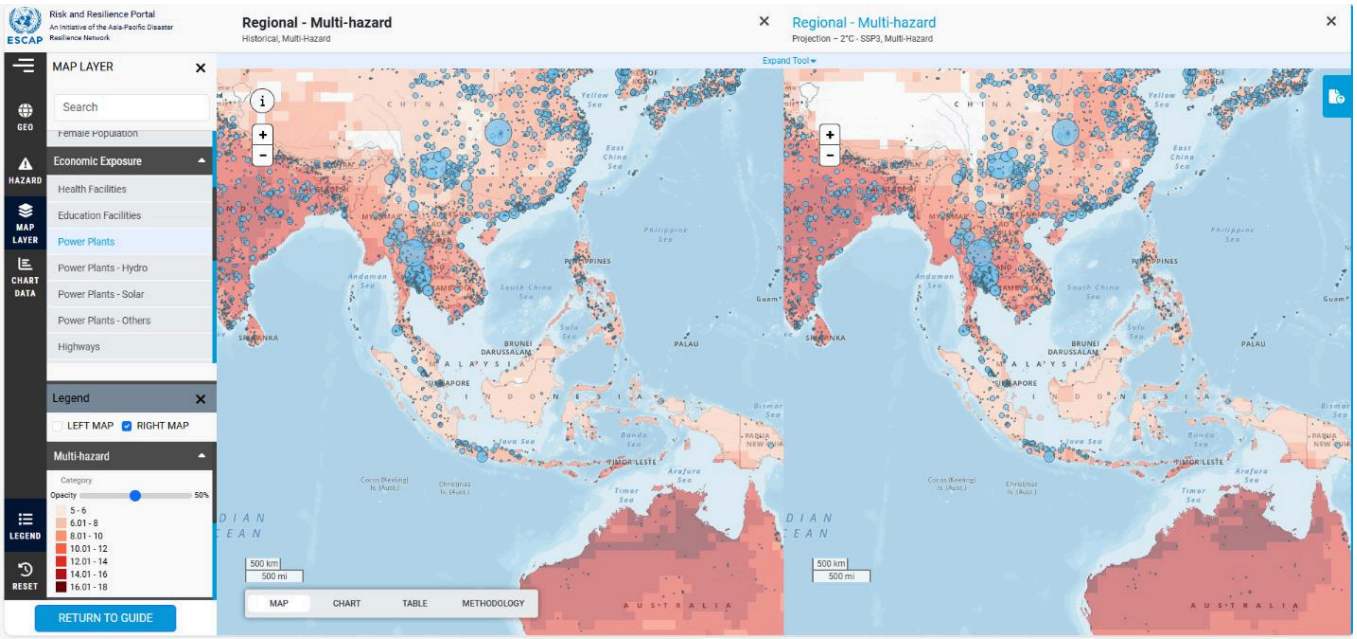
Figure 3-2: Multi-Hazard Risk Exposure to Agricultural Production under Current and 2°C degree Climate Scenarios



B. ENERGY SYSTEM RESILIENCE

Energy systems are critical to the region's infrastructure, supporting essential services and daily life. Figure 3-3 highlights Southeast Asian countries are at heightened risk from climate impacts, particularly under a 2°C warming scenario. High-density areas, such as Viet Nam, Thailand, and the Philippines, face increased vulnerability due to their proximity to coastal and riverine regions that are susceptible to flooding and extreme weather events. Coastal power plants in the Philippines and Viet Nam are particularly exposed to storm surges and sea-level rise, which could cause physical damage and operational disruptions. This underscores the urgency of implementing adaptation measures, such as strengthening flood defenses, elevating critical infrastructure, and relocating highly vulnerable plants, to ensure energy resilience in Southeast Asia's power sector under future climate scenarios.

Figure 3-3: Multi-Hazard Risk Exposure to Power Plants Capacity under Current and 2°C degree Climate Scenarios



Technology and Innovation for Adaptation

Effective adaptation strategies necessitate a combination of economic incentives, robust policies, and localized actions. Understanding risks and vulnerabilities is essential for formulating impactful policies. Adaptation technologies are critical for fair transitions, addressing risks, facilitating the uptake of green technologies and building resilience (Figure 3-4). These technologies can be categorized into three types: (i) science-based, (ii) innovative technologies, and (iii) data-driven risk analytics (Figure 3-5) (ESCAP,2024d).

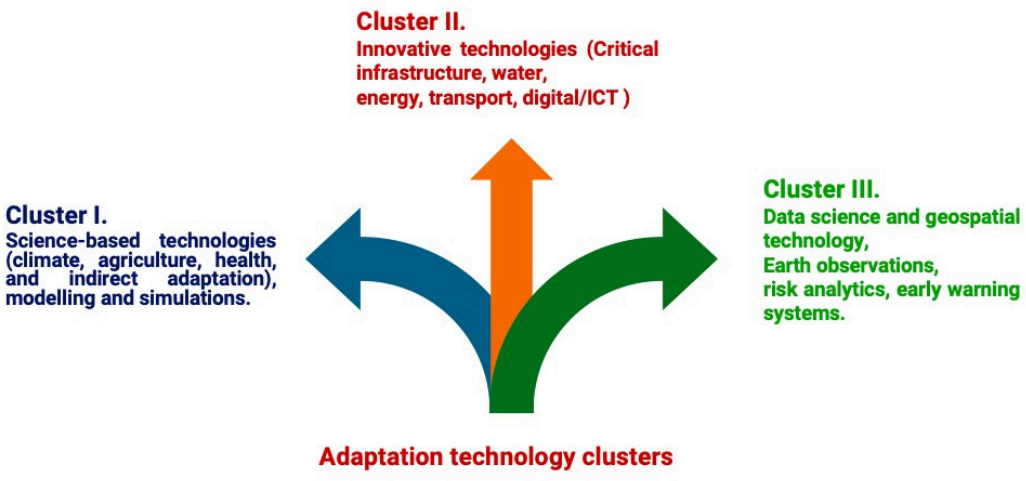
For example, in Viet Nam, cutting-edge climate adaptation measures are being implemented through Water Sensitive Urban Design (WSUD) initiatives. Supported by the Asian Development Bank, these nature-based solutions focus on managing the water cycle within urban landscapes, integrating features like rain gardens, green roofs, permeable pavements, and constructed wetlands to reduce flooding, improve water quality, and mitigate urban heat. (ADB, 2019).

In Thailand, Climate-Smart Agriculture (CSA) is being advanced through a range of initiatives that enhance the resilience of rural communities across key regions, including the north, northeast, central, and southern areas. These initiatives are part of the Climate Change Action Plan for Thai Agriculture (CCAPA), which runs from 2023 to 2027 and promotes adaptation to changing climate conditions (UNDP, 2022).

Figure 3-4: Adaptation Technologies led Pathways for 'A Just Transition' in Climate Adaptation

Source: ESCAP, 2024. Available at https://www.unescap.org/blog/scaling-climate-adaptation-technology-just-transition

Figure 3-5: Ecosystem of Adaptation Technology



Source: ESCAP, 2024. Available at https://www.unescap.org/blog/scaling-climate-adaptation-technology-just-transition

Read more on "Leveraging AI for Climate Adaptation" here

At ESCAP, initiatives like the Asia Pacific Risk and Resilience Portal are leveraging predictive AI to improve multi-hazard-multi-criteria risk modeling and impact based forecasting by using open-source datasets on climate, hazards, socioeconomic factors and the environment to pinpoint vulnerable locations in developing countries

URL: https://rrp.unescap.org

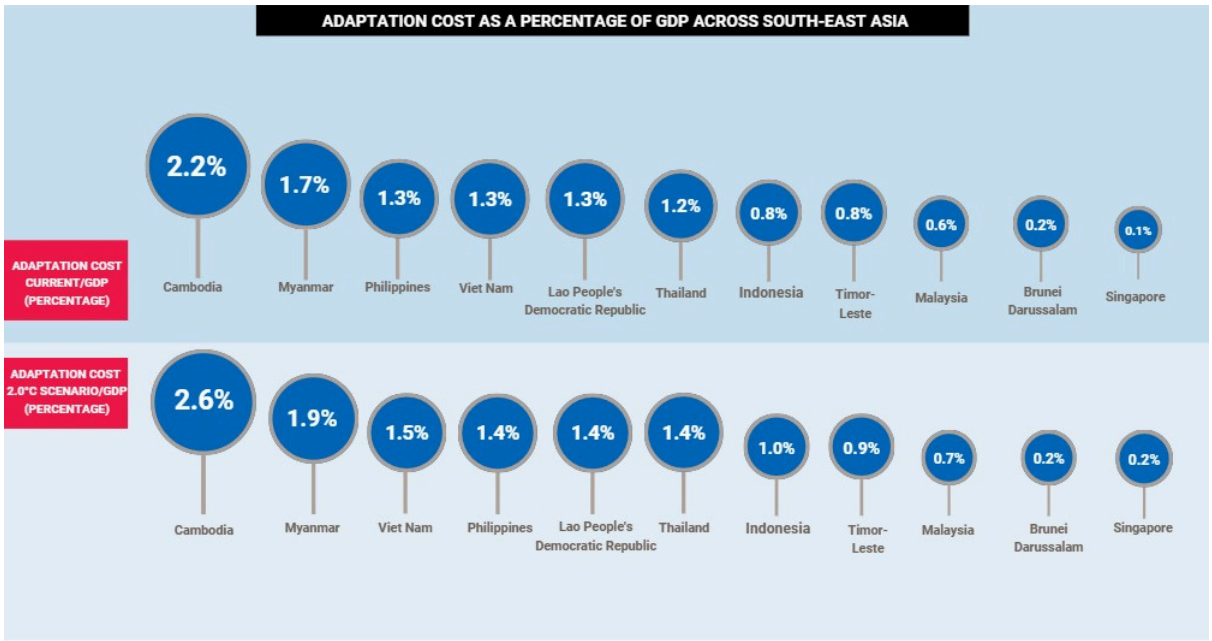
Financing Transformative Adaptation

Currently, Asia and the Pacific region invest less than 10 per cent of what is needed to build resilience to climate change. To effectively tackle climate change and build stronger, more resilient communities, it is crucial to close this funding gap (ESCAP, 2023d). according to UNEP the current adaptation finance gap is estimated to range from US$ 194 billion to US$366 billion annually. Concurrently, adaptation planning and implementation seem to be stagnating (UNEP, 2023).

While climate change is global, the adaptation required needs tailoring to the specific needs of local people, communities, and ecosystems. The creation of the Loss and Damage Fund at COP 27 is an important step in this direction, as it aims to provide financial support to countries that are especially vulnerable to the negative effects of climate change (UNEP, 2022).The United Nations Framework Convention on Climate Change (UNFCCC) stresses the importance of covering the adaptation costs of climate change. These costs include planning, preparing, and putting measures in place to either reduce harm or take advantage of new opportunities created by climate change (UNFCCC, 2022).

Figure 3-6 shows the adaptation cost as a percentage of GDP across South-East Asia, comparing the current adaptation costs with those under 2oC climate scenario. While it indicates that Cambodia and Myanmar have the highest share of adaptation cost as a per centage of GDP under 2oC climate scenario, adaptation costs are a fraction of the annual losses that will be incurred with climate change.

Figure 3-6: Adaptation Cost as a Percentage of GDP Across South-East Asia



Cutting-edge Climate Adaptation Measures in South-East Asia

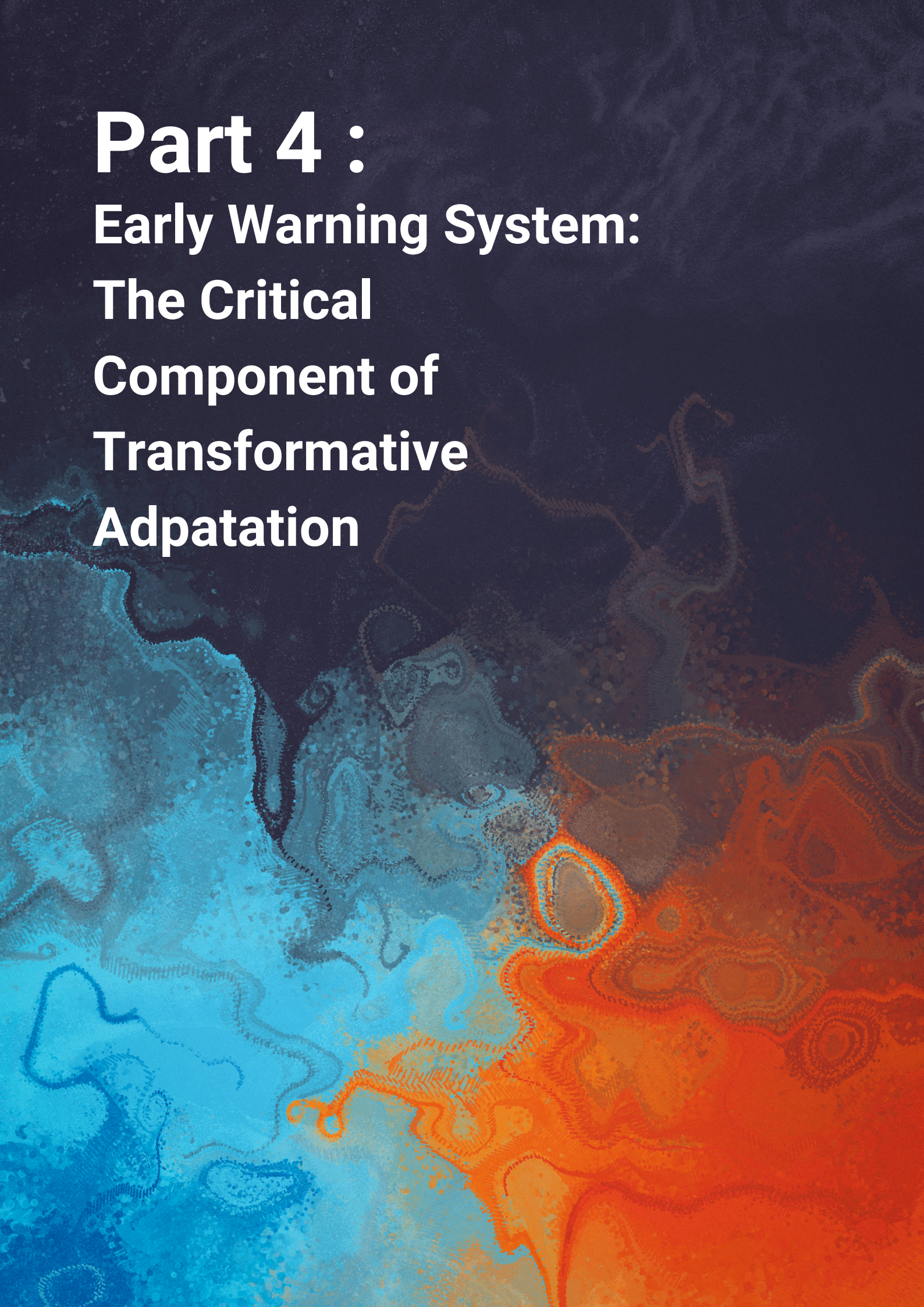
In Southeast Asia, a variety of innovative climate adaptation measures are being implemented, especially focused on disaster risk reduction. For instance, the Philippines has developed early warning systems for flooding and landslides, aimed at providing timely information to reduce casualties in vulnerable communities. For instance, the Department of Science and Technology's Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) provides advanced weather forecasting, early warning systems, and climate-smart agriculture advisories to help farmers and fishers manage climate-related risks. This collaboration also supports aquaculture with climate-specific guidance, aiding sectors vulnerable to typhoons and floods, which regularly impact the region's food security and economy (UNFCCC, n.d) (FAO, 2017).

Thailand has adopted innovative, community-driven approaches to adaptation through initiatives like the Flood Management Master Plan and community-based climate adaptation projects. Supported by the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP), these projects focus on building resilience in agriculture and water management. Thailand also utilizes the climate-smart agriculture (CSA) approach to support farming communities (Green Climate Fund, 2021). For instance, the *Bang Rakam model* in the Chao Phraya River Basin utilizes wetland flood retention areas, integrating natural floodplain management to reduce flooding during heavy rains and provide water storage for agricultural use during the dry season The country also promotes mangrove restoration as a natural barrier against coastal erosion and storm surges (Cowan, 2023).

Viet Nam’s adaptation efforts are heavily focused on water resource management and agricultural resilience, given the country’s vulnerability to flooding and rising sea levels. Supported by the UNDP and other international partners, Viet Nam has implemented large-scale mangrove reforestation and coastal protection projects, which protect coastal communities from storm surges and soil erosion (UNDP, 2019). Additionally, the National Climate Change Strategy emphasizes adaptive agricultural practices, such as flood-resilient rice varieties and water-efficient irrigation systems. Viet Nam has also partnered with the World Bank to develop integrated water management systems that address the dual challenges of salinization and water scarcity, especially in the Mekong Delta region (World Bank, 2019a).

Part 4 :

Early Warning System: The Critical Component of Transformative Adpatation



Key Highlights

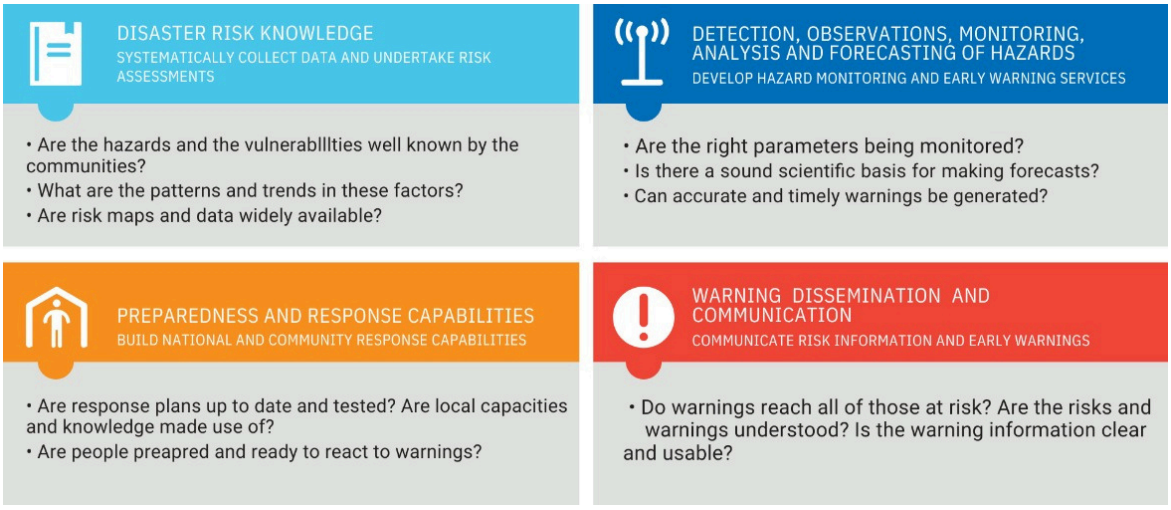
- **Importance of Multi-Hazard Early Warning Systems (MHEWS):** MHEWS play a vital role in reducing increasing disaster losses under climate change. A 24-hour advance warning can reduce damage by up to 30 percent.
- **Regional Disparities in Early Warning Systems (EWS) Coverage:** While the region overall is making progress, significant disparities exist among countries needing additional investments and further cooperation.
- **Economic Benefits of Early Warning Systems:** The potential economic savings from effective early warning systems in South-East Asia could be between $8.7 billion to $13.1 billion annually in avoided disaster losses.
- **Need for Enhanced Regional Cooperation**: To effectively strengthen early warning systems across borders, regional cooperation is essential

Pillars of Early Warning

Asia-Pacific's increasing disaster vulnerability demands the expansion of early warning systems (EWS), especially as climate change escalates risks. Multi-hazard EWS (MHEWS) are vital, offering critical warnings that enable timely responses, potentially reducing disaster losses by up to 30 per cent with just 24 hours' notice (Global Commission on Adaptation, 2019).

Countries with limited EWS coverage see disaster mortality rates eight times higher than those with comprehensive systems (UNDRR and WMO, 2022). The Early Warnings for All (EW4All) initiative, which targets global coverage by 2027, is pivotal for the region (WMO, 2022). The initiative with four pillars of early warning, (Figure 4-1) aims to foster unprecedented coordination among diverse organizations and funding mechanisms to achieve this shared goal.

Figure 4-1: Four Pillars of Early Warning Systems



Source: World Meteorological Organization, "Early Warnings For All initiative saled up into action on the ground", 21 March 2023. Available at: https://wmo.int/media/news/early-warnings-all-initiative-scaled-action-ground

Despite progress, global early warning coverage remains a challenge. Since 2015, coverage has doubled, but half of the world's population still lacks access to critical warning systems, particularly in vulnerable regions (UNDRR and WMO, 2022).

Box-4: Harnessing AI for Inclusive and Efficient Disaster Risk Management: Enhancing Early Warning for All Initiative

Extreme weather events, such as floods, storms, and droughts, are becoming more frequent and severe, highlighting the need for innovative methods to protect at-risk communities. Artificial Intelligence (AI) offers significant potential for improving early warning systems (UNU-EHS, 2024).

1.AI can help advance disaster risk knowledge

AI can help gather crucial exposure and vulnerability data, which improves the identification of affected settlements when a disaster strikes. AI in early warning systems enables data-scarce regions to benefit from people-centred alerts.

2. AI can speed up hazard detection and monitoring

As seen in the WMO's Severe Weather Information Center 3.0 (SWIC 3.0), AI is used in Early Warning Systems to advance predictive analytics and real-time data assessments.

3. AI can accelerate warning delivery and improve communication and dissemination

Delivering early warnings accurately to the right target is extremely important. AI can help translate alerts and send warning messages through various channels to ensure no one is left behind.

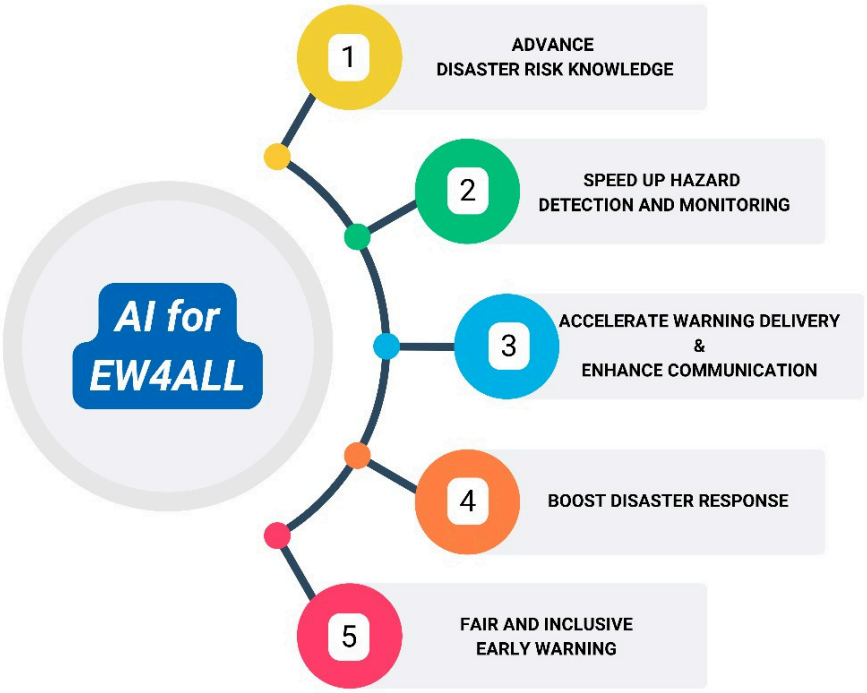
4. AI can boost disaster response through real-time simulations

AI helps prepare for actions when a disaster occurs. By simulating various situations in real time, AI can assist in planning and distributing resources effectively in collaboration with humanitarian organizations and governments.

5. Ethical use of AI is key to fair and inclusive early warning

It is evident that AI is contributing to the advancement of early warning systems, but there are also challenges. As AI relies on existing data, it can widen the development gap between data-rich and data-scarce regions. To overcome this challenge, frameworks for Early Warning Systems need to be developed from the perspective of each region. Guidelines for the ethical use of AI in Early Warning Systems are needed. Moreover, strategies for mitigation and adaptation that are feasible in each region should be planned.

Figure 4-2: AI For EW4ALL: Enhancing Early Warning Systems through Artificial Intelligence



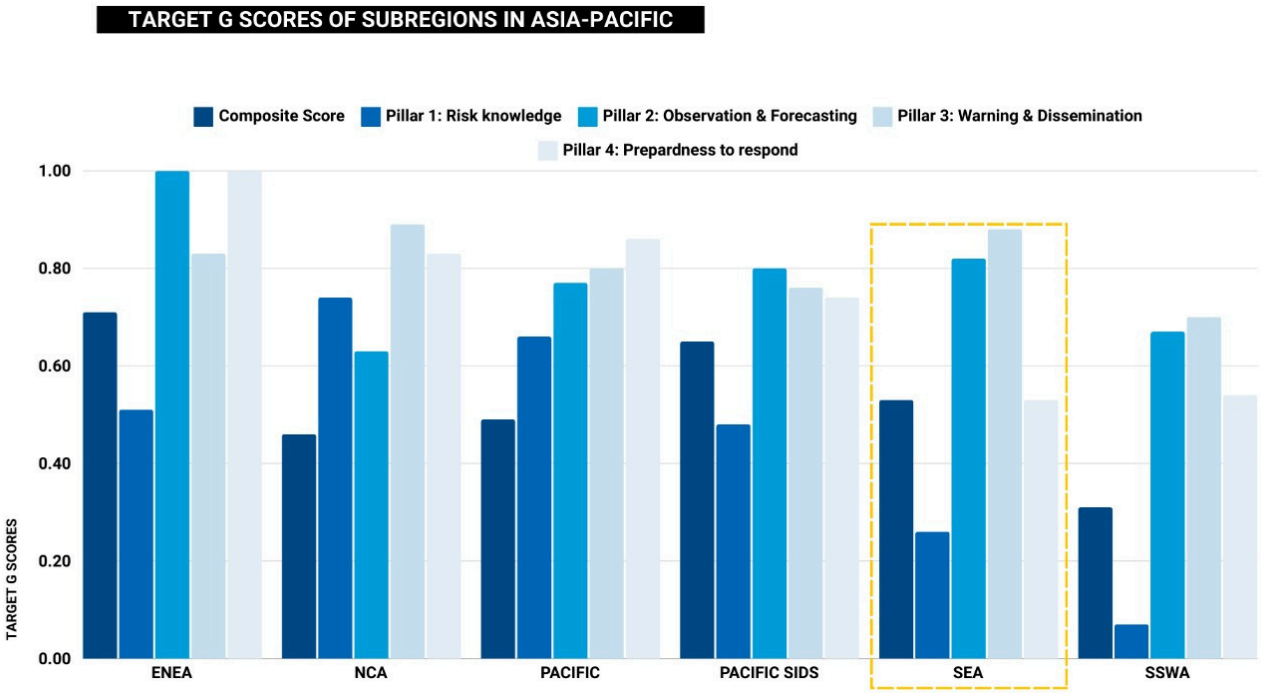
Source: United Nations University - Institute for Environment and Human Security, "5 Ways AI can strengthen Early Warning Systems," 2024. Available at https://unu.edu/ehs/series/5-ways-ai-can-strengthen-early-warning-systems

Assessment of Target G Scores of the Sendai Framework

The World Meteorological Organization (WMO) and the UN Office for Disaster Risk Reduction have released a report assessing the effectiveness of Multi-Hazard Early Warning Systems (WMO, 2022). This report, part of the Sendai Framework's Target G, serves as a key tool for understanding disaster risks and necessary improvements across the Asia-Pacific region.

Figure 4-3 shows the Target G comparison across the Asia and the Pacific subregions. The South-East Asia shows moderate to comprehensive performance across the four pillars of Multi-Hazard Early Warning Systems (MHEWS). The subregion demonstrates strength across Pillar 2 (Observation & Forecasting) and Pillar 3 (Warning & Dissemination). Preparedness in risk knowledge in Pillar 1 could benefit from further development. Whereas in Pillar 4 (Preparedness to respond) the subregions has moderate score. Five countries from South-East Asia have submitted their scores, highlighting a need for stronger regional cooperation to enhance data sharing, thereby improving collective disaster preparedness and response across the region.

Figure 4-3: Target G Scores of Subregions in Asia-Pacific



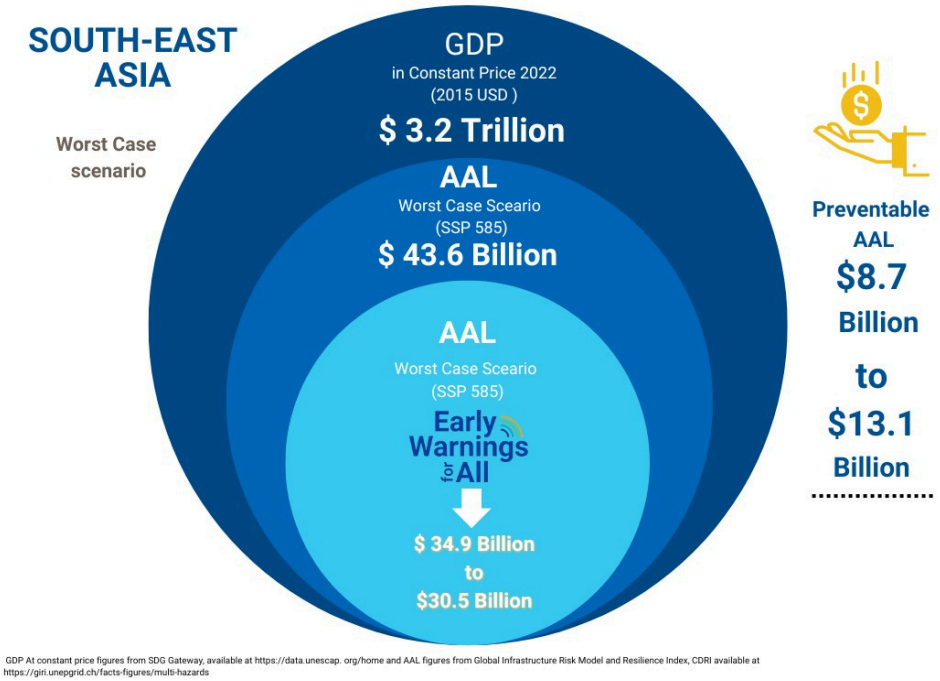
Source: United Nations Office for Disaster Risk Reduction (UNDRR)

Economic benefits of Early Warning Systems in South-East Asia

Implementing a 24-hour advance warning for severe weather events, such as storms or heatwaves, can reduce potential damage by up to 30 per cent. Specifically, flood warnings alone can prevent up to 32.58 per cent of related damages (Global Commission on Adaptation, 2019; Pappernberger et al., 2015).

In South-East Asia, with a total cumulative GDP of $3.2 trillion, annual average loss (AAL) under 2oC warming scenario is estimated at $43.6 billion. However, effective early warning systems could reduce these losses to between $34.9 billion and $30.5 billion, potentially saving $8.7 billion to $13.1 billion annually (Figure 4-4). Moreover, weather prediction services could further reduce disaster-related losses by 20 to 60 per cent (World Bank, 2019b), highlighting the critical role of early warning systems in safeguarding economic stability and mitigating the financial impacts of extreme weather events in the region.

Figure 4-4: Preventable Average Annual Loss with Early Warning



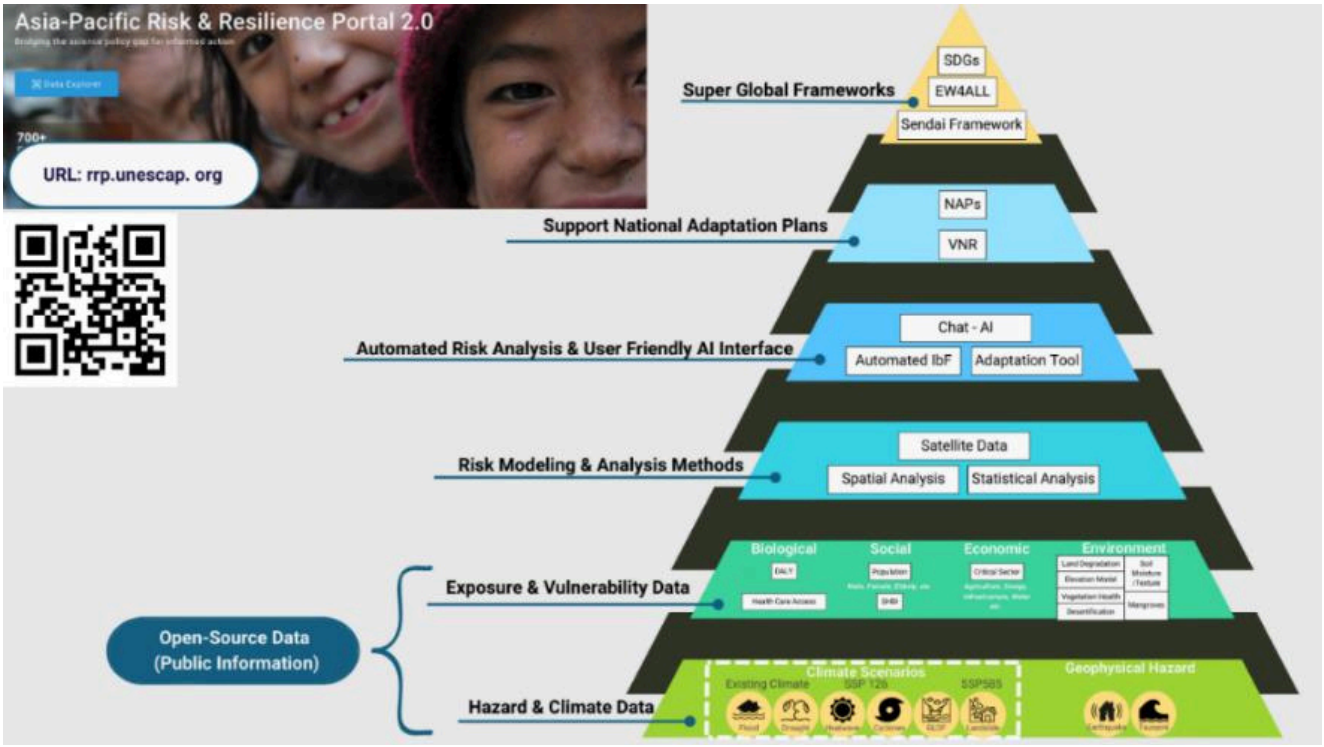
Enhancing Regional Cooperation for Pillars of Early Warning Systems

Regional cooperation is vital for the effectiveness of Early Warning Systems (EWS) in the Asia-Pacific region, where disasters often transcend national borders. Recognizing this, the Committee on Disaster Risk Reduction, during its 8th session, called for implementation of a Regional Early Warning Strategy (ESCAP, 2023a) aligned with the Early Warning for All Global Initiative (ESCAP, 2023a). This strategy aims to:

- Strengthen both national and transboundary capabilities in early warning systems.
- Improve the availability, accessibility, and effectiveness of multi-hazard early warning systems.
- Address gaps in disaster risk information and ensure seamless integration of information across borders.

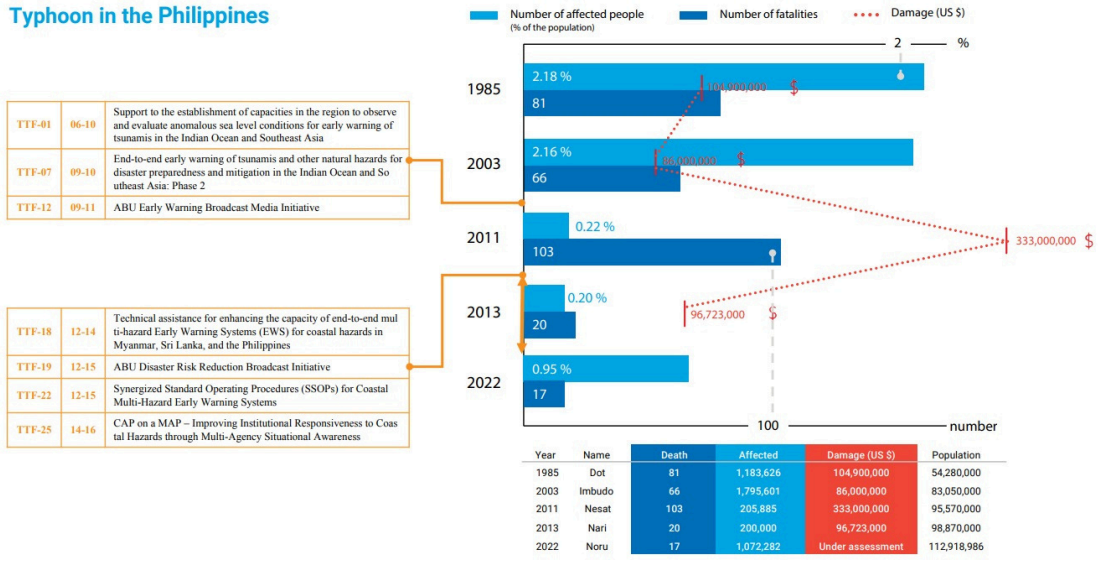
ESCAP's Risk and Resilience Portal supports Pillar 1 of Early Warning by providing critical data on risk hotspots for populations and infrastructure under different climate scenarios. It also estimates economic and non-economic losses and helps set adaptation priorities, enabling local governments to take informed actions (Figure 4-6). he Impact Based Forecasting tool, also available in the Portal, further supports Pillar 2 of the early warning by translating forecasted hazards, such as seasonal forecast data for precipitation and temperature, into likely impacts on user-input exposure and vulnerability data, such as vulnerable population and critical infrastructure. ESCAP is committed to advancing early warning systems by integrating new technologies and fostering innovation. As the IBF Tool continues to evolve, it will play a critical role in climate adaptation and sustainable development, reinforcing regional resilience against disasters.

Figure 4-5: ESCAP's Risk and Resilience Portal Data Architecture



Source: ESCAP

Box 5: Saving Lives Through Improving the Early Warning System (Philippines)



Source: EM-DAT, "The International Disaster Database." Available at https://www.emdat.be

The ESCAP Trust Fund for Tsunami, Disaster and Climate Preparedness ("Trust Fund") is a multi- doner trust fund that was created in 2005 after the 2004 Indian Ocean Tsunami resulted in a widespread tragic loss of life and livelihoods. The Trust Fund has provided global-to-regional-to-local financial support for the establishment of key initiatives that deliver cost-effective warning products and services in 19 countries, which have directly benefitted from support in building regional and national end-to-end warning systems for coastal hazards, including the Philippines.

Comparing impacts of Tropical Cyclone Noru (2022) to that of Tropical Cyclone Nari (2013) and Tropical Cyclone Nesat (2011), it is possible to see a significant reduction in the number of deaths from over 100 to 20 deaths in 2013, and to 17 in 2022. Between the three most recent big cyclones, four initiatives were supported by the Trust Fund, which included improving early warning systems by strengthening their operational capacity and modelling methods on early-stage detection of natural hazards, developing guidelines for communicating with persons with disabilities in emergencies, and improving capacity to issue warnings in the common alerting protocol (CAP) format.

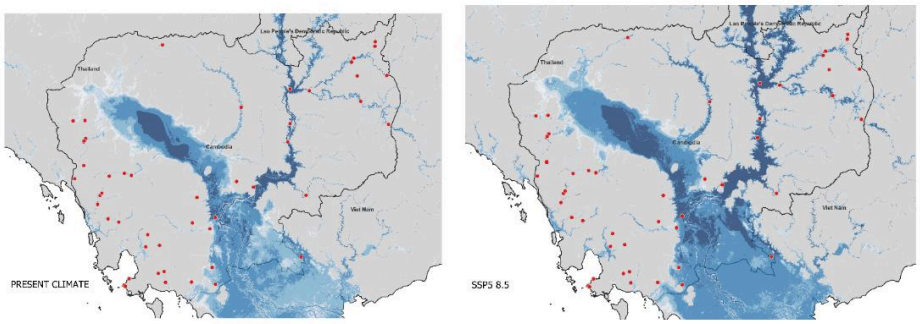
Source: ESCAP

Box 6: ESCAP's contribution to the Early Warnings for All initiative in Cambodia

As a contribution to the Early Warnings for All (EW4All) initiative in Cambodia, ESCAP has been working with the Ministry of Water Resources and Meteorology (MOWRAM) to implement activities related to Pillar 1: Disaster risk knowledge and Pillar 2: Detection, observations, monitoring, analysis and forecasting. The initial gap analysis has found that there is a need for improved climate projection analysis on hazards using the latest climate projection data with downscaling as well as the use of locally available exposure data to accurately estimate the impact of hazards in the country. The map in Figure 4-7, for example, illustrates the spatial distribution of power plants and their exposure to flooding under current and SSP5 climate scenario, highlighting areas of heightened flood risk.

Based on the gaps and needs identified, ESCAP has made available the climate projection data on flood, drought, temperature and precipitation at the resolution of 1 kilometer. Also, ESCAP plans to incorporate locally available data on agriculture to enrich the impact based forecasting capabilities of the country using seasonal forecasting data.

Figure 4-7: Estimated impact of flood on power plants under current and SSP5 8.5 climate scenarios (at 100m resolution)



Sources: ESCAP calculations based on Global Infrastructure Risk Model and Resilience Index (GIRI) CDRI (2023); and UN Geospatial.

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Source: ESCAP

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Way forward for South-East Asia

Seizing the Moment: Protecting Our Future

Over the last five decades, climate related risks have affected over 580 million people and caused $235 billion in economic damages in South- East Asia, which is close to 8 per cent of the disaster damage in the Asia Pacific region. To mitigate future risks and protect development gains, four strategic actions are critical:

1. **Greater investment in multi-hazard early warning systems (MHEWS):** Expanding MHEWS is essential for reducing disaster impacts, especially in the least developed countries and high-risk areas like the Myanmar, Lao People's Democratic Republic, Cambodia and Timor-Leste. MHEWS can cut disaster losses by up to 60%, with sector-specific coverage needed for critical areas like agriculture and energy. Investments in these systems provide a tenfold return, making them indispensable for the sub-region's resilience.
2. **Nature-based solutions (NbS) at the heart of mitigation and adaptation strategies:** Nature-based solutions—such as reforestation, wetland restoration, and sustainable land management—offer dual benefits of reducing disaster risks and restoring ecosystems. These approaches are crucial in South-East Asia's biodiversity hotspots, including Philippines and Indo-Myanmar, where climate impacts threaten ecosystems and species.
3. **Transformative adaptation for systematic change:** The sub-region must adopt transformative adaptation to address multi-hazard risks and climate-induced loss and damage. This requires integrating climate adaptation across sectors, enhancing social protection for vulnerable groups, and employing innovative technologies like AI, data science, and geospatial analysis for informed decision-making.
4. **Disaster risk financing needs to be dramatically increased:** Strengthening disaster risk financing will be key to protecting critical infrastructure, such as energy systems, from the escalating impacts of climate change. Scaling up innovative financing mechanisms—such as green bonds, insurance schemes, and climate funds—will help close financial gaps, ensuring resilience investments are more cost-effective than post-disaster recovery.

Now is the time to work together, to build on innovation and scientific breakthroughs to accelerate transformative adaptation across the region. A regional strategy which supports early warnings for all is needed to strengthen cooperation through the well-established United Nations mechanisms, and in partnership with subregional intergovernmental organizations. The United Nations 2030 Agenda for Sustainable Development can only be achieved if we ensure disaster resilience is never outpaced by disaster risk. Let us seize the moment and protect our future in Asia and the Pacific.

Extreme weather events and natural hazards have become more frequent and intense. Asia and the Pacific remains the most disaster-prone region in the world where 2 million people have lost their lives to disasters since 1970. The Asia-Pacific Disaster Report 2023 demonstrates that the existing disaster risk hotspots are forecasted to face more frequent and intense disasters and new risk hotspots are expected to emerge.

To protect people and the development gains, the Report urges for transformative adaptation measures, including increased investments in multi-hazard early warning systems, innovation and scientific breakthroughs capable of advancing early warnings and nature-based solutions. In the absence of immediate action, temperature rises of 1.5°C and 2°C will cause disaster risk to outpace resilience beyond the limits of feasible adaptation and imperil sustainable development. The Report makes the case for scaling up regional cooperation to ensure disaster resilience is never outpaced by disaster risk in Asia and the Pacific