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The Benefits of Early Warning Systems in Reducing Risks for the Population in Southeast Asian Countries

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Abstract

The impact of natural disasters continues to increase at a rapid pace, driven by the climate emergency. The Early Warning System (EWS) is a proven measure to reduce disaster risk and adapt to climate change. The World Meteorological Organization (WMO) emphasizes that early warning systems play an important role in reducing human hazards by providing timely information and rapid response to disasters from climate change. This article will analyze the Early Warning System (EWS) and its benefits in reducing human-centered hazards in Southeast Asian countries. In addition, the article will present statistics and charts illustrating the benefits of this system in some Southeast Asian countries.

Keywords: Early warning system, natural disaster risk management, risk reduction, natural disasters, human protection

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INTRODUCTION

Southeast Asia is one of the regions most affected by natural disasters due to its geographical location and climate change. Several countries in the region, including Vietnam, Thailand, the Philippines, Indonesia, and Malaysia, frequently face floods, earthquakes, hurricanes, and tsunamis. The implementation of early warning systems (EWS) has been playing an important role in minimizing damage to people and property, as well as improving disaster response capacity.

In the context of climate change and increasing natural disasters, the development and implementation of early warning systems (EWS) has become more urgent than ever. This system not only helps detect and forecast natural disaster risks but also provides early warning information to residents and authorities. Thereby, EWS enables early action to save and protect the lives, livelihoods and property of those at risk, in order to minimize the loss of life and property, and to improve disaster response capacity.

2. CONTENT

2.1. Global status of early warning systems

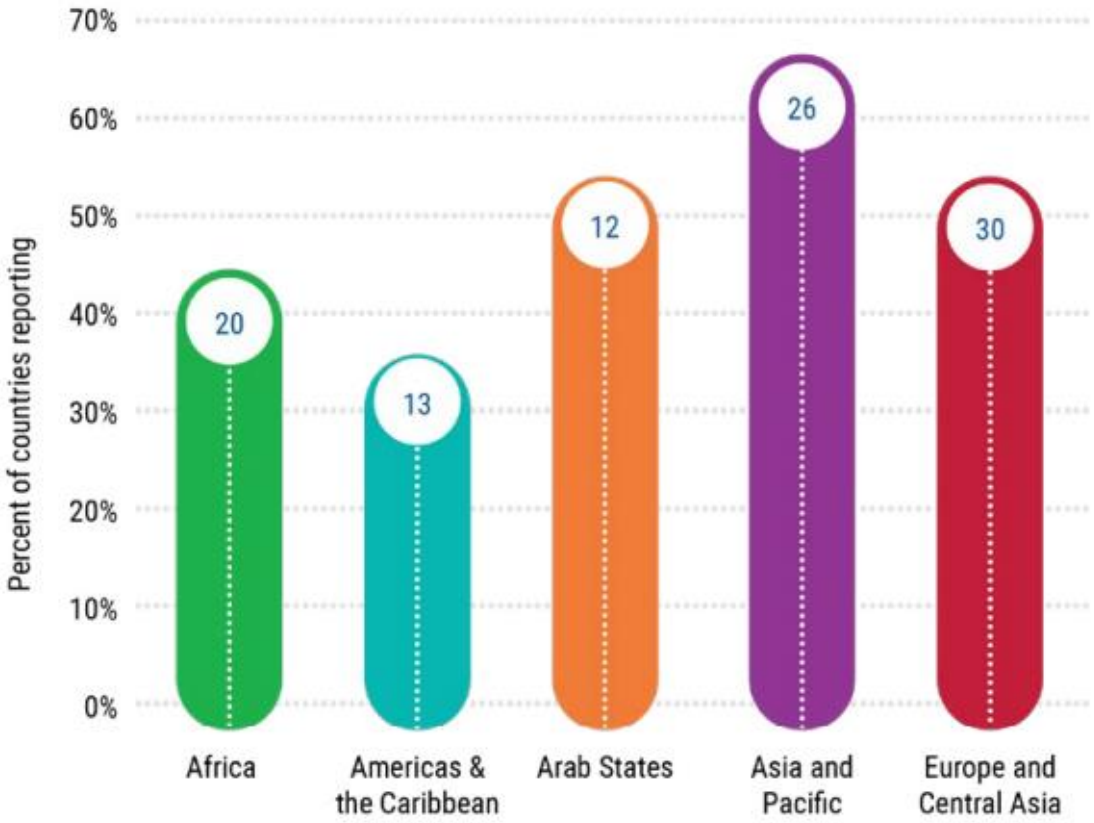
A central instrument in the development, monitoring and strengthening of people-centred multi-hazard early warning systems (MHEWS), the Sendai Framework monitor (SFM)21 aims to assess Member States' continuing progress on Target G: "Substantially increase the availability of and access to multi hazard early warning systems and disaster risk information and assessments to the people by 2030" through robust, timely, well-defined and internationally comparable official data.Target G has six indicators: G1–G6. Indicators G2–G5 map to the four pillars of the Early Warnings for All (EW4All) initiative and four

corresponding MHEWS key elements. Indicator G1 is a compound indicator that combines progress made in indicators G2–G5. Indicator G6 measures the effectiveness of MHEWS by considering the number of people pre-emptively evacuated compared with the exposed or at-risk populations. The definitions and mappings of these indicators can be found in table 4. To help countries better assess and monitor the effectiveness of their MHEWS, custom indicators have also been developed (Side feature: development of MHEWS custom indicators). In reporting on the global status of MHEWS, this report also includes an update on the progress that has been made since the launch of EW4All (in March 2022) and the publication of the associated Executive Action Plan in November 2022 (WMO, 2022a). To do this, it draws information and insights from the EW4All pillar leads23 and other implementing partners. For example, this report includes information from the WMO relating to a rapid assessment of country capacity that was recently undertaken in support of the initiative (section 3.5). Other sources have been used to add detail about the status and progress of the initiative, for example, the latest data from ITU regarding access to mobile networks and devices, and information from the Anticipation Hub regarding the existence and activation of anticipatory action frameworks.

2.1.1. Global MHEWS coverage:

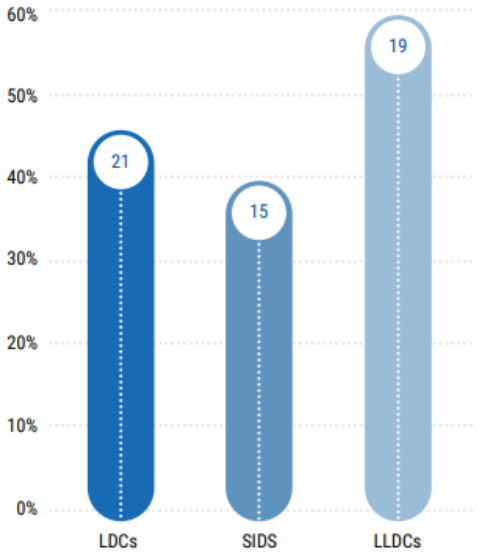
More than half of the world's countries have reported the existence of MHEWS. As at March 2023, 101 countries are reporting the existence of MHEWS24 – 52 per cent of all countries in the world (figure 2.1). Compared with the 2022 report, six additional countries have reported the existence of MHEWS, including a mix of countries that have recently started reporting on SFM, and those that have indicated the existence of MHEWS for the first time. These results confirm that the number of countries reporting the existence of MHEWS since 2015 has doubled, when only 50 countries reported having MHEWS. However, just under half of all countries are still not covered by MHEWS. In Africa, 20 ountries (or 45 per cent of countries in the region)25 reported having MHEWS by 2022, compared with only 9 countries (20 per cent) reporting having MHEWS in 2015. On the other hand, the Americas and the Caribbean region has only 13 countries (37 per cent) reporting having MHEWS in 2022, albeit an increase from 8 countries (23 per cent) in 2015. 24 Any score above zero is counted towards a positive report of MHEWS. 25 For SFM-related figures, the regional categories as per UNDRR regional offices have been followed. See www.undrr.org/about-undrr/where-we-work. Other regions fare better relatively, with 67 per cent of Asia and the Pacific countries, 55 per cent of Arab States, and 55 per cent of countries in the Europe and Central Asia region reporting the existence of MHEWS as at 2022. These three regions have all witnessed more than a doubling in the number of countries reporting since 2015. In terms of countries in special situations, 21 LDCs have reported having MHEWS (46 per cent of all LDCs), compared with 15 SIDS (39 per cent), and 19 LLDCs (59 per cent, figure 2.3). While the number of SIDS reporting the existence of MHEWS is still lagging behind the global average, this still represents a doubling or tripling of improvement since 2015, when only 11 LDCs, 5 SIDS and 9 LLDCs reported having MHEWS. The lower coverage of MHEWS in the Americas and the Caribbean region and the Africa region suggests that efforts to implement MHEWS need to be increased in these regions. While improved since 2022, coverage remains lower than 50 per cent in LDCs and SIDS, confirming that expediting support for MHEWS in these countries remains a high priority.

Figure 2.1 Regional differences in the status of MHEWS. The bars show the percentage and the numbersinside the bars show the number of reporting countries within that region



Nguồn: SFM

Figure 2.2 Status of MHEWS in LDCs, SIDS and LLDCs. The bars show the percentage and the numbers inside the bars show the number of reporting countries within each country group



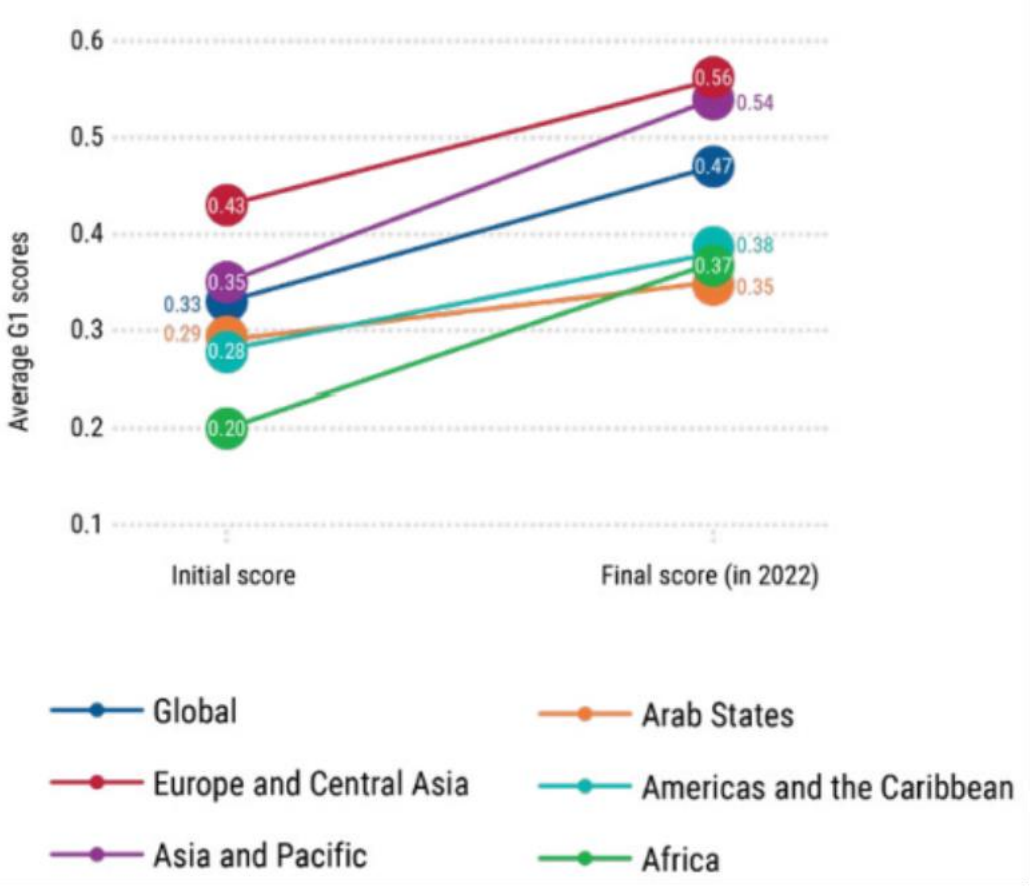
Nguồn: SFM

2.1.2. Progress in MHEWS coverage

An overall positive story of improving scores for G1 can be seen (figure 2.3). Globally, the average self-assessed G1 score has improved from 0.33, when first reported by countries, to 0.47 for the final reporting (as at the end of 2022). The improvement is visible across all regions, with the highest increase seen in Africa, where scores have increased from 0.20 at initial reporting to 0.37 in the latest reporting.

Yet even the latest score of the Africa region is only close to the baseline scores of the global average. The second largest improvement is seen in the Asia and Pacific region. When focusing on the countries in special situations, significant improvements can be seen between the first and last reported scores of the LDCs. The average baseline MHEWS score was 0.18 for LDCs, which has improved to 0.35, representing a 90 per cent improvement. A similar trend can also be observed for LLDCs, which witnessed an 81 per cent improvement of MHEWS scores, from 0.23 in baseline reporting to 0.41 in the latest reporting. However, these country groups are progressing from lower baselines. The improvement is vidently less marked in SIDS, where the initial score was comparatively higher at 0.36 (higher than the final score of LDCs) resulting in a 51 per cent improvement. Nonetheless, all country groups show greater provements than the global average (42 per cent), which may reflect MHEWS investments in these countries to date are making meaningful impacts to their MHEWS capacities.

Figure 2.3 Average initial and final G1 scores by UNDRR region



Nguồn: SFM

2.1.3. Status of coverage

The MHEWS pillars The comprehensiveness of MHEWS is determined by the four interconnected pillars, which serve as a value cycle and are underpinned by cross-cutting enablers of governance, coordination, advocacy, 26 The aggregated global score of all country reporting is considered as an average of country scores and reflects the coverage of MHEWS, measured through the four interrelated elements where zero indicates no MHEWS, a non-zero score under 0.25 indicates "limited" MHEWS coverage, 0.25-0.50 is "moderate", 0.50-0.75 is "substantial" and 0.75 and above is comprehensive". financing and monitoring. The average self-assessed scores are relatively similar for three of the four pillars and represent "substantial" progress towards comprehensive MHEWS (figure 2.6): 0.75–0.77 for MHEWS Pillars 2, 3 and 4. However, the score for Pillar 1 is significantly lower (0.56). There is considerable discrepancy between the availability of data and capacity of the countries among the four pillars, as the maps in figure

2.7 demonstrate. The highest percentage of countries reporting by pillar was for Pillar 3: Warning dissemination & mmunication (G3), where 89 countries, or 46 per cent of the world, reported a positive score, indicating that their citizens were covered by early warning information through local governments or through national dissemination mechanisms. The other three pillars show evidently lower reporting rates, with the lowest for Pillar 1: Risk knowledge, where only 22 per cent of the countries in the world have reported having accessible, understandable, usable and relevant disaster risk information and assessment available to people at the national and local levels.

2.2. The reality of the impact of climate change threatens many Southeast Asian countries

2.2.1. Human damage caused by disasters from climate change

Climate change is one of the biggest threats to the long-term stability of the region in Southeast Asia. In this context, natural disasters are tending to continue with increasing intensity.

The world is witnessing more frequent and more severe disasters, leading to significant casualties, human and livelihood losses, as well as wide-ranging economic damage, including critical infrastructure. According to the United Nations Office for Disaster Risk Reduction, preliminary statistics and assessments indicate: "Over the past decade, the impacts of disasters have spread to every corner of the globe. In July 2023, the world experienced record-breaking heatwaves, followed by the wettest month, as well as unprecedented warm ocean temperatures, sea heatwaves, and record low sea ice levels in the Antarctic. With the official declaration of El Nino in July 2023, the coming months and possibly years may bring new temperature records."[1]

The World Meteorological Organization (WMO) reports that between 1970 and 2023, the number of natural disasters has increased 5-fold globally, from 1970 to 2023, water-related disasters are the most common type of natural disaster, and tropical storms are the leading cause of human and economic losses globally. Overall, between 1970 and 2023, nearly 12,000 weather, climate, or water-related disasters have been recorded, resulting in more than 2 million deaths and $4.3 trillion in economic losses (according to the WMO report, 2023).

Recently, the Ministry of Meteorology and Water Resources of Cambodia (MWRM) forecasts that many localities of the country will have rain to very heavy rain and the possibility of flash floods in 8 provinces. Due to the influence of tropical depressions from India along with the rainy season in the Southwest, MWRM said that some provinces, namely Kampong Thom, Preah Vihear, Ratanakiri, Stung Treng, Kratie, Tboung Khmum, Kampong Cham and Oddar Meanchey, are at risk of flash floods due to heavy rains. MWRM has recommended that people increase their vigilance to avoid dangers and property damage.

Floods often occur in Cambodia. According to a report by the Cambodian Disaster Mitigation Agency, in 2023, flash floods have killed 11 people and displaced over 172,000 people. Meanwhile, heavy rainfall in many areas across Laos has caused flooding, damaged homes and infrastructure, and submerged hundreds of hectares of agricultural land in many provinces and the capital Vientiane. Accordingly, heavy rains and floods have affected the capital Vientiane, Sekong and Savannakhet provinces, as well as some districts of Champasak and Xayaboury provinces, among other places. In the capital Vientiane, flooding has disrupted traffic on a large scale.

Laos officials have conducted a survey of the areas most severely affected by flooding. There are 29 areas damaged by floods in 25 villages, with at least 839 families affected in Sikhottabong district of the capital Vientiane. Some places are still heavily flooded due to increased rainfall causing inundation in low-lying areas, water drainage systems being blocked by debris and mud, posing difficulties for water drainage.

According to the report, Thapangthong district in Savannakhet province has been experiencing continuous heavy rain for several days, leading to water accumulation causing flooding in many houses

[1] *WMO, "Preliminarydatashowshottestweekonrecord.UnprecedentedseasurfacetemperaturesandAntarcticseaiceloss", 10July2023.*

and farmland along the Mekong River and some streams. Preliminary data collected by the local government in Savannakhet shows that at least 9 villages in Thapangthong district are affected, with over 63 houses damaged by the floods. Nearly 200 hectares of agricultural land have been deeply flooded, and some infrastructure has been damaged.

In Thailand, after weakening into a tropical depression, Storm Mulan continued to bring heavy rain to Mae Sai district, Chiang Rai province in northern Thailand, causing the Sai River to exceed the alert level. The embankment of Sai River was breached in some sections, resulting in over 2,000 houses and 200 shops in 4 villages being submerged in floodwater.

Meanwhile, the town of Tachileik in Myanmar, across from Mae Sai district over the Sai River, is also flooded due to a breach in the embankment. Floodwaters in 11 provinces in northern and northeastern Thailand, mostly caused by the influence of a tropical depression, have mostly receded, except for the districts of Bo Kluea, Thung Chang, Muang, and Tha Wang Pha in the northernmost province of Nan. It is expected that the floodwaters will completely recede in the coming days. The head of the provincial disaster prevention and mitigation office stated that the flood situation is improving, but water levels in the Nan River, which flows through the province, remain high. Over 5,000 households in 11 northern, northeastern, and eastern provinces have been affected by the floods.

Facing that danger, the National Water Command Center of Thailand is advising residents living near the Mekong River in 7 northeastern provinces to be cautious of sudden flooding. According to the center, heavy rainfall caused by a tropical depression in the Luang Prabang area of Laos has significantly increased the water flow through the Xayaburi Hydropower Dam, resulting in rising water levels downstream of the Mekong River.

Recently, in Switzerland, the Vietnam Meteorological and Hydrological Administration (Ministry of Natural Resources and Environment) and the World Meteorological Organization (WMO) signed a Memorandum of Understanding on the cooperation for the Regional Centre of the System for Forecasting Floods in Southeast Asia (SeAFFGS).

Participating in the signing of the Memorandum of Understanding to concretize the tasks of assuming the role of a Regional Center of the Flood Warning Support System in Southeast Asia entrusted to the General Department of Meteorology and Hydrology. This is an important activity in mitigating natural disaster risks caused by flash floods and landslides for Vietnam in particular and Southeast Asia in general, contributing to the construction of a sustainable, peaceful, and prosperous socio-economic infrastructure in Southeast Asia. This activity acknowledges the role and position of Vietnam on the international stage in the field of meteorology and hydrology.

It is known that the Southeast Asia region has a tropical monsoon climate and is one of the areas heavily affected by hydrological disasters such as floods, flash floods, and landslides. However, the early warning system for flash floods and landslides in the area is not yet sufficient and appropriate.

2.2.2. Economic damage

According to official reports from governments, in 2023, the economic losses caused by natural disasters accounted for about 0.83% of the global GDP.[2]

The economic losses caused by natural disasters in Southeast Asian countries are significant. According to the United Nations Economic and Social Commission for Asia and the Pacific, the annual economic losses in this region due to natural disasters are estimated at around 86.5 billion USD. Natural disasters such as typhoons, floods, and earthquakes frequently occur in countries like the Philippines, Vietnam, Thailand, Malaysia, and Indonesia, resulting in significant human and property damages. For example, in the

[2] Target C of the Sendai Framework, shared with SDGs 1 and 11, aims to reduce direct economic lossin relation to global GDP

Philippines, Typhoon Rai in 2021 caused damages of up to 400 million USD, affecting over 1 million people and damaging more than 54,000 houses. In Vietnam, a comprehensive report on the economic losses from natural disasters in 2023 shows that the damages are severe, including losses to houses, infrastructure, and post-disaster recovery costs.

Below are some specific statistics for the year 2023:

able 1: Economic Losses

Country	Agricultural Losses (Billion USD)	Infrastructure (Million USD)	House	Total loss (Billion USD)
Vietnam	1,0	350	150	1,5
Indonesia	1,2	1,5	300	3,0
Philippines	1,3	700	300	2,3
Thailand	1,0	100	100	1,2
Malaysia	1,1	450	150	1,7

Source: ASEAN DRR Knowledge Hub

2.3. Overview of the benefits of early warning systems

An early warning system is established to analyze and identify risks and potential hazards related to weather and climate. All early warning systems aim to enable early actions to save and protect the lives, livelihoods, and assets of those at risk.

An early warning system is only effective when it can meet the needs and prompt actions. By identifying impending hazards as early as possible, the community can prepare in advance and strive to minimize disruptions and damages.

The dangers include weather phenomena such as tornadoes, hurricanes, floods, and tsunamis. They can also include heatwaves, wildfires, droughts, sand and dust storms, volcanic eruptions, earthquakes, and other non-weather-related disasters such as disease outbreaks, technological accidents, and destructive pest infestations. An early warning system is built on four pillars:

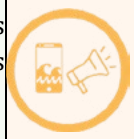
Hazard, vulnerability and exposure indices have been developed for each province by integrating the socioeconomic, geographic and climatic indicators specific to these territories. For hazard assessment, the Standardized Precipitation Index (SPI) and the Vegetation Health Index (VHI) were selected from the WMO Spaced-based Weather and Climate Extremes Monitoring programme. Based on the selected inputs, spatial maps of the area covering the 22 provinces have been produced, representing hazard, vulnerability and exposure, as well as an overall drought risk.

The system combines satellite products (SPI and VHI) with seasonal probabilistic forecasting outputs, such as the chance of rainfall in the below average tercile for the next three months. The selected inputs are combined to produce drought warnings categorized as either “DROUGHT WATCH”, “DROUGHT ALERT” or “DROUGHT CRITICAL”. Drought maps and provincial status summaries are generated and used by the Papua New Guinea National Weather Service (PNGNWS), to inform improved DRM in the country by advising decision makers, including risk managers and policymakers on which provinces are a priority for resource allocation.

PNGNWS incorporates the maps into the Drought Update Bulletin, the Seasonal Climate Outlook, the Early Action Rainfall Watch and other products. Since July 2022, drought risk assessments and early warnings have been disseminated to a range of key stakeholders from the agriculture, energy, health, water and other sectors.

PNGNWS uses drought risk maps and early warnings to inform the national disaster management office and provincial disaster committees about drought status and assist with decision-making. The three–five-month lead times enable proactive drought responses with the potential for prioritized allocation of funds at the provincial level, which is crucial for enabling the reduction of economic and human losses.

Table 2: Interconnections between the elements of MHEWS

	Riskknowledge	Observations&forecasting	Warningdissemination & communication	Preparednessto respond
Risk knowledge		Which hazards to monitor,whereand how	Communicationstrategiesto reachvulnerablepopulations Abilityofcommunications equipment to withstand extremeevents	Developmentofplans andprotocols Testing/optimising commschannels Publicawareness/ educationcampaigns
Observations&forecasting	Data and informationtoquantifyhazardsand exposure to risk		Warningsastriggersfor communication	Warningsprovidedetails on impact and response
Warning dissemination&communication	Strengths/weaknesses ofcommunication channels	Agreementson authoritativeand consistentwarning protocolsandlanguage		Plansinclude communication channelsandprotocols
eparednessto respond	Feedback and lessons learnt from events and exercisesusedtoupdate riskknowledge	Feedbackandlessons learnt from eventsandexercises usedto optimisemonitoring, forecastingandwarning	Feedback and lessons learnt from events and exercisesusedtooptimise communicationmechanisms/ channels	

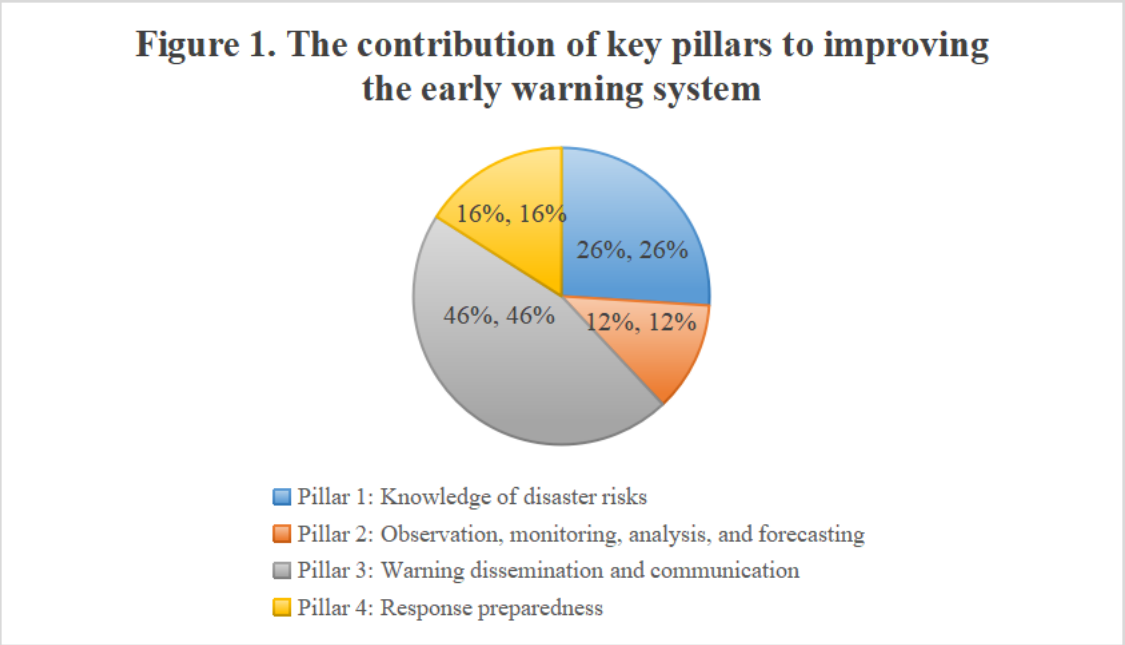
Source: United Nations Office for Disaster Risk Reduction, Sendai Framework, 2022)

All four pillars are equally important in minimizing the impact of extreme events. Each factor can be implemented individually or in conjunction with other factors requiring the involvement of at-risk individuals and organizations.

Early warning systems are crucial because climate change is causing more frequent, intense, and unpredictable climate-related hazards. An early warning issued within 24 hours of a hazard occurring can reduce its impact by 30%.

Ensuring early warning for everyone requires broad-based partnerships at the global, regional, and national levels to support the most vulnerable and at-risk individuals.

Figure 2.3: Contribution of the pillars to the MHEWS improvement



Source: UNESCO Disaster Risk Reduction - Early Warning Systems, 2024

2.3.1.Benefits of early warning systems in Southeast Asian countries

In an increasingly climate-impacted world, natural disasters, and security incidents, owning an effective early warning system is extremely important. This system not only helps minimize human and property damage but also brings many other benefits. Below are some key benefits of the early warning system. The early warning system brings many important benefits in Southeast Asian countries, including:

*Firstly, minimize human and property damage:*an early warning system's greatest and most visible benefit is its ability to minimize human and property damage by allowing citizens and businesses to protect their assets in advance. When timely warnings about natural phenomena such as storms, floods, earthquakes, or tsunamis are issued, people and authorities can rapidly implement preventive measures, such as evacuation and property protection, safeguarding lives and valuables. This early preparation gives people ample time to relocate and secure essential belongings, reducing the risks to both personal safety and property. Moreover, natural disasters can lead to severe economic losses, impacting livelihoods and community stability. An effective early warning system enables businesses, industries, and farmers to make informed adjustments to operations, like relocating equipment, securing harvests, or adjusting production schedules, thereby significantly reducing economic disruptions. This proactive approach not only saves costs but also promotes resilience, allowing communities to recover faster after a disaster, ultimately fostering long-term economic stability and sustainability.

*Secondly,*enhancing emergency response capabilities: Early warning systems provide valuable time for relevant agencies to prepare and implement emergency response measures. Timely information gives

authorities the necessary time to plan, organize personnel and equipment, and deploy effective rescue strategies. This allows rescue and relief efforts to operate quickly and precisely, minimizing chaos and increasing response efficiency. A comprehensive early warning system not only provides information on the expected time and location of disasters but also includes detailed instructions for evacuation, identifies safe zones, and outlines resource allocation plans. This enables agencies to coordinate closely, avoiding resource overlaps or shortages during relief operations. Such preparedness not only increases the protection of lives and property but also helps maintain social order, minimizing psychological impact and panic among the public. Furthermore, well-prepared response plans foster stronger relationships between agencies and communities, building trust and enhancing disaster awareness. This proactive approach supports sustainable community development by improving resilience and readiness to face future disasters.

Thirdly, enhancing community awareness: Early warning systems do more than just provide timely information; they play a vital role in educating the community about potential threats, preventative measures, and preparing for disaster risks. By disseminating information about natural hazards and safety protocols, early warning systems empower individuals with essential knowledge, allowing them to understand the nature of potential dangers and the best ways to mitigate them. This awareness-building fosters a proactive mindset, enabling people to take personal safety measures, such as preparing emergency kits, identifying safe evacuation routes, and staying updated through official channels.

Moreover, early warning systems encourage community-wide involvement in disaster preparedness. Educational programs, workshops, and drills organized around early warning systems help individuals practice response skills, ensuring that they know how to act promptly and decisively. This collaborative approach strengthens the social fabric, as people learn not only to protect themselves but also to assist their neighbors and contribute to broader community safety. Through increased awareness and knowledge sharing, communities become more resilient, reducing fear and uncertainty during disasters. Ultimately, this focus on education and awareness promotes a culture of preparedness, enhancing the community's ability to face and recover from natural disasters effectively.

Fourthly, supporting resource management: Early warning systems play an essential role in effective resource management, particularly in agriculture, where timely information can greatly influence productivity and sustainability. By providing real-time data on weather patterns, climate forecasts, and potential outbreaks of pests and diseases, early warning systems enable farmers to make informed decisions about resource allocation. For instance, accurate forecasts allow farmers to plan irrigation schedules, fertilization, and harvesting times with precision, thereby conserving water and optimizing the use of fertilizers and pesticides.

This proactive approach not only helps increase yields and product quality but also reduces the negative impact of extreme weather events or unexpected climate fluctuations. When farmers are informed about upcoming droughts, heavy rains, or sudden temperature changes, they can take measures to protect crops, prevent soil erosion, or even delay planting to avoid potential losses. In areas prone to pests or diseases, early warnings enable farmers to implement targeted treatments, reducing crop damage and minimizing financial losses.

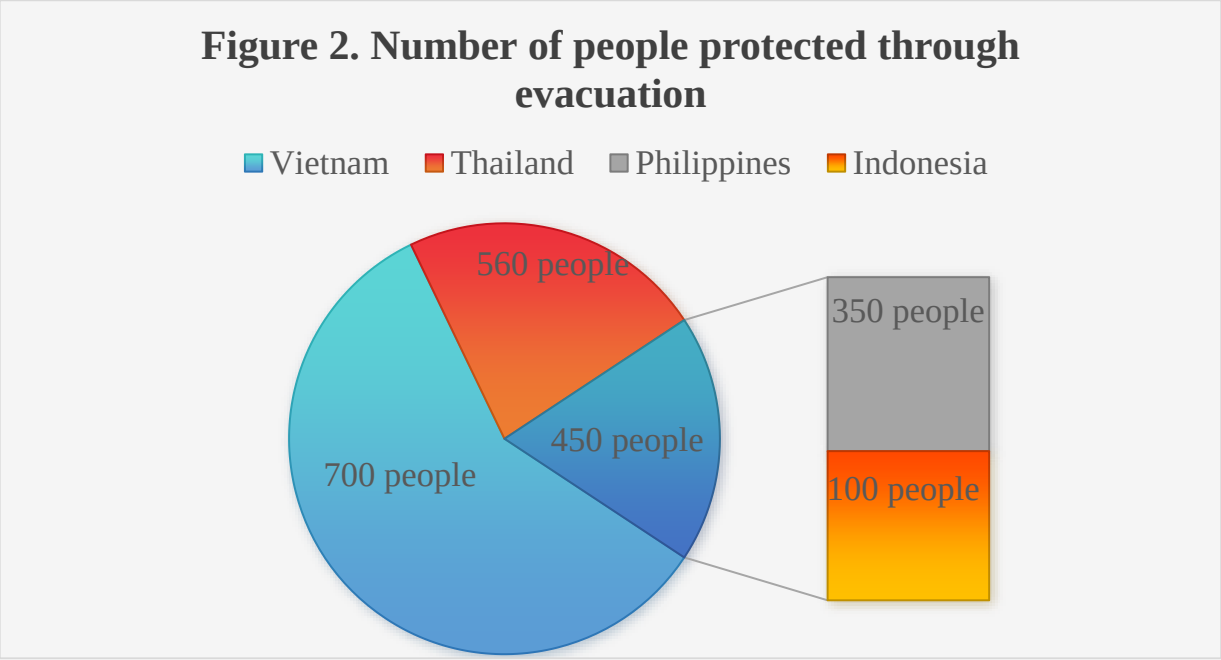
Moreover, early warning systems contribute to sustainable agricultural practices. By reducing the overuse of water, chemicals, and other inputs, they help minimize environmental impact, such as soil degradation and water contamination. This sustainable approach benefits both the ecosystem and the long-term viability of agricultural production. Additionally, with more efficient resource management, farmers can reduce operational costs, leading to increased profitability and improved resilience to market fluctuations. Ultimately, early warning systems empower the agricultural sector to adapt to environmental challenges, fostering economic stability and food security within communities.

The Fifth Environmental Protection Measure:

By forecasting and providing early warnings of environmental phenomena such as wildfires, floods, or pollution, early warning systems play a crucial role in safeguarding the living environment and conserving natural resources. Preventative and timely response measures can effectively prevent or minimize negative impacts on the environment. For example, by alerting communities to impending wildfires, these systems enable authorities to implement controlled burns or establish firebreaks, thereby reducing the risk of uncontrolled wildfires spreading.

The early warning system is an important and necessary tool in protecting human beings, property, and the environment from disasters. Investing in and developing modern, effective early warning systems is not only a preventative measure but also the best preparation to deal with future challenges and risks. These systems foster a culture of awareness and readiness, encouraging communities to engage in sustainable practices that protect both their surroundings and their livelihoods.

Additionally, by enhancing community resilience through education and preparedness training, early warning systems empower individuals to respond proactively to environmental threats. This holistic approach ensures a healthier ecosystem, ultimately benefiting both current and future generations.



Source: Visit ASEAN DRR Knowledge Hub

2.3.2. Statistics and illustrations with charts

To illustrate the benefits of early warning systems in Southeast Asian countries, below are some statistics and charts:

- *Minimizing Human Losses:*

According to a report by the Asian Disaster Preparedness Center (ADPC), countries with well-implemented early warning systems (EWS) can reduce human casualties by up to 30% compared to those lacking such systems. Early warning systems play a critical role in reducing loss of life by providing timely alerts and information, allowing people and communities to evacuate or take necessary precautions before disaster strikes.

In the case of Vietnam, Thailand, and the Philippines—three Southeast Asian countries frequently impacted by typhoons, floods, and earthquakes—the implementation of EWS has had a marked impact on reducing fatalities. For instance, before EWS implementation, communities in these countries often faced devastating human losses due to the sudden onset of disasters and limited time for evacuation. However,

with the advancement of EWS technologies, these countries can now better monitor, predict, and communicate potential disaster risks to local populations.

Additionally, the existence of EWS has brought about more community involvement in disaster preparedness programs, where local populations are educated on how to respond effectively to warnings. These systems empower individuals with the knowledge and confidence to act promptly, creating a more resilient society that can withstand and recover more quickly from natural disasters. In the long term, EWS reduces not only the immediate human toll but also the emotional and psychological impact on communities, fostering a safer and more secure environment for all.

The chart below illustrates the significant difference in the number of fatalities before and after the adoption of EWS in Vietnam, Thailand, and the Philippines. This data showcases the life-saving benefits that EWS provides by increasing the preparedness of communities and enhancing response coordination among agencies.

Table 3: Minimizing Human Losses

Year	**Country**	**Damage (person) without EWS**	**Damage (person) with EWS**
2010	Vietnam	1,000	700
2010	Thailand	800	560
2010	Philippines	1,200	840
2015	Vietnam	1,200	840
2015	Thailand	1,000	700
2015	Philippines	1,400	900
2020	Vietnam	1,500	1050
2020	Thailand	1,200	840
2020	Philippines	1,800	1,260

Source:ASEAN DRR Knowledge Hub

- Minimize Property Damage:

Early warning systems (EWS) play a vital role in mitigating property damage caused by natural disasters. By providing timely alerts about impending threats such as storms, floods, and earthquakes, these systems enable individuals, businesses, and governments to take precautionary measures to protect their assets. The implementation of EWS has been particularly impactful in countries like Indonesia, Malaysia, and Vietnam, where natural disasters can lead to catastrophic economic losses.

Prior to the establishment of EWS, property damage from natural disasters often reached staggering amounts, leading to prolonged recovery times and significant economic hardship for affected communities. For instance, buildings and infrastructure were frequently left vulnerable, resulting in not just physical destruction but also the loss of valuable resources and investments. However, with the introduction of EWS, there has been a noticeable reduction in property damage as communities can now prepare in advance for potential disasters.

The statistic below illustrates the stark contrast in property damage before and after the implementation of EWS in Indonesia, Malaysia, and Vietnam. These figures highlight how timely warnings can facilitate the implementation of effective response strategies, such as reinforcing structures, securing valuable equipment, and even evacuating properties in high-risk areas.

Moreover, businesses can adapt their operations based on early warnings, allowing them to minimize disruptions and protect their investments. For example, agricultural producers can harvest crops in advance of approaching storms, while retailers can secure inventory to prevent losses. This proactive approach not only safeguards physical assets but also fosters economic resilience in the face of natural disasters, ensuring communities can bounce back more quickly after events occur. Ultimately, the reduction in property damage contributes to long-term sustainability and stability in these regions, allowing them to thrive even amid the challenges posed by natural phenomena.

Table 4: Minimizing property damage

Year	Country	Damage (million USD) without EWS	Damage (million USD) with EWS
2010	Indonesia	300 triệu USD	210 triệu USD
2010	Malaysia	200 triệu USD	140 triệu USD
2010	Vietnam	500 triệu USD	350 triệu USD
2015	Indonesia	400 triệu USD	280 triệu USD
2015	Malaysia	250 triệu USD	175 triệu USD
2015	Vietnam	600 triệu USD	420 triệu USD
2020	Indonesia	500 triệu USD	350 triệu USD
2020	Malaysia	300 triệu USD	210 triệu USD
2020	Vietnam	750 triệu USD	252 triệu USD

Source:ASEAN DRR Knowledge Hub

- Minimize Property Damage:

Allowing citizens and businesses to protect their assets before being affected by disasters is a critical function of early warning systems (EWS). These systems provide timely alerts about impending threats, enabling proactive measures that can significantly reduce property damage. For instance, in the case of severe weather warnings, individuals can secure their homes by reinforcing windows, moving valuable items to safer locations, and preparing emergency supplies.

Businesses, particularly those in vulnerable sectors such as agriculture, manufacturing, and retail, benefit immensely from early warnings. With advanced notice of approaching storms or floods, they can implement measures such as relocating equipment, safeguarding inventory, and adjusting operational hours to minimize disruptions. This preparedness not only protects physical assets but also ensures business continuity, which is crucial for economic stability.

Moreover, early warning systems contribute to better community planning and infrastructure resilience. Local governments can utilize the data provided by EWS to reinforce public buildings, improve drainage systems, and develop emergency response plans tailored to specific risks. Such strategic investments can greatly reduce the extent of property damage during disasters, leading to quicker recovery times and less economic impact.

Additionally, educating the community about the importance of preparedness can foster a culture of resilience. Workshops and training sessions can empower citizens with the knowledge and skills needed to respond effectively to disaster warnings, further enhancing their ability to protect their properties. In essence, minimizing property damage through early warning systems is not just about immediate response; it's about fostering long-term resilience and sustainability in communities. By taking proactive measures, societies can significantly mitigate the economic and emotional toll that disasters can impose.

3. CONCLUSION

Early Warning Systems (EWS) have proven to be essential in protecting people from the dangers of natural disasters and crises in Southeast Asian countries, a region frequently impacted by extreme natural phenomena such as typhoons, floods, earthquakes, and tsunamis. Southeast Asia, with its high population density and economies heavily reliant on agriculture and fisheries, is particularly vulnerable to natural disasters. The introduction of EWS has helped mitigate risks, protect lives and livelihoods, and promote sustainable development in the region.EWS function as a critical link between scientific monitoring and community preparedness. By integrating advanced meteorological and geological technologies, these systems are capable of detecting early signs of impending disasters. For instance, satellite imagery and remote sensing can identify weather patterns that may lead to typhoons or heavy rainfall, while seismic sensors can provide real-time data on earthquakes. This timely information is disseminated through various channels, including mobile alerts, radio broadcasts, and community meetings, ensuring that people are well-informed and can take necessary precautions.

Moreover, EWS foster community resilience by empowering local populations with knowledge and tools to respond to disasters effectively. Educational campaigns, simulations, and training workshops enable communities to develop response plans and practice evacuation procedures. This preparedness not only enhances safety but also reduces panic and chaos during actual emergencies, enabling quicker recovery.Furthermore, the economic benefits of investing in EWS are substantial. By minimizing damage and loss, these systems can save governments significant costs associated with disaster response and recovery. They also help maintain the stability of local economies, particularly in sectors like agriculture and fisheries, which are often the hardest hit by natural disasters.

In conclusion, investing in Early Warning Systems is not just an investment in technology; it is a commitment to the safety, resilience, and sustainability of societies across Southeast Asia. As climate change continues to exacerbate the frequency and intensity of natural disasters, enhancing these systems

will be vital for protecting vulnerable communities and promoting sustainable development in the region. By fostering a culture of preparedness, Southeast Asia can better withstand the challenges posed by nature and ensure a more secure future for its people.

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