The Water is RISING

A Report to Commemorate the 20th Anniversary of the 2004 Indian Ocean Tsunami

OCTOBER 2025

Table of contents

ACKNOWLEDGEMENTS

This report was led by the United Nations Development Programme (UNDP) Bangkok Regional Hub (BRH), in close collaboration with the ASEAN Secretariat, as part of a regional project titled, “Partnerships for Strengthening School Preparedness for Tsunamis in the Asia-Pacific region (Tsunami Project) Phase IV”, in partnership with the Government of Japan.

We wish to express our sincere gratitude to the community members who generously shared their testimonies: Azzahra Layusa, Cut Sa’adah, Laila, Pipit and Yusnia from Indonesia, and Namfon Mianthong and Maitree Jongkraijuk from Thailand. We are also grateful to Irina Rafliana, Badan Riset dan Inovasi Nasional (BRIN), Indonesia, and the German Institute of Development and Sustainability, who shared her testimony directly with UNDP, and to Chaiwat Chuntirapong (former Director-General of the Department of Disaster Prevention and Mitigation (DDPM)), Thailand, and Ridwan Jamil, Regional Disaster Management Agency (BPBD), Aceh Besar, Indonesia, whose testimonies were shared through ASEAN.

We are grateful to the following government officials and experts for their contributions: Tavida Kamolvej, Bangkok Metropolitan Administration (BMA); Lt. Gen. (Rtd.) Amnat Barlee, Thai Red Cross Society; Bhichit Rattakul, Thai Network for Disaster Resilience; Muhammad Dirhamsyah and Teuku Alvisyahrin, Syiah Kuala University, Indonesia; Tadashi Nakasu, Chulalongkorn University; and Yuichi Ono, International Research Institute of Disaster Science (IRIDeS), Tohoku University.

We are grateful to regional experts Mona Chhabra Anand; Thitiphon Sinsupan (Hope); Sisira Madurapperuma, Asian Disaster Preparedness Center (ADPC); A.R. Subbiah and John Mark Marcos, Regional Integrated Multi-Hazard Early Warning System (RIMES); Temily Isabella Baker, ESCAP; and Anita Cadonau, UNDRR, for sharing their perspectives. We also wish to thank Dipo Djungdjungan Summa and Riyanti Djalante at the ASEAN Secretariat for their support throughout this journey.

We wish to acknowledge with gratitude the contributions of those who assisted in collecting testimonies: Taratan Intarachatorn, UNDP Thailand Country Office; Andrys Erawan, UNDP BRH; and Firhandika Ade Santury and Afridah Ikrimah, Chulalongkorn University.

This report was prepared by Sooin Bang, Disaster Risk Reduction and Recovery for Building Resilience team, UNDP BRH, with support from Sanny Ramos Jegillos (former team leader). We wish to thank Panvipa Lekluanngarm for administrative support, Viktoria Wittlinger de Lima for the layout and design, and Andy Quan for editing and proofreading.

INTRODUCTION

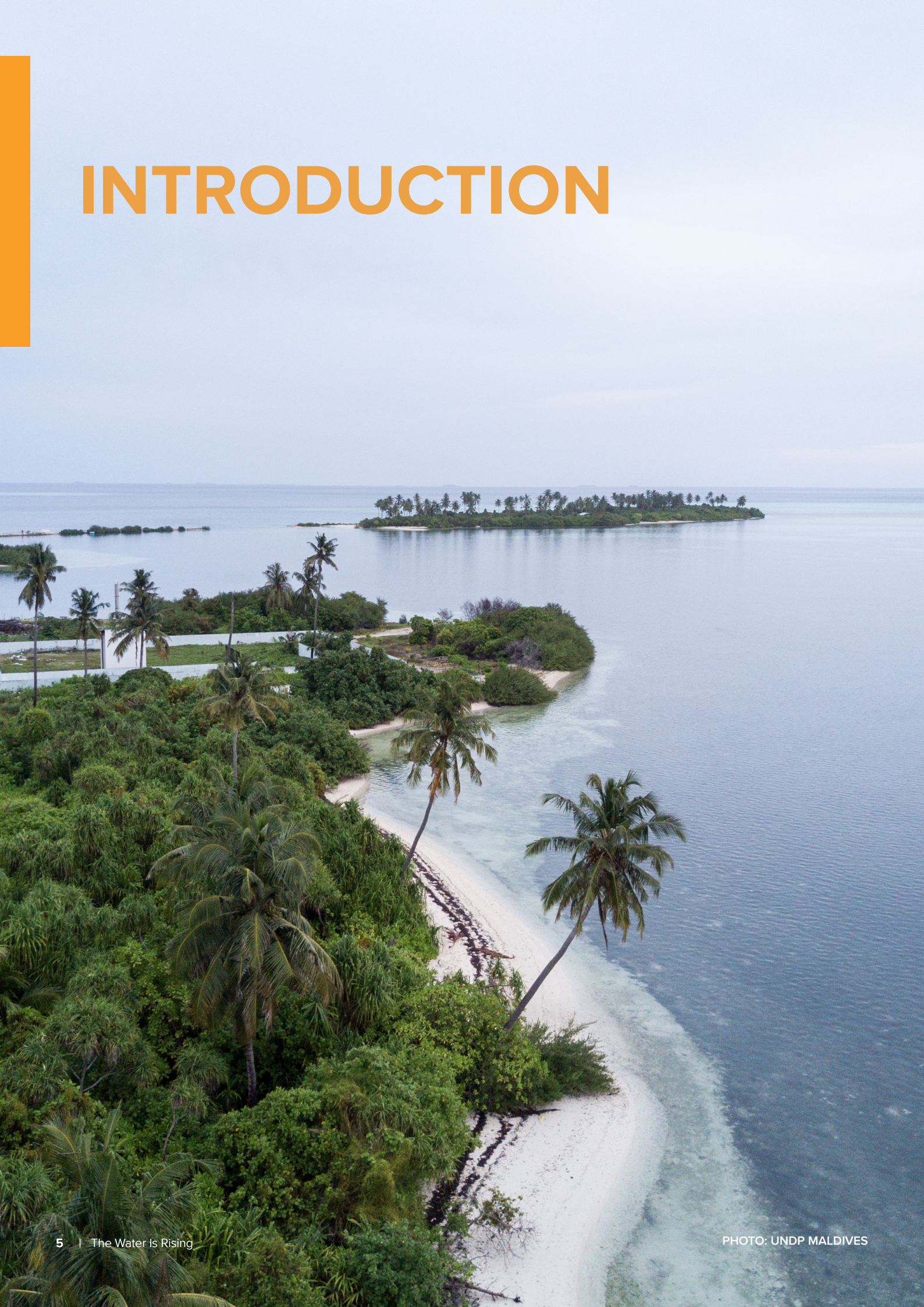


PHOTO: UNDP MALDIVES

The 2004 Indian Ocean Tsunami (the 'IOT' or '2004 tsunami') remains one of the most devastating disasters in modern history, never to be forgotten in the countries it affected. It has shaped the trajectory of disaster management and humanitarian response in the Association of Southeast Asian Nations (ASEAN) region and beyond.

HOW THE DISASTER UNFOLDED

Triggered by a powerful undersea earthquake, the tsunami radiated immense energy across the Indian Ocean, causing widespread destruction and loss of life. On the morning of 26 December 2004, at 7:58 am local time in Aceh, a massive earthquake occurred off the west coast of Northern Sumatra, Indonesia. The earthquake was caused by a rupture along a 1,200-kilometre section of the subduction zone where the Indian Plate was thrust beneath the overriding Burma Plate. This sudden movement displaced enormous volumes of water, generating tsunamis that travelled at speeds exceeding 500 kilometres per hour. The violent displacement not only caused the seafloor to rise but also pushed water columns upward, setting off a series of waves that spread in all directions. This underwater seismic activity exemplifies the sheer unpredictability of tectonic processes, which can unleash catastrophic consequences without warning.

While the tsunami waves appeared small in deep ocean waters, they grew to devastating heights of over 20 metres in some areas. The waves struck coastal communities in Indonesia, Sri Lanka, India, Thailand and the Maldives within hours. Some areas, such as Aceh Province in Indonesia, were struck within 20 minutes, leaving no time for evacuation. The tsunamis also travelled as far as the eastern coast of Africa, impacting countries including Kenya, Somalia and Tanzania. The event underscored the immense vulnerability of coastal regions to seismic events and highlighted gaps in regional and international tsunami preparedness. The lack of early warning systems, combined with the geographic scale of the disaster, made it particularly challenging to mount timely responses, resulting in one of the deadliest disasters in recorded history.

THE HUMAN AND ECONOMIC COSTS

The IOT claimed over 227,000 lives across 14 countries, with Indonesia, Sri Lanka, India, and Thailand bearing the brunt of the fatalities. Indonesia alone accounted for over 167,000 deaths, with entire communities in Aceh obliterated by walls of mud and debris. Over 40 countries reported the loss of their citizens, underscoring the disaster's global reach. The loss of life was compounded by the destruction of homes, infrastructure, and public services, leaving millions grappling with homelessness, injury, and trauma. For many families, the tsunami not only took loved ones but also erased their means of livelihood, particularly in agriculture, fishing, and tourism-dependent sectors.

The tsunami displaced approximately 1.7 million people and caused extensive physical and economic damage, estimated at USD 9.9 billion. Indonesia's Aceh Province experienced damage equivalent to nearly its entire GDP, while the Maldives suffered losses equivalent to 83.6 percent of its national GDP. The destruction of housing, infrastructure and livelihoods compounded pre-existing vulnerabilities, particularly in communities already grappling with poverty, environmental degradation and weak governance. The disaster highlighted stark inequalities in affected countries' differing capacities to recover and rebuild, further amplifying the need for coordinated international support. The long-term ramifications extended far beyond the immediate destruction, as rebuilding efforts stretched over years and underscored the importance of proactive disaster resilience in policy planning and implementation.

The disaster's impacts were not evenly distributed. Vulnerable groups, such as the elderly, faced heightened risks due to physical frailty and limited access to timely assistance. Marginalized communities were more likely to reside in poorly constructed housing or live in high-risk areas near the coast, further exposing them to the tsunami's devastation. The tsunami magnified existing social inequalities, with those already disadvantaged bearing the brunt of the disaster.

The socio-economic effects were pronounced in the ASEAN region, where many affected communities were already contending with structural inequalities. Chronic poverty, displacement and weak disaster management capacities compounded the disaster's impacts, underscoring the need for inclusive and sustainable recovery efforts. The unequal distribution of resources during the initial recovery process sometimes exacerbated tensions and left marginalized groups further behind. This disparity emphasized the importance of adopting people-centred approaches to disaster recovery that address the specific vulnerabilities of different population groups and promote equitable access to resources and opportunities.

The psychological toll on affected populations was immense. Survivors grappled with trauma, loss and the daunting task of rebuilding their lives. The destruction of community structures and social networks compounded feelings of isolation and helplessness, particularly among displaced populations. Long-term mental health support was often inadequate, leaving many to cope with unresolved grief and anxiety. These psychological impacts underscored the importance of integrating mental health services into disaster response and recovery plans, ensuring that survivors receive comprehensive support to rebuild not only their homes but also their lives and well-being.

THE GLOBAL RESPONSE

The unprecedented scale of devastation and the involvement of international tourists captured global attention, prompting an extraordinary humanitarian response. Media coverage of the disaster was extensive, with dramatic images and stories flooding news outlets worldwide. This coverage galvanized governments,

organizations and individuals to contribute to relief and recovery efforts, resulting in over USD 13.5 billion in pledged international aid. High-profile media campaigns helped bring attention to the plight of affected communities, generating both monetary contributions and in-kind support.

Despite the generosity, the response faced significant challenges. The influx of international aid and agencies created coordination issues and, in some cases, undermined local and national capacities. The disaster also highlighted the inefficiencies of existing humanitarian systems, particularly in aligning aid distribution with actual needs. Sometimes local actors felt sidelined as international agencies took the lead in recovery efforts, leading to tensions and missed opportunities for capacity building. These challenges underscored the importance of integrating local knowledge and leadership into disaster response frameworks, ensuring that external aid complements rather than displaces local initiatives.

LESSONS FROM THE DISASTER

Lesson 1: *Create an enabling environment for people-centred early warning systems*

The absence of a tsunami early warning system in the Indian Ocean was one of the most glaring gaps exposed by the disaster. Unlike the Pacific Ocean, which had an established tsunami warning system, the Indian Ocean lacked the infrastructure and mechanisms to detect and communicate tsunami threats. This absence resulted in significant delays in issuing warnings and evacuations, particularly in countries where waves struck hours after the earthquake, including Sri Lanka, India and Thailand. Countries also faced challenges in hazard monitoring, risk assessments, warning dissemination and response capabilities, which left vulnerable communities unprotected. The catastrophe underscored the importance of people-centred early warning systems (EWS) that integrate scientific monitoring with community empowerment. Significant progress has been made since the disaster, including the development of regional mechanisms such as the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS) and the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES). The disaster highlighted the need for robust collaboration and integration of disaster risk reduction into long-term development planning to create resilient coastal communities.

Lesson 2: *Establish the foundations for Resilient Recovery*

The 2004 Indian Ocean Tsunami demonstrated the critical importance of preparing for disaster recovery before disasters occur. Resilient Recovery requires robust institutions, inclusive planning, effective coordination, and proactive financial mechanisms to address vulnerabilities and build long-term resilience. Lessons learned from the tsunami emphasized the need to move beyond simply rebuilding what was lost, focusing instead on 'Building Back Better' by reducing risks and improving conditions through strategies including community-driven reconstruction and sustainable development practices. The recoveries from the disaster in countries like Indonesia and Thailand underscored the value of comprehensive disaster governance frameworks in ensuring effective recovery efforts.

Lesson 3: *Empower communities to take action*

The 2004 tsunami revealed critical weaknesses in community preparedness, particularly the lack of public awareness, accessible evacuation plans and inclusive strategies for vulnerable groups. This tragedy underscored the need for community empowerment, emphasizing community engagement in risk assessments, accessible and tailored evacuation plans, institutionalized tsunami drills, and building a culture of preparedness through public awareness campaigns. The IOT highlighted the necessity of empowering communities as central actors in disaster preparedness efforts against future tsunamis.

Lesson 4: *Strengthen regional cooperation*

The 2004 Indian Ocean Tsunami underscored the critical importance of regional cooperation in disaster risk reduction, response and recovery. The lack of coordinated early warning systems, response mechanisms and recovery capacities led to significant loss of life and highlighted gaps in preparedness across the affected countries. Lessons from this tragedy catalysed the development of regional frameworks such as the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) and the establishment of institutions such as the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (the AHA Centre). These initiatives fostered collective action, standardized practices and knowledge sharing. The progress made through regional cooperation since the IOT has reinforced the value of unified regional efforts in reducing disaster risks and building resilience against future tsunamis.

THIS UNDP REPORT

The 2004 Indian Ocean Tsunami was a stark reminder of the destructive potential of disasters and the vulnerabilities of communities in their path. Its unprecedented scale of destruction revealed significant gaps in disaster preparedness and response systems. The lessons learned from this tragedy have since informed efforts to build resilience and enhance collaboration among ASEAN countries and the global community.

To mark the 20th anniversary of the Indian Ocean Tsunami, UNDP has developed this commemorative report that aims to leverage the collective memory of lessons learned to galvanize and renew political commitment and strengthen efforts towards building and advancing the resilience of communities and people at risk of continuing threats of tsunamis and other hazards. The report contains the following sections:

- Section 1 presents testimonies from affected communities, highlighting voices from survivors and members of vulnerable groups.
- Section 2 serves as a useful stocktaking of lessons and best practices in tsunami preparedness and recovery from the past 20 years.
- Section 3 provides policy recommendations for ASEAN countries to build upon the considerable progress from the past 20 years.

This commemorative report was developed and funded through UNDP's regional project, 'Partnerships for Strengthening School Preparedness for Tsunamis in the Asia Pacific Region' (the Tsunami Project), which is funded by the Government of Japan.

SECTION 1

TESTIMONIES FROM SURVIVORS OF THE INDIAN OCEAN TSUNAMI

PHOTO: UNDP SOLOMON ISLANDS

Indonesia

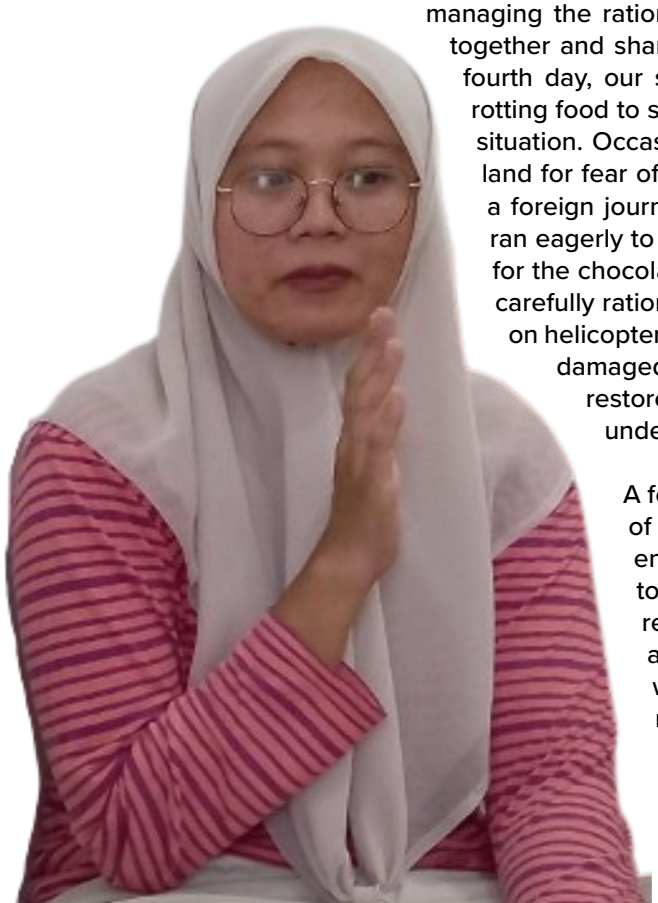
AZZAHRA LAYUSA

Azzahra Layusa, who was a 10-year-old girl in Aceh when the Indian Ocean Tsunami struck, on how she survived, how people came together in the aftermath to share resources, and how the experience has taught her the importance of preparedness.
Interview conducted by UNDP in July 2024

"When I was just 10 years old, our lives changed drastically on what should have been an ordinary Sunday. Our house was situated in a relatively high area, about 4 kilometres from the coast, and we always felt safe from the threat of disasters. However, on that day, a very strong earthquake suddenly shook our region with tremendous force. The tremors made the entire house shake, and fear enveloped us.

About an hour after the earthquake, I saw many people running towards our house with pale, terrified faces, shouting in panic, 'the sea water is rising, the sea water is rising!' The atmosphere became increasingly tense as some cried and ran aimlessly, as if being chased by something invisible. Amidst this chaos, I noticed my aunt running while holding her young niece. With a sorrowful face, she tried to protect the little girl, who had tragically lost her mother to the tsunami. Witnessing my aunt's distress and hearing the tragic story of her niece made me truly grasp the severity of the disaster we were facing. Initially, we thought the rising sea water was just due to ordinary flooding, but people explained that the water was massive and terrifying, with giant waves that destroyed everything in their path.

The impact of the disaster was immense, shaking our lives to the core. In the aftermath, food and clean water were scarce, electricity was non-existent, and the grim news of the destruction of the city of Meulaboh from the earthquake reached us. As night fell, the tremors persisted, a relentless reminder of the catastrophe that had struck. I remember watching as countless refugees sought shelter on the porches of local residents' homes, crowding together in a desperate search for safety



For the first three days, aid did not arrive, and we had to make do with whatever food we had. The adults took on the responsibility of ensuring that everyone could eat and drink, managing the rations carefully. Fortunately, despite the crisis, everyone came together and shared resources, preventing any conflicts from arising. By the fourth day, our supplies were dwindling, and we were even forced to eat rotting food to survive. The children, including myself, felt the severity of the situation. Occasionally, helicopters would come, but they were reluctant to land for fear of being overwhelmed by desperate, frantic people. One day, a foreign journalist arrived with chocolates. All the children, me included, ran eagerly to get them. I ran barefoot and injured my feet in the scramble for the chocolates. We were extremely hungry and thirsty, while the adults carefully rationed the limited drinking water. Soon after, aid began arriving on helicopters, but supplies were dropped from the air, with the food often damaged upon landing. A week later, when the electricity was finally restored, we were able to see our situation on the television and understand what a tsunami was and what had happened.

A few days later, my family and I decided to evacuate to the city of Medan using the available refugee transport. However, we encountered significant difficulties because the roads leading to Aceh were blocked. Our journey took us through several regions that had not been affected by the tsunami, making it a gruelling and challenging trip. Once we arrived in Medan, we stayed in a rented house for a month while we waited to return home and assess the damage. When we finally went

back, I was deeply traumatized to see my school destroyed and covered in mud. The devastation was overwhelming. After the disaster, four elementary schools in our area were merged into one because so many students had died. Many children became orphans and were either taken in by their families or adopted.

One day, I reunited with my elementary school friends and learned that they had continued their education in refugee tents for a year. Some of them still carry deep trauma from the experience. With our home and school in ruins, my family decided to remain in Medan longer and continue our schooling there. We returned to Medan on a Hercules plane (a military transport aircraft), and I will never forget the sight of the tsunami-affected areas, covered in black mud, and the horrific smell of decay and corpses. Those memories continue to be deeply traumatic for me.

The tsunami also had a significant impact on the factory where my mother worked, which ceased operations until 2011. My mother had to stop working during that period. Fortunately, we received adequate economic aid and special assistance for tsunami victims, which helped us cope. My mother also started selling snacks to earn a living.

In the aftermath of the tsunami, the Tsunami and Disaster Mitigation Research Center was established by Syiah Kuala University in Banda Aceh. Education on disaster preparedness increased significantly, and disaster simulations are now held every few years to commemorate the tsunami. Residents are informed in advance about these simulations, ensuring they understand it is a drill and can participate effectively. Moreover, many of my friends received scholarships to study in Japan, focusing on fields related to tsunamis, such as hydrology.

Many people living in coastal areas now are newcomers, as the original residents have relocated to higher ground or other cities in an attempt to avoid future disasters. Our family is no exception: we now choose to live in higher areas far from the coast. My husband and I have agreed that if a tsunami were to occur again, we would not return home but would immediately seek higher ground. We have prepared a backpack with essential documents wrapped in plastic that we can quickly grab if a disaster strikes."

CUT SA'ADAH

Cut Sa'adah, on how she survived during and immediately after the Indian Ocean Tsunami. She was a 65-year-old woman staying in Meulaboh, the capital of West Aceh Regency, Indonesia, when the tsunami struck.
Interview conducted by UNDP in July 2024

"That morning, I was with my extended family at a relative's house. Suddenly, a powerful earthquake shook the ground so violently that I could barely stand. It felt like the end of the world. Soon after, someone shouted, 'Everyone run, the sea water is rising!' Instantly, everyone fled the house. Being older, I was the slowest and before I realized it, I was alone. Recognizing the seriousness of the situation, I took a shortcut through the back of the house, hoping to catch up with those who had already run ahead. I ran barefoot, despite my feet still aching from recent hip surgery, and cut myself on sharp objects along the way.

As I fled, I kept my eyes forward and did not look back. People I met urged me to climb to a higher hill. When I finally reached the hill, they continued to urge me to go higher. Looking back, I witnessed a terrifying scene: debris, including mosque domes, was being carried away by the rising waters. The water climbed swiftly, nearly reaching where I was. I kept climbing, clinging to tree branches for support. From the top, I could see that the land below was entirely submerged. Overcome with emotion, I cried and prayed. I stayed on the hill for three days, fasting the entire time. With no electricity and limited clean water, some people went down to search for food and shared whatever they found. I saw them find rice mixed with sand, which they dried and cooked for us. We were desperately hungry and the children suffered from diarrhoea. We all gathered at a transmitter station, where we waited in line for instant noodles and other food supplies. I received three pieces of bread, of which I gave two pieces to others and kept one for myself.

On the morning of the fourth day, we decided to leave the hill and take a fishing boat to the refugee area in Banda Aceh. The boat had survived because fishermen noticed the darkened land from a distance. Soldiers helped us board, prioritizing women first. It was extremely crowded and I could barely sit upright. Seeing the overcrowded situation, the soldiers asked some people to disembark to lighten the load. On the boat, I felt extremely hungry and cold, shaking and unable to stand. The journey was terrifying as we navigated through debris. We arrived at Lampulo village by 11 pm. Since it was too late to continue, we spent the night on the boat, extremely hungry and shivering in the cold and darkness.

On the fifth day, we walked to a mosque. On the boat with me was a relative whose wife and mother-in-law had been killed and whose house had been destroyed. His child was missing. When we reached the mosque, he frantically searched for his child among the survivors, calling out his name. Hearing this, his child ran to him, limping with a severed leg. The reunion was heart-wrenching as the father embraced his child with relief and gratitude. We learned that the child had survived by clinging to a refrigerator door carried by the current until he reached the mosque.

When I used to recount these events, I would feel sad and cry. Now, I am able to share this story. After the tsunami, NGOs [non-governmental organizations] and the government provided housing aid to disaster victims. By the time the aid arrived, I was already in Medan city, far from Aceh. I worried about missing out on the assistance and inquired if I could still receive it. Thankfully, they provided aid to me.

We have never returned to our original home that was destroyed by the tsunami. The disaster changed our lives completely. We decided to move to a higher area to avoid similar risks in the future. In addition to the temporary housing we received, we found a very helpful programme: training to make cakes. This programme, a collaboration between NGOs and the government, was designed specifically for widows in our community. It provided not only new skills but also some relief from the burdens we faced after our immense losses. There is a disaster simulation programme conducted every few years to prepare the community for potential emergencies. Additionally, there is a disaster siren system installed in various strategic locations.

The tsunami was a deeply painful experience that left a lasting impact on my life. This traumatic event taught me how to deal with disasters and take action to protect myself. Now, I feel more prepared to face challenges, thanks to the invaluable lessons I have learned from the hardships we endured in Aceh."

LAILA

Laila, who was a 14-year-old girl in Aceh during the tsunami, on what she experienced during the IOT, and how Aceh was able to recover in the aftermath of the disaster.
Interview conducted by UNDP in July 2024

"I was still in middle school. My father worked as a woodcutter and my mother was a housewife. My house was relatively far from the sea. I had never heard of a tsunami before. It was never taught in school. Besides, I was still a child, so I did not really understand what was happening. There was no special preparation for natural disasters, including tsunamis. We never had any specific programmes, either within our family or at the village community level.

When the earthquake struck, my friends and I, who were playing, panicked and were confused. However, we thought nothing would happen. We continued playing until a little later when we heard someone shouting and running, saying that the sea was rising. At first, I was confused about what they meant. Then, my friends and I ran with the adults to get away from the sea waves. I did not think about saving anyone at that time. I just ran and kept running towards the mosque. My thought, and that of others at the time, was that if we did not survive, at least we would die in the house of our God. At that time, some adults quickly directed us to enter the mosque and ordered us not to leave.

I did not face any significant obstacles, just fear and confusion when I first realized the sea was rising. However, from inside the mosque, on the second floor, I could see people trying to save themselves from being hit by the waves. They were being struck by wood and building debris. Some of them made it to the mosque where we were, but the rest were swept away and disappeared. As people panicked and scattered to save themselves, I saw some of them fall and get trampled. Amidst the chaos, I noticed a toddler sitting still. As the water got closer, a man bravely pulled the child and carried him. The child was placed on the roof of a house that happened to remain intact after being hit by the waves. After the water subsided, we learned that the child survived, though was very weak.

The seawater swirled like a top from a distance and when that whirlpool hit the coastline, it splashed large waves that engulfed settlements. The water was black and smelled terrible. I clearly remember that there were corpses everywhere. Houses were destroyed. There were so many bodies that when we walked out, we sometimes had to step on them.

While taking refuge in the mosque, we did not eat at all for several hours. We received food aid from Acehnese people who had not been directly affected by the tsunami. The community spontaneously distributed food to us and raised aid from other areas as well.

After the tsunami, evacuation efforts were carried out together, including by the government, the military and local communities, especially for those who wanted to find their families. Public kitchens were set up at several locations. Aid poured in from various parties, including from abroad. At that time, my family and I received food, clothing and even temporary housing assistance.

I clearly remember that the process of restoring the living conditions of the community went quite well, thanks to the continuous aid we received. Economically, our situation improved year by year, although I still feel the trauma. But, on several occasions, the distribution of aid caused problems. Some victims did not receive houses, clothing or other assistance simply because they were missed from the recipient list, even though they were true victims. This issue was quite common during the recovery process at that time.

Compared to before the tsunami, development in Aceh has progressed well, the conflict has ended and certainly, job opportunities have increased. However, in my opinion, there are still important issues that need attention, particularly concerning environmental conservation in coastal areas. Year by year, the coastline continues to encroach inland and more attention needs to be given to mangrove forests.

The tsunami ultimately led me to decide to study environmental and disaster issues more seriously. That is why I am now part of an environmental organization. I now understand a lot about disasters, including about mitigation and evacuation. However, I still have trauma related to earthquakes to this day. I always cry when an earthquake happens.

Disasters are very serious because they involve matters of life and death. I believe everyone must be well-prepared. I hope that what I experienced never happens again, but we never really know when it will strike. However, in some cases, we can take preventative efforts to reduce the losses that may arise if a disaster does happen.

I think the community is now more open to information about disasters. There have been many developments in disaster infrastructure, such as the giant evacuation buildings that are now in several locations in case an earthquake or tsunami happens again. Currently, there are regular awareness or simulation programmes held at least once a year. These aim to inform the public about what and how to act if a disaster occurs. Besides that, there are also special lessons about disasters in elementary schools, although it is not yet a priority."

PIPIT

Pipit on how she survived during and immediately after the IOT in Aceh, and on the lasting impacts of her experiences in the years since. She was 21 years old during the tsunami.
Interview conducted by UNDP in July 2024

"It was a Sunday and I was relaxing with my family at home. Suddenly, a powerful earthquake shook our area. Although our house was about five kilometres from the coast, that distance did not shield us from the devastating effects of the earthquake and the ensuing tsunami. We quickly rushed outside to the yard, seeking a safer place. I saw many people running in panic, while others stood frozen, trying to understand what was happening. I had never experienced such a strong earthquake before and the effects were immediate: I felt dizzy and confused.

Then I heard people around me shouting in panic, 'The water is rising, the water is rising!' At that moment, I did not fully understand what was happening. I had never even heard of a tsunami before. But seeing people running in fear, my instincts told me to run too, even though my parents were still inside the house. I ran aimlessly, overwhelmed by confusion and fear, until I was eventually swept away by the powerful current. It felt like walking in the middle of waves that suddenly grew and hit mercilessly.

Swimming was futile. The water was not only powerful but also filled with sharp and dangerous objects like sheets of metal and debris from buildings. Every movement was risky and I had to struggle hard to stay afloat amidst the chaos. Fortunately, I got caught on a mattress that was floating with the waves. Around me, I heard people shouting for help, but I was in shock, not knowing what to do. I could only wonder, 'Where am I? What is really happening?'

Amidst the chaos, I briefly saw a few two-storey houses still standing amidst the debris. The survivors who had managed to reach the second floor were shouting, calling out to those still floating to come and save themselves. The strong current carried me about a kilometre, until I eventually washed up in a field. Somehow, I escaped that situation without injuries, which felt like an incredible stroke of luck. However, once the water receded, the sight was truly horrifying. I saw corpses stuck on doorways and many other bodies swollen from being submerged during the disaster. The event left a deep scar on my memory.

After being swept by the current and arriving in the field, I tried to find shelter by walking to the nearby mosque. The people there who saw my condition immediately gave me a karate uniform to wear because my clothes were completely torn. Though it was not ordinary clothing, anything that could protect me was valuable at that moment. Later, I, along with many others, took refuge in a university building that still stood firm. We hoped this place would be safe from aftershocks, but the tremors continued, making us feel unsafe inside. Eventually, we all chose to sit outside in the open field for safety instead.

No aid arrived during the first days at the shelter. Those early days were extremely difficult. We struggled to get food and clean water. Aid started coming a few days later, but it was limited and I received only a few packs of biscuits. Despite the hardship, my thoughts were with my family back home. I worried about my parents and other relatives. Eventually, I decided to return home, despite many roads being blocked. I walked barefoot through the debris with water up to my chest, starting at 9 am and continuing until 1 pm. I could only pray that my feet would remain unharmed.

When I finally arrived home, the sight was heart-wrenching. My house was still standing, but much of it was destroyed and surrounded by trash and debris. The devastation was evident: behind my house, there were about 20 rental homes, all of which were completely demolished. Only two or three people from that entire complex survived. Upon arrival, I was informed by some relatives that my parents were gone and that their bodies had not been found. This news hit me hard. I had lost not only my parents but also my younger siblings, my grandmother and my niece. Everyone I loved had disappeared in an instant.

After meeting with relatives, one of them took me on a motorcycle to a higher place. I stayed there for several months. Due to the limited food, we made various dishes from sardines to survive. Even now, I

cannot eat sardines because I had them so often during that time. The recovery process took about five years. During that period, I received some aid from the government for repairing the house. However, the amount I received was not enough to repair the roof and some walls of my damaged house. After the tsunami, there were various entrepreneurship and training programmes for housewives affected by the tsunami which really helped us to survive. Now, it is part of my job as a government employee.

Amidst the deep sorrow, we knew we had to survive. If we had been trapped in trauma, Aceh would not have recovered as it has. We realized that to move forward, we needed to overcome the deep pain and trauma. This experience made me more resilient and self-reliant. After the disaster, facing life's challenges became easier because nothing could be as difficult to deal with than the tsunami.

Now, I always hope my child never has to experience such a disaster. When an earthquake occurs, my family and I know how to run away from the sea. I teach children that if an earthquake happens, they must run immediately. If running is not possible, they should go to the second floor. I stress that material possessions are unimportant; safety and life are what matter most.

Despite trying to move on, the fear remains. Every time I see large waves at sea, that fear returns. I also feel scared when the sky is too dark or when the weather is extremely hot. It feels as though these signs might predict another disaster. These fears are now a part of my life, reminding me of the fragility and uncertainty I experienced that day."

YUSNIA

Yusnia, who was 29 years old during the tsunami in Aceh, on her experiences during the disaster and how she was able to survive by taking shelter on the second floor of a house.
Interview conducted by UNDP in July 2024

"I had just started working at an insurance company. I lived with my mother and younger sibling in a house in Banda Aceh. My mother was 69 years old, while my sibling was still in school. I had no knowledge of tsunamis. There were no emergency drills. We absolutely had no preparations. Our community never thought something like that would happen. My family and I never considered the possibility of such a disaster. We knew that disasters existed, but we never thought it would happen in our area.

That day, I had just taken my mother to the Quran study group on a motorcycle. I was about to return home when suddenly the earthquake struck. Without thinking twice, I rushed home, but before I could reach the house, I saw people running from the direction of the coast, shouting, 'the sea is rising, the sea is rising'. I did not know exactly what was happening. I ran with the others, abandoning my motorcycle, filled with fear. At that moment, I was not thinking about anything other than saving myself. I ran along with everyone else, trying to escape the waves. The situation was terrifying, especially since we did not really know what was happening or what we should do. We just ran in all directions. Eventually, we took shelter on the second floor of a house.

The situation was so frightening. There are many things I remember and all of them are horrifying. I still remember shortly after the earthquake, the sea level rose and the waves were pitch black and smelled awful. As the waves chased us, I saw an old man being swept off his motorcycle and thrown into a roadside ditch. The old man was trapped and his motorcycle fell on top of him. He cried out for help, but no one paid attention. Everyone was focused on saving themselves. People were in a state of panic; some even had their clothes torn off by the waves. They were trying to find anything to cover themselves. I saw dead bodies everywhere, including a floating baby. I could not hold back my tears.

I remember clearly the moment I found my mother, who had survived the tsunami. She had held onto a mango tree, clutching a Quran. It was only after the waves had subsided that a few brave individuals decided to come down and help those who were still alive. They waded through the black, foul-smelling seawater to save the people who were still trapped in trees, wood and other debris.

We could not eat while we were in that second-floor house. Everything was destroyed and submerged in water. It was not until the afternoon that we received food. The fastest aid came from the Acehnese people who were not directly affected by the tsunami and from some people from other regions, like Medan city. I remember receiving bread. Because our area was still flooded, food could not be distributed properly, so it was thrown to us from below.

Our house was destroyed. We lost many things, both property and family. We tried to rebuild with the help that poured into Aceh. The assistance with housing, clothing, food and other necessities was very helpful. Thankfully, our situation has improved since then. I still work at the same insurance company and my mother is still healthy.

The tsunami changed many things in the lives of Acehnese people. The economy improved, housing aid was provided and infrastructure developed rapidly. Not to mention, at the time there was still a conflict in Aceh and the tsunami brought an end to that terrifying conflict with a peace agreement.

However, the disaster left me with a fear of the sea. I have not been to the beach since the tsunami. In fact, I am afraid to get on a boat. Now, I avoid the sea as much as possible, including choosing a place to live far from coastal areas. The dark memories have left trauma that lingers to this day. I am still scared that a disaster like that could happen again.

If a similar disaster does occur, at least we now know what to do and where to go: away from the sea and to higher ground. This is based on my own experience."

IRINA RAFLIANA

Irina Rafliana is a researcher in social science and humanities, focusing on tsunamis, science and technology, and disaster risks at Badan Riset dan Inovasi Nasional (BRIN) Indonesia and the German Institute of Development and Sustainability (IDOS). She reflects on how awareness of the disaster spread in the hours after the tsunami, and how her and her colleagues' work at the Indonesian Institute of Sciences (LIPI) in the aftermath of the Indian Ocean Tsunami informed the country's preparedness efforts and supported Indonesia's first tsunami drill.
Written testimony shared with UNDP in November 2024

"Twenty years have passed by already. It felt so very fast. At the same time, when looking back, it is fascinating and also humbling how one particular event can so significantly change our lives.

The year 2004 was vibrant and inspirational for me, as I was engaged with programmes that were coordinated by the Indonesian Institute of Sciences (LIPI – Lembaga Ilmu Pengetahuan Indonesia), supporting coastal communities, including school education on coral reef rehabilitation and management. My book on coastal education for first-grade children was published in 2003 as part of a book series for elementary schools. Throughout 2004, together with LIPI researchers and the Indonesian Ministry of Education, we facilitated training for teachers in remote islands and coastal areas to use the books creatively. Aceh, however, was not among the regions covered by this campaign, with many coastal and environmental projects avoiding such military-conflicted zones, in which tensions might compromise trust-based relations and the safety of training participants.

I was in Jakarta on 26 December 2004, watching the news on television. Strikingly, the news from Aceh that morning was not about the humanitarian consequences of the conflict in the province. Instead, the news was about massive earthquakes followed by tsunami waves that had severely hit Aceh and Nias that morning. The news escalated slowly, maybe due to the extremely limited ability of anyone to enter the affected areas. The more time passed, the more the news covered the devastation. National media were not shy in showing the sorrow of the disaster: screaming and crying, the angry and bewildered, the injured and the dead. These vivid images and sounds haunted us for a long time, even those not directly affected by the waves.

The disaster swiftly filled conversations in households, markets, offices and public places. My office was no exception. Many researchers gathered and discussed it from their different points of interest: how the tsunami was generated, the magnitude of the earthquakes, the slow response, the immense trauma and the unimaginable recovery it would need. Some people were starting initiatives to collect clothes to be sent or establishing volunteer networks to support response and relief efforts. One thing is certain: we were not prepared for this magnitude of disaster. Most of us were unfamiliar with the word, 'tsunami', and how to deal with it.

Over the following days and weeks, along with a small group of researchers at LIPI, I prepared public education materials and equipped volunteers with key knowledge about earthquakes, tsunamis, how to work with communities in developing preparedness, and how to help survivors release the trauma of the event. The materials that we at LIPI produced in a very short amount of time caught the attention of the Vice President of the Republic of Indonesia, who then announced that the Institute was to lead preparedness initiatives at national and local scales. The activities were later funded by the Government of Indonesia through a National Priority Program on Science-Based Tsunami Education and Preparedness and implemented collaboratively through LIPI's Community Preparedness Program (COMPRESS). At this point, the linkages between science, humanitarian aid, disaster response and preparedness interventions were becoming better understood. Lessons from different parts of the world were adapted, including from Japan on the role of knowledge to save lives, and from Bangladesh for the Community Based Disaster Risk Management approaches for cyclones and atmospheric hazards.

It can be argued that the first tsunami drill in Indonesia was conducted in a village called Seuneubok, Aceh Besar. This village was hosting an exodus of tsunami survivors from the neighbouring island of Pulo Breuh (which literally translates as Rice Island), that was completely washed away by the 2004 tsunami. Survivors were still living in tents when LIPI and IFRC (the International Federation of Red Cross and Red Crescent Societies) collaborated to provide affected communities with knowledge about preparedness: women, men, younger participants, religious leaders, farmers, fishermen and

sometimes children sat down and listened. It took a while for the survivors to decide whether they wanted to hold a tsunami drill, with several days of discussions taking place in the Meunasah (small mosque). In the end, they decided that it was worthwhile to try, despite the painful memories and trauma that were evident in their eyes and bodies.

This was my first experience facilitating a tsunami drill, and was an emotional experience. But it was the sense of hopefulness and agency to get their lives back through learning what they should do if another earthquake and tsunami happened that moved these communities to hold their first-ever tsunami drill. The entire process was documented on video by Forum Lenteng, an art community that supports social and human engagement through art literacy. The video of the Seuneubok community became the reference for tsunami drills elsewhere in Indonesia, including the first-ever national tsunami drill in Padang, West Sumatra, in 2005, which involved 5,000 local communities.

Several years passed, as IFRC and ARC (the American Red Cross) facilitated the return of these communities back to their island and built more resistant homes. The communication with LIPI continued, often at a personal level, which I suppose is crucial for scientific organizations to maintain the public's trust. It was clear that these communities still remembered their first experience in Seuneubok. Almost 10 years after the Indian Ocean Tsunami, the communities in Pulo Breuh experienced a huge earthquake that potentially could bring another giant wave. They decided, without receiving any official warning from local authorities or the National Tsunami Warning Centre, to self-evacuate to the nearby hill where they had built a small hut for such emergencies.

The experience of the Indian Ocean Tsunami reminds us of the limits of our knowledge in understanding and living with dynamic Earth processes, and their complexities and uncertainties. We have built our knowledge, technologies and social interventions around these Earth processes, but this in turn results in social and political consequences which we often did not anticipate. The 20 years since the tsunami have been a continuous learning process for coastal communities, scientists, policymakers and all related sectors. The Indian Ocean Tsunami globally affected people, institutions and organizations in ways one would not have been able to imagine beforehand: not only the unprecedented devastation, but also how the disaster led to tremendous advancements and networks in science and disaster risk reduction, and how in Indonesia one learned from real events to move forward and live with tsunami risks as an integral part of social life."

MR. RIDWAN JAMIL

Mr Ridwan Jamil, S.Sos., M.Si, Head of the Regional Disaster Management Agency (BPBD) Aceh Besar. He reflects on his experiences during the disaster, and how the Government of Indonesia, at both national and subnational levels, supported the victims of the Indian Ocean Tsunami in its aftermath.

Interview conducted by ASEAN in July 2024

"As well as being an ordinary citizen, I was at that time serving as one of the subdistrict heads (camat) in Aceh Besar. The event happened during the weekend holiday. Everyone was in a relaxed state with their families, then suddenly there was a big earthquake and after that there was a tsunami. Tsunamis were unknown at the time, which is why we had so many victims and such great devastation. Nobody knew what to do. Not a single family in Banda Aceh and Aceh Besar is intact because of the tsunami. There were so many victims, and the agencies also did not know what to do. Communication was not possible; the power went out.

Towards the late afternoon, I explored the affected areas. I walked to the Belang Padang area. It was such a big field, full of garbage, wood, roof panels, mattresses, all kinds of things that the tsunami water carried. I saw people moaning, people in pain. We evacuated several people with used mattresses, but could only evacuate a few people because it was difficult to get through all the debris. Even walking was difficult.

That night, there was no lighting. We saw that there were several Banda Aceh residents who were evacuated to the Cashdam hospital. We did not sleep that night, seeing people passing by in a bad condition. Some people travelled with pedicabs, some on foot, others on motorcycles. At that time, there were no gas stations either.

In the morning, the evacuation of residents from Aceh Besar took place. People started looking for relatives. Bodies were scattered in Lambaru, where there used to be the Aceh Besar Red Cross. That is where the bodies were temporarily kept, because there was no solution, nowhere to take them. There we met all kinds of affected people, men and women, some in makeshift clothes, in a distressed condition.

The next day, everything started working. The Aceh Besar government had started to gather. On the third day, the bodies could be evacuated to the mass grave at Lambaru. I took part in counting the bodies in the afternoon, which is why I know that there were bodies buried there in a mass tsunami cemetery, more than 46,000 in one big hole. Every day, our task was to count the bodies that came by truck.

After that, many residents were placed in temporary shelters. At that time, there was no good temporary housing, there were only refugee tents. Some took refuge with family, some were taken in by community members, and the government was present, providing basic needs and food. We also had the huntara: a sort of temporary barracks that had rooms. This was before the BRR [The Agency for the Rehabilitation and Reconstruction of Aceh and Nias]. There were community members who were still wandering, did not have any land and were looking for new settlements. It would be a long process. They spent some time at the temporary shelters, then there were the many huntara in Banda Aceh and Aceh Besar. Residents lived there for a long time. They received rations and food from the government. It was handled well. After the BRR was established, the community members recovered, have housing, then work returned to normal. Now, all of us have risen again.

Now all community members are aware of what to do when the threat of disaster occurs. The government also, both the central government and the regions, were inspired by the extraordinary incident in Aceh. The BNPB [Indonesia's National Disaster Management Agency] was born. We have educated the community. Together with BNPB, we have built disaster-resilient villages (Desa Tangguh Bencana). We often conduct simulations and educate communities and students. This is the preparedness that we are doing today. I have been to some of the villages here, and I see that the preparedness of the communities is quite extraordinary. They already have a good understanding and have structures in place for mitigating disasters.

Now, there are many generations who only heard the stories. They were not yet born when Aceh experienced this terrible event that took many victims. Hopefully we do not forget what happened. That is why we also go to schools, together with the teachers, to convey what kind of area we live in, so that we can transfer the experience of history and stories to them. It is one of the lessons for our students, about living in a country, region and area that is disaster-prone. They need to understand that we must prepare ourselves."

Thailand

NAMFON MIANTHONG

Namfon Mianthong, who was a 15-year-old girl when the Indian Ocean Tsunami struck, on how she survived the tsunami, and how her experiences inform her work at the Ban Nam Khem Tsunami Museum.
Interview conducted by UNDP in January 2025

“I was living on Koh Kho Khao Island, just across from Ban Nam Khem village in Phang Nga province. Back then, I had never even heard of a tsunami, let alone learned about one. Nobody in our community had. There were no drills: we simply were not prepared.

That morning, I was at home when I saw the wave. My father shouted for me to run, but I was frozen in shock. The wave was massive, dark and towering. My parents and I climbed a tree, but when the wave hit, I was thrown off. I ended up floating near the tree, helpless, bobbing up and down. Then, just by chance, a buoy floated my way. I grabbed it and held on as the wave carried me out to sea. I was out there alone for what felt like forever: six or seven hours. It was not until evening, around 5 or 6 pm, that a long-tailed boat finally rescued me.

In the aftermath, Thai and foreign volunteers, along with local authorities and private groups, came together to help us recover. I could not go near the sea for a long time: I was terrified. I still remember the first time a volunteer took us back to the beach. We did not step onto the sand right away. It was a slow process: standing, walking and eventually running on the beach again. It took years for me to feel comfortable being near the water.

For my family, the experience taught us the importance of being prepared and acting quickly during emergencies. We agreed that if the warning siren sounds, we will evacuate to higher ground immediately and meet at a designated spot. We will not search for each other: we know that delay can cost lives, and we do not want to repeat the mistakes of the past.

As a community, we have learned a lot since then. We decided to always keep important documents packed in a single bag, ready to grab if we ever need to evacuate quickly. It is a small change, but it makes a big difference. Every year, we hold community meetings on preparedness and run evacuation drills. It has become a part of life here because we know we cannot predict when it might happen again.

The tsunami left a deep mark on me and inspired me to help others. When I heard that the Cultural Office of Phang Nga province was hiring at the Ban Nam Khem Tsunami Museum, I applied right away. I am so happy to be here, working with the community, sharing what I have learned, and helping others to stay prepared.

Our community has come a long way. Every village now has a tsunami working group with specific roles: search teams, first aid teams and others. These measures make us hopeful that if a disaster strikes again, we will be able to minimize the loss of life. One challenge we now face is with the younger generations. They did not live through the tsunami, so they do not really understand how serious it can be or why preparedness matters so much. That is why continuing these efforts is so important: to make sure they are ready too.

The Museum plays a big part in this as well. Visitors learn how to respond in the event of a disaster, and it is especially valuable for the younger generations. They may not fully grasp the severity of such events, but through education, we are making sure they are better prepared for the future.”

MAITREE JONGKRAIJUK

Maitree Jongkraijuk was working at a local government unit in Phang Nga province when the Indian Ocean Tsunami struck. He reflects on his experiences during and after the disaster, and on how the local government supported survivors to take ownership of their recovery. He is the President of the Tsunami Victim Network.
Interview conducted by UNDP in January 2025

"A few months before the tsunami, I was elected as a member of the Subdistrict Administrative Organization (SAO) in Bang Muang subdistrict (Takua Pa district, Phang Nga province).

That morning was a Sunday. My wife was sitting by the sea, while I was at my sister's house. Around 10 am, someone came running to tell me to come and look, because the sea water had receded unusually. I went to look and told them to stop overreacting, as I thought the water was just going down. I even told him to go get a camera and take a photo. But not long after that, I saw the waves in the distance. It looked like something from a movie, so I shouted, 'A giant wave is coming! Run!' Boats that were at the river mouth were swallowed by the wave. I ran with my wife and told her to get the kids from the upper floor, while I went to get my mother, who was on the ground floor.

My brother and I carried my mother out, and my father ran behind us. When we reached my sister's house, everyone ran to the second floor. My father was almost at the second floor when he changed his mind and went back down to close the front door of the house. At that moment, the wave hit. My father disappeared right before my eyes. The water was almost up to the second floor. Everyone was scared, confused, shouting and cursing the waves. We saw people being carried away by the sea. When people were washed up to the house, we pulled them out, one by one, until we had about 30 people gathered together. Some were familiar, others were strangers.

Not long after, the water receded. I rushed downstairs to find my father. I saw he was trapped in a room. I picked him up and draped him over my shoulder, shaking him, thinking that maybe he could still survive because it had only been a few minutes. But he did not survive. I was the ninth child, the youngest in the family. My father taught me many things; he was everything to me. Just a few days before, my father had sat outside the house, complaining to his children, 'What would you do if one day I am not here?' I had arrogantly replied, 'Even without a father, I can manage'. But when my father was really gone, I immediately questioned how we would survive without him.

My brother remembered that his son might have gone fishing, so we went to the concrete bridge (now the Ban Nam Khem Tsunami Memorial Park) to look for him, but we did not find him. The area was in ruins and we saw dead bodies lying around. It looked like something from a nuclear explosion movie. At that time, it seemed like the sea had receded further. We were so shocked that we rushed back to the upper floor of my sister's house but this time the water did not reach us. People on the second floor were talking about how we could not stay here anymore because we did not know if the wave would come again, so we decided to evacuate.

We drove to the Takua Pa Senanukul School. As we turned in, someone said that the gas at the hospital was about to explode, but it was just a rumour. While waiting there, we heard someone shout, 'The water is coming, the water is coming!' We were getting ready to flee, but it turned out to be a donated water truck. The atmosphere was tense. We drove to a vocational college where a relative was an administrator. We stopped to rest and think about what to do next. In the end, we decided to call a relative in Nakhon Si Thammarat to come help pick up my father's body. They came that night. I told my siblings to keep my father's body for a while because I wanted to return and take care of the villagers first.

On 27 December, I visited villagers in various locations. Some were at the temple, some at the school and some in the forest. When they saw me, they yelled, 'You are in the SAO, why did you not take care of your people?' Everywhere I went, I was scolded. I understood their frustration but explained that my father was dead too, and my life was just as chaotic. The problem everywhere was that there was no food to eat, no water to bathe and no toilets. On 28 December, donations began to arrive. On 30 December, people from the Thai Community Foundation, the Housing Development Foundation and the Community Organization Development Institute came to the area to talk.

I said I wanted to gather the villagers to help with the immediate reconstruction work. On 31 December, we started building six toilets. It was the beginning of the temporary shelter in Bang Muang subdistrict. Once the people gathered, we could identify problems and work together to solve them. We helped the survivors take ownership of their situation, dividing tasks and responsibilities and forming committees. Around 3,000 villagers were involved, divided into groups for the kitchen, toilets, security and others. After that, we started raising funds to build temporary shelters because we could not stay in tents for a long time. Once we had temporary houses, we began thinking about how to reintegrate the survivors into the community.

After we returned to the village, when we heard news of earthquakes elsewhere, we were very afraid. We evacuated several times. One day, I realized that if we kept running like this every time, we would not be able to live happily. The committee discussed how to prepare for future disasters in Ban Nam Khem village. Now, the village has an early warning tower. We know where to go and which areas are safe. We practise drills seriously once a year, setting the date but not announcing the time. If the early warning tower alerts, we run.

I lost 46 relatives during the Indian Ocean Tsunami. I believe that if a similar event happens again, the number of casualties will be much lower. Preparedness means empowering communities with the knowledge, information and tools for evacuation, as well as promoting volunteers and experts within the community. I believe the government must promote preparedness through communities and local governments, giving them the power, responsibility and budget, and working together with the community. This applies not just to tsunamis, but to other disasters as well. We cannot stop disasters, but what we can do is reduce the losses and damages as much as possible."

CHAIWAT CHUNTIRAPONG

Chaiwat Chuntirapong, Former Director-General, Department of Disaster Prevention and Mitigation (DDPM), Thailand. He reflects on how the Government of Thailand supported the victims of the Indian Ocean Tsunami in its aftermath, and how DDPM learned from the disaster in its efforts to reduce disaster risks.
Interview conducted by ASEAN in August 2024

"When the tsunami occurred, the Department of Disaster Prevention and Mitigation had only been established for two years. At that time, our knowledge about tsunamis was quite limited. However, following the disaster, we quickly mobilized resources and personnel to help the people in affected areas. DDPM did not work alone: we had networks, with all sectors contributing to assist the people affected by the tsunami. We would like to express our gratitude to all the personnel, as well as the executives and the government, for mobilizing all resources to help the people in the affected areas.

On that day, the government, through the Ministry of the Interior (MOI), mobilized personnel to assist the people in affected areas. We divided the zones and assigned responsibilities. The challenge was how we could assist the people, as we were racing against time, helping victims trapped under buildings, those in distress, the missing and the displaced people. Everything had to be done swiftly to minimize losses and alleviate the suffering of the people as much and as quickly as possible. All these efforts needed to be integrated and coordinated. Since it was a new type of disaster and we lacked prior knowledge, we had to integrate and collaborate, working on an ad hoc basis. We faced an emergency situation with time as a critical factor to provide timely assistance to those in need. We have successfully navigated through that crisis and we have incorporated those experiences into our knowledge base. This includes developing a tsunami response plan and the 2007 Disaster Prevention and Mitigation Act, which have significantly improved the DDPM's preparedness to handle disasters more effectively.

Our ultimate goal is the well-being of our people. Everything we do today is to ensure that the public is not at risk. Therefore, we educate the public, including the younger generation, about various types of disasters. We provide knowledge: when our personnel and citizens are well-informed, disaster prevention becomes more effective. Preparing, developing and rehearsing plans to respond to various disasters helps to reduce losses. From major damage, it could become minor, and from minor damage, it could lead to no loss at all. These efforts represent our hope that although disasters occur naturally, we will be able to prevent and reduce losses."

SECTION 2

LESSONS FROM THE 20 YEARS SINCE THE INDIAN OCEAN TSUNAMI

PHOTO: UNDP THAILAND

Lesson 1: Create an enabling environment for people-centred early warning systems

Introduction

The 2004 Indian Ocean Tsunami was a turning point in the history of disaster risk reduction. This catastrophic event highlighted the pressing need for a coordinated regional tsunami early warning system (EWS), which had not been already established because countries considered the costs too high, given the lower perceived risk of tsunamis in the Indian Ocean compared to the Pacific.[1] Only a few countries in the region, such as Australia, had the capacity to provide even basic alerts to their communities. The tsunami's devastating impacts underscored that effective early warning is not merely about sensor and modelling technologies, but is just as much about ensuring that warning systems are people-centred, with warnings that reach and empower those most at risk. In the years since the Indian Ocean Tsunami, ASEAN countries have made huge strides in developing and enhancing early warning systems that can better detect tsunamis, particularly through collaborative efforts at the regional level, and in establishing the planning, policy and legal frameworks that can ensure that warnings are effectively disseminated.

An early warning system is defined as an integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities, systems and processes, that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events.[2] People-centred EWS recognize that individuals and communities are not passive recipients of warnings, but active participants in the entire process of disaster preparedness and response.[3] This people-centred approach integrates local knowledge with scientific expertise, ensures warnings are understandable and actionable by diverse populations, and empowers communities to take appropriate and timely action. A comprehensive people-centred early warning system is made up of four key elements: Risk Knowledge, Monitoring and Warning Service, Dissemination and Communication, and Response Capability (Box 1.1).[4] Each of these elements play a crucial role in creating a comprehensive and effective EWS. These elements require robust policies, institutional frameworks and coordination across local, national and regional levels to function effectively.

1 Jegillos, S.R. (unpublished). The Region Remains in Danger, But Is Better Prepared (UNDP internal document).

2 As defined 1 December 2016 by resolution 69/284, United Nations General Assembly, in: United Nations (2022). Early Warnings for All: Executive Action Plan 2023–2027. https://www.preventionweb.net/media/84612/download?startDownload=20250206.

3 United Nations (2006). Global Survey of Early Warning Systems. https://www.unisdr.org/2006/ppew/info-resources/ewc3/Global-Survey-of-Early-Warning-Systems.pdf.

4 UNISDR (2006). Developing Early Warning Systems: A Checklist. Third International Conference on Early Warning, Bonn, Germany, 27–29 March 2006. https://www.preventionweb.net/files/608_10340.pdf

Box 1.1: The four elements of people-centred early warning systems

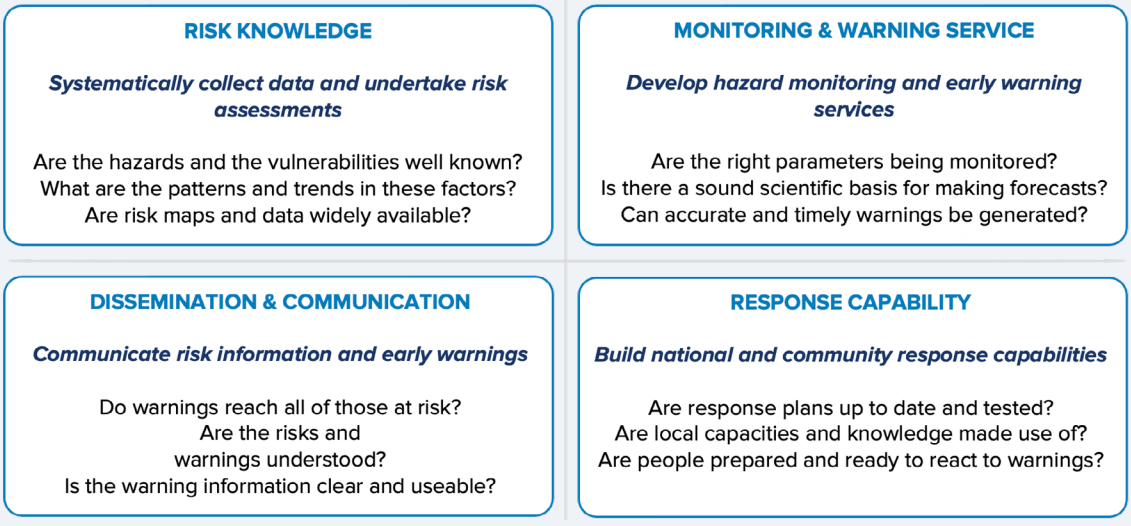


Figure 1.1: The four elements of people-centred early warning systems

Source: UNISDR (2006). Developing Early Warning Systems: A Checklist. Third International Conference on Early Warning, Bonn, Germany, 27–29 March 2006: 2. https://www.preventionweb.net/files/608_10340.pdf.

People-centred early warning systems aim to empower communities and individuals that are exposed to hazards to be able to respond in enough time and in an appropriate manner in order to reduce the likelihood of injury and loss of life, as well as damage to property and the environment.[5] A holistic and effective EWS is made up of four interconnected elements (Figure 1.1). Each element is introduced below, along with a brief explanation of how the 2004 Indian Ocean Tsunami revealed critical systemic gaps that contributed to the tragically high death toll and extensive economic losses across the region. These four elements also align with the four Pillars of the Early Warnings for All (EW4All) initiative that aims to ensure every person on earth is protected by early warning systems within five years.[6]

Risk knowledge

The risk of a disaster results from the combination of a hazard and vulnerabilities at a specific location. Systematic collection and analysis of data is needed for assessing risk, and such assessments should also consider the changing nature of hazards and vulnerabilities that result from complex processes including urbanization, land-use change, climate change and environmental degradation. Risk assessments and risk maps can be used to motivate communities and individuals, to identify and prioritize the gaps in early warning systems, and to guide disaster preparedness and response efforts.

Unfortunately, there was insufficient knowledge of risks before the 2004 Indian Ocean Tsunami. Indian Ocean countries faced significant challenges in tsunami preparedness due to limited historical data on major tsunamis, which led to a low awareness of tsunami risks and inadequate scientific capacity and resources for conducting thorough risk assessments that incorporated physical hazards as well as the social, economic and environmental vulnerabilities of coastal communities. There was also a disconnection between scientific understanding and traditional local knowledge of the natural warning signs of a tsunami. These risk knowledge gaps left many countries underprepared to effectively mitigate and respond to the tsunami. For example, in Thailand, the limited understanding of the potential impacts of tsunamis on coastal areas had meant that the country's rapid coastal development, particularly for tourism, had occurred without proper consideration of tsunami risks in zoning policies.[7]

Monitoring and warning services

Monitoring and warning services are key for any early warning system. A rigorous scientific foundation is essential for predicting and forecasting hazards using a reliable warning system that must be operational at all times. Continuous monitoring of hazard parameters and precursors is needed to generate accurate warnings in a timely manner. Multi-hazard early warning systems should be prioritized but, at the very least, warning services for different hazards should coordinate with each other to benefit from shared institutional, procedural and communication networks.

Regional monitoring and warning services did not exist in 2004, which undermined ASEAN's tsunami preparedness, severely limiting the ability to detect and forecast impending tsunamis. In contrast to the Pacific, which had the Pacific Tsunami Warning and Mitigation System (PTWS), there was no dedicated regional warning centre for Indian Ocean countries to coordinate detection and alert efforts, and insufficient seismic monitoring networks in many countries. These systemic gaps meant that ASEAN countries were often unable to provide timely and accurate warnings to at-risk coastal populations. In Indonesia, for example, the national Meteorology, Climatology and Geophysical Agency (BMKG) detected the initial earthquake but lacked the capabilities to determine whether it had generated a tsunami. This limitation, combined with the absence of ocean-based sensors, resulted in critical delays in issuing warnings to coastal communities.[8]

Dissemination and communication

5 UNISDR (2006). Developing Early Warning Systems: A Checklist. Third International Conference on Early Warning, Bonn, Germany, 27–29 March 2006. https://www.preventionweb.net/files/608_10340.pdf
6 United Nations (2022). Early Warnings for All Initiative Executive Action Plan 2023–2027. https://www.preventionweb.net/media/84612/download?startDownload=20250206
7 UNCT Thailand (2005). Tsunami Thailand: One Year Later – National Response and Contribution of International Partners. https://www.gfdrr.org/sites/default/files/publication/Tsunami%20Thailand%2C%20One%20Year%20Later%2C%20National%20Response%20and%20the%20Contribution%20of%20International%20Partners.pdf.
8 Government of Indonesia (2005). Indonesia: Preliminary Damage and Loss Assessment – The December 26, 2004 Natural Disaster. https://www.preventionweb.net/media/75348/download?startDownload=20250206.

Warnings must reach all communities and individuals who are at risk from an impending hazard. Clear messages containing simple and actionable information are essential for enabling effective responses that can save countless lives. Regional, national and community-level communication systems must be planned in advance of a disaster. Multiple communication channels should be used to help ensure that warnings reach as many people as possible, both to avoid the failure of any one communication channel, and to reinforce the urgency of the warning message to its intended recipients.

In 2004, the effectiveness of tsunami warnings in Indian Ocean countries was compromised by the absence of early warning systems, along with a lack of established channels for rapid and efficient communication of warnings to at-risk populations. Without standardized communication protocols, warnings from authorities often struggled to reach local communities, and there was insufficient public awareness among coastal populations of tsunami risks and how they should respond to warnings. In Malaysia, for example, the lack of a standardized communication protocol led to delays in relaying crucial information from national authorities to local communities: the country's disaster management mechanism at the time was primarily designed for floods[9] and did not adequately address rapid-onset disasters like tsunamis, resulting in confusion and delayed evacuation orders.

Response capability

Public awareness and education programmes are critical for ensuring that communities have the knowledge to understand their risks and respect the warning services, and have the capacities and understanding of how to react to early warning messages. Disaster management plans should be in place, well-practised, and regularly tested and improved. Communities should be well-informed about how they should respond, the available escape routes, and how best to avoid damage to property.

The 2004 tsunami revealed that coastal communities in affected countries were not prepared to respond effectively to a tsunami. Critical gaps included the absence of community-level disaster preparedness plans that were specifically tailored for tsunami response and evacuation, insufficient public education on tsunami risks and appropriate response actions, and inadequate infrastructure, including proper evacuation routes, safe shelters and emergency supplies. These systemic gaps in resilience significantly hindered the ability of coastal populations to protect themselves and mitigate the impacts of the tsunami. For example, in Myanmar, like many other countries in the region, there was a lack of community-level disaster preparedness plans, evacuation routes and regular drills, which severely limited the ability of people to take appropriate and timely action. The country's coastal communities, which were already vulnerable due to high poverty rates and limited investments in infrastructure, were left with little guidance on how to respond to the unfolding disaster, and weak capacity to do so.[10]

9 Government of Malaysia (1997). National Security Council Directive No. 20: Policy and Mechanism of National Disaster Management and Relief. https://www.rcrc-resilience-southeastasia.org/wp-content/uploads/2017/12/1997_policy_and_mechanism_of_national_disaster_management_and_relief_national_security_council_directive.pdf

10 Government of Myanmar (2016). Myanmar National Framework for Community Disaster Resilience: Promoting People-centered, Inclusive, and Sustainable Local Development. https://themimu.info/sites/themimu.info/files/documents/Core_Doc_National_Framework_for_Community_Disaster_Resilience.pdf.

The 2004 tsunami served as a wake-up call, highlighting the urgent need for comprehensive, people-centred early warning systems. Significant efforts have been made in response to this catastrophic event to establish and strengthen EWS, not only for Indian Ocean countries, but globally as well. These efforts have been guided by international frameworks, particularly the Hyogo Framework for Action (HFA) 2005–2015 and, subsequently, the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030, which emphasizes the importance of people-centred approaches to disaster risk reduction.[11] The improvements in tsunami EWS in the ASEAN region have been underpinned by several key enabling factors, which have created an environment conducive to the development and implementation of people-centred early warning systems.

11 United Nations General Assembly (2015). Sendai Framework for Disaster Risk Reduction 2015–2030. 23 June. A/RES/69/283. https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_69_283.pdf.

Box 1.2: Key findings from the 2024 assessment of early warning capacities of ASEAN countries

Risk knowledge

The assessment found that legislative frameworks across ASEAN provide a foundation for disaster risk knowledge, with most countries assigning risk assessment responsibilities to a designated national agency. This institutional clarity enables systematic data collection and analysis, yet gaps remain in integrating scientific and technical expertise into risk assessments. While strong legislation exists, the incorporation of scientific review and best practices for risk data collection and sharing is still in early stages. Malaysia's Science Expert Panel (SET) serves as a model for bridging this gap by engaging academia, the private sector and technical agencies in EWS development. However, most ASEAN countries face challenges in understanding compound and secondary risks, particularly in relation to critical infrastructure vulnerabilities, which are often overlooked in disaster risk reduction efforts.

A key limitation in ASEAN's disaster risk knowledge is the fragmented nature of risk and hazard data management. Most ASEAN countries rely on multiple data repositories spread across different agencies, leading to inefficiencies such as data silos, duplication and inconsistencies. While the ASEAN Disaster Monitoring and Response System (DMRS) offers a regional repository, integration with national data sets remains limited. Moreover, the assessment found that while sex- and age-disaggregated vulnerability data are commonly collected, disability data are often absent. Systematic engagement with diverse groups, including rural and urban populations, women, children, older people and persons with disabilities, is also limited, reducing the inclusivity of disaster risk assessments.

Monitoring and warning services

The assessment found that the ASEAN region exhibits significant variability in hazard detection, monitoring and forecasting capacities. While some ASEAN countries, notably Indonesia and the Philippines, have made substantial progress in modernizing their systems, others face challenges in maintaining and upgrading monitoring infrastructure. A major concern is the lack of long-term planning for system maintenance, which has led to ageing equipment and service disruptions in several countries. Moreover, EWS software is not consistently updated to meet evolving security and performance standards, increasing the risk of system failure. Malaysia presents a model for system monitoring, with daily system logs ensuring continuous functionality, yet many ASEAN countries lack similar oversight, leading to potential gaps in hazard detection.

Another critical issue is the absence of interagency agreements and protocols for data exchange, which hinders the consistency of warning information across the region. While warning agencies are generally aware of their responsibilities, coordination between institutions remains weak. Cross-border exchange of hazard data is also inconsistent. Given the transboundary nature of many hazards, including tsunamis, this gap presents a significant risk to regional early warning efforts.

Dissemination and communication

The assessment found that warning dissemination remains one of the weakest components of ASEAN's early warning systems, with significant limitations in most ASEAN countries. While countries such as the Philippines and Singapore have well-developed systems, many others struggle with ensuring warnings are clear and actionable and effectively reach at-risk populations. The assessment found that while multi-channel dissemination approaches exist, they often fail to address the specific needs of different demographic groups. The Lao People's Democratic Republic demonstrates a strong multi-channel approach, yet most ASEAN countries lack tailored communication strategies for women, older people, youth and persons with disabilities. This results in uneven warning coverage and increased vulnerabilities among marginalized communities.

A further challenge is the limited clarity of warning messages. Many ASEAN countries issue hazard alerts but do not provide explicit guidance on necessary actions, reducing public responsiveness. Singapore's Public Warning System is an exception, employing a siren network with well-understood signals that trigger specific protective actions. Moreover, many ASEAN

countries lack mechanisms to assess the effectiveness of their warning channels, leaving gaps in coverage unaddressed. Trust in warning providers is also a concern, with many countries exhibiting significant public uncertainty about which agencies are responsible for issuing alerts.

Response capability

The assessment found that while ASEAN countries generally have well-defined legislative frameworks outlining responsibilities for preparedness and response, implementation remains uneven. A key gap is the lack of capacities to assess how communities respond to early warnings, limiting the effectiveness of preparedness strategies. Innovative approaches, such as Indonesia's Petabencana.id and the Philippines' Mapakalamidad.ph, which use crowd-sourced alerts via social media and mobile technologies, offer promising models for enhancing community-level communication. However, in most ASEAN countries, limited understanding of local communication barriers undermines response efforts. Furthermore, while some ASEAN countries, including the Lao People's Democratic Republic, Myanmar and Viet Nam, have well-developed disaster preparedness plans, the regular testing and revision of these plans remain insufficient.

Another area of concern is the inconsistent use of risk assessments in evacuation planning. The Philippines and Singapore lead in this regard, integrating multi-hazard risk data into evacuation route design and shelter planning. However, many other ASEAN countries have faced situations where shelters have been inundated or evacuation routes obstructed, highlighting weaknesses in preparedness measures. There is also limited consideration of vulnerable groups in disaster planning, with education and awareness programmes often failing to address their specific needs. A notable exception is the Mekong Flood and Drought Forecast TV Channel, used in Cambodia, the Lao People's Democratic Republic, Thailand and Viet Nam to enhance public awareness. However, broader efforts are required across ASEAN to ensure preparedness measures are inclusive and linked to early action mechanisms, with adequate funding to support emergency responses.

Source: ASEAN (2024). Strengthening ASEAN Multi-Hazard End to End Early Warning System for Natural Disasters: An Assessment of Current Capacity. https://asean.org/book/strengthening-asean-multi-hazard-end-to-end-early-warning-system-for-natural-disasters/.

PHOTO: UNDP CAMBODIA

Enabling factors for people-centred early warning systems

The improvements in tsunami early warning systems in the ASEAN region have been underpinned by five key enabling factors, which have created an environment conducive to the development and implementation of people-centred EWS:

- Tsunami monitoring and risk assessments
- Regional early warning implementation and coordination
- National policy and legal frameworks
- Planned responses to an early warning
- Sustainable financing for EWS.

1. TSUNAMI MONITORING AND RISK ASSESSMENTS

Tsunami monitoring and risk assessments are the foundation for effective people-centred EWS in the ASEAN region. In the wake of the devastating 2004 Indian Ocean Tsunami, it was clear that there was a pressing need for more accurate and timely tsunami monitoring and comprehensive risk assessments that could help countries to better understand the tsunami threats they face, enabling them to make decisions that strengthen their preparations and responses to tsunami threats.

Tsunami monitoring

The adoption of real-time tsunami monitoring systems has been a critical advancement. Technologies and instruments such as tsunameters (which detect and measure tsunamis by monitoring changes in ocean bottom pressure caused by tsunami waves), tide gauges (which measure the height of the water level relative to a fixed point), buoys (which detect changes in sea surface height and pressure) and satellite-based observations (which monitor sea surface changes and wave propagation) are now deployed across the Indian Ocean to detect tsunami waves and provide early warnings.[12] These real-time systems help detect the speed, height and direction of waves, allowing for more accurate warnings of when and where a tsunami might make landfall. This information is vital for issuing timely warnings, giving coastal communities precious minutes or hours to evacuate and prepare. These tools have also allowed disaster management agencies to optimize evacuations based on the speed and direction of tsunamis, significantly enhancing the likelihood of saving lives during emergencies.

Thailand, for example, has installed a national tsunami detection and warning system, including buoys and coastal radar stations. The country now operates two tsunami detection buoys in the Andaman Sea, which can detect changes in water pressure, which are indicative of a tsunami.[13] This system is complemented by a network of 136 warning towers along the Andaman coast, capable of broadcasting warnings in multiple languages to cater to both local residents and tourists.[14] Thailand has also produced detailed tsunami inundation maps for six Andaman coast provinces, which show potential inundation areas for different tsunami scenarios, and which have been crucial in urban planning, determining evacuation routes, and raising public awareness about tsunami risks.[15]

Tsunami risk assessments

Tsunami risk assessments draw from historical tsunami data, scientific models, and bathymetry and topography data, which help authorities to better understand where, how large and how likely a tsunami could occur, and provide targeted support to reduce tsunami risks. Tsunami risk assessments provide the foundational data that countries can use to develop products critical for people-centred EWS, including evacuation maps, hazard maps, inundation maps, Scenario-based Tsunami Hazard Analysis (STHA) and Probabilistic Tsunami Hazard Analysis (PTHA). Risk assessments also increasingly incorporate multi-hazard analysis, recognizing that areas that are vulnerable to tsunamis are often exposed to other coastal hazards, such as cyclones and storm surges. By integrating tsunami risk assessments with other hazard analyses, governments can develop comprehensive disaster risk reduction strategies that protect populations from a range of threats, helping authorities allocate resources more effectively across different types of emergencies.

Based on the 2024 Capacity Assessment of the Indian Ocean Tsunami Warning and Mitigation System (IOTWMS), led by UNESCO-IOC,[16] 86 percent of Indian Ocean countries that responded to the survey (19 out of 22 countries) conduct tsunami risk assessments, either through a multi-hazard risk assessment that includes tsunamis or a single hazard assessment on tsunamis.[17] However, the capacity for undertaking tsunami hazard assessments varies between countries: while 59 percent

12 UNESCO (2023). "New ocean observing technologies to advance vital Tsunami Warning Systems". 28 July. https://www.unesco.org/en/articles/new-ocean-observing-technologies-advance-vital-tsunami-warning-systems.

13 Bangkok Post (2022). "Two tsunami-detection buoys off Phuket being replaced". Achadthaya Chuenniran. 15 November. https://www.bangkokpost.com/thailand/general/2438534/two-tsunami-detection-buoys-off-phuket-being-replaced.

14 Government of Thailand (2015). National Disaster Risk Management Plan 2015. https://www.disaster.go.th/upload/download/file_attach/584115d64fcee.pdf.

15 Government of Thailand (2005). Green Line Vol. 15. https://datacenter.dcce.go.th/service-portal/environmental-media-system/electronics-detail/?id=10044.

16 UNESCO Intergovernmental Oceanographic Commission (UNESCO-IOC) (2025) (forthcoming). Capacity Assessment of Tsunami Preparedness in the Indian Ocean: Status Report 2024. This report conducted a survey of Indian Ocean countries, of which 22 responded: Australia; Bangladesh; Comoros; France Indian Ocean Territories; India; Indonesia; Iran; Kenya; Madagascar; Malaysia; Maldives; Mauritius; Mozambique; Myanmar; Oman; Pakistan; Seychelles; Singapore; South Africa; Sri Lanka; Thailand; and United Arab Emirates.

17 ESCAP (2024). Tsunami Preparedness Within a Multi-Hazard Context: Opportunity for Enhanced Regional Cooperation – Summary for Policy and Decision Makers in the Indian Ocean Basin. https://www.unescap.org/kp/2024/tsunami-preparedness-within-multi-hazard-context-summary-policy-and-decision-makers-indian.

of countries (13 out of 22 countries) rate their capacity as very good or good, 14 percent (3 out of 22 countries) report poor or very poor capacity, indicating areas where further support is needed.[18]

For example, Indonesia, one of the countries most affected by the 2004 tsunami, has made significant progress in mapping tsunami-prone areas and identifying vulnerable communities along its extensive coastline.[19] The country has conducted detailed tsunami risk assessments for major coastal cities, incorporating factors such as population density, critical infrastructure and evacuation capacity. These assessments have been used to develop targeted risk reduction measures, including the designation of tsunami-safe zones and the construction of evacuation shelters.[20]

To strengthen tsunami assessments, countries can use a combination of Scenario-based Tsunami Hazard Analysis (STHA) and the newer Probabilistic Tsunami Hazard Analysis (PTHA) to evaluate the potential size and likelihood of tsunamis affecting coastal areas.[21] STHA, also known as deterministic analysis, considers specific scenarios based on likely or worst-case tsunami events and historical data. It provides valuable insights for targeted areas, guiding evacuation planning and informing tsunami countermeasures and land-use planning. However, STHAs are often limited in scope, as they do not account for varying probabilities across regions, which can limit broader disaster planning efforts. PTHAs are a complementary forecasting methodology that offer a structured framework for understanding tsunami risks over time and space, taking into account uncertainties such as variations in seismic source characteristics and the probability of extreme events. The primary benefit of PTHA is its ability to provide a long-term risk perspective, informing the design of infrastructure, urban planning, and disaster management strategies.

18 Ibid.

19 AHA Centre and JICA (2015). *Country Report: Indonesia – Natural Disaster Risk Assessment and Area Business Continuity Plan Formulation for Industrial Agglomerated Areas in the ASEAN Region.* March. https://openjicareport.jica.go.jp/pdf/1000023394.pdf.

20 Benazir and Oktari, R.S. (2024). "Assessing tsunami risk along the Aceh coast, Indonesia: A quantitative analysis of fault rupture potential and early warning system efficacy for predicting arrival time and flood extent". Natural Hazards, 120: 4875–4900. https://link.springer.com/article/10.1007/s11069-024-06401-x.

21 UNESCO-IOC (2015). *Tsunami Risk Assessment and Mitigation for the Indian Ocean: Knowing Your Tsunami Risk – and what to do about it.* IOC Manuals and Guides No. 52. Second Edition. July. Paris: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000184777.locale=en.

Box 1.3: Probabilistic forecasting

Forecasts need to be expressed in probabilistic terms that account for uncertainty, in order for users to be able to make risk-informed decisions based on the likelihood of potential risks. A probabilistic approach can provide the full range of possible scenarios while taking into consideration the level of importance of the situation and the magnitude of potential impacts. A regional organization like the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) could be entrusted by ASEAN countries to provide this forecasting support, based on its economies of scale and ability to facilitate ensemble forecasting (a method used in numerical weather prediction that produces a set of forecasts, rather than a single forecast of the most likely weather), based on different schemes and multiple data sources. Ensemble forecasting can then be adopted for a probabilistic approach to generate forecast communications that can be used to inform decision-making processes.

For extreme hazard events like tsunamis, predictions should be probabilistic in nature rather than deterministic. For example, over 200 people were killed after a tsunami hit coastal towns on Indonesia's Sunda Strait in 2018. There was no warning of the giant waves that struck at night, destroying hundreds of buildings. This event was presumed to be caused not by an earthquake, but by submarine landslides from the Anak Krakatau volcano, and as major regional and national tsunami EWS relied on earthquake parameters at that time, no early warning was issued. This kind of significant disaster event happens only once every 25 to 100 years, so are not captured in short-term project implementation periods, are not remembered due to the long time between infrequent high-impact disasters, and information on such events happening in a particular location in one country is not necessarily shared with other at-risk countries. Therefore, regional institutions like RIMES are important to institutionalize the memories of such events and link them with other hazard events in the future.

Source: Expert inputs from RIMES (2024).

Gaps remain, despite the progress made in the last 20 years. Some countries in the region still lack comprehensive, real-time data for certain hazards, and rural areas often have insufficient resources to maintain advanced monitoring equipment.[22] Moreover, the variability in data quality and risk assessment

22 Behrens, J., Løvholt, F., Jalayer, F., Lorito, S., Salgado-Gálvez, M.A., Sørensen, M., Abadie, S., Aguirre-Ayerbe, I., Aniel-Quiroga, I., Babeyko, A.Y., Baiguera, M., Basili, R., Belliazzi, S., Grezio, A., Johnson, K., Murphy, S., Paris, R., Rafliana, I., De Risi, R., Rossetto, T., Selva, J., Taroni, M., Del Zoppo, M., Armigliato, A., Bureš, V., Cech, P., Cecioni, C., Christodoulides, P., Davies, G., Dias, F., Bayraktar, H.B., González, M., Gritsevich, M., Guillas, S., Harbitz, C.B., Kâno□lu, U., Macías, J., Papadopoulos, G.A., Polet, J., Romano, F., Salamon, A., Scala, A., Stepinac, M., Tappin, D.R., Thio, H.K., Tonini, R., Triantafyllou, I., Ulrich, T., Varini, E., Volpe, M. and Vyhmeister, E. (2021). "Probabilistic Tsunami Hazard and Risk Analysis: A Review of Research Gaps". Frontiers in Earth Science, 9: 628772. https://gfzpublic.gfz-potsdam.de/rest/items/item_5007372_1/component/file_5007390/content.

methodologies across ASEAN countries complicates regional cooperation and data sharing. There is also a growing need for more localized risk assessments that account for community-specific vulnerabilities, particularly in coastal areas where populations are highly exposed to tsunami risks. According to the 2024 IOTWMS Capacity Assessment, while 13 out of 22 countries (59 percent) conduct tsunami hazard assessments at the national level, coverage decreases at more local levels, with only 6 out of 22 countries (27 percent) conducting them at the village level. Notably, only half of the countries perform hazard assessments across multiple levels, highlighting the need for more comprehensive, community-specific assessments in tsunami-prone areas.[23]

While progress has been made in early detection of tsunamis, significant gaps remain in terms of near-field tsunami detection and response, particularly for atypical tsunami sources like coastal landslides or volcanic collapses. Tsunami hazard assessments should consider the likelihood of tsunamis triggered by sources other than earthquakes, as well as those from subduction zone earthquakes.[24] The 2004 tsunami was triggered by the Sumatra subduction zone earthquake. Since then, the Indian Ocean has experienced several additional tsunamis, most of which were triggered by subduction earthquakes, but these tsunamis have largely been effectively managed by the interoperable IOTWMS. However, two tsunamis in Indonesia in 2018—one in Sulawesi and another in Anak Krakatau—were triggered by non-earthquake sources (by a submarine landslide and a volcanic flank collapse respectively). These types of events generate local tsunamis and fall outside the original design of the IOTWMS. This underscores the need to address tsunamis from non-seismic and complex sources, which has become a primary focus in advancing tsunami hazard assessment, warning and mitigation by the IOTWMS and other global systems. To support this, Indonesia has established national warning systems to address the risk of locally generated volcano-triggered tsunamis, and Australia has developed regional threat information products for tsunamis generated by volcanic activity.

23 ESCAP (2024). Tsunami Preparedness Within a Multi-Hazard Context: Opportunity for Enhanced Regional Cooperation – Summary for Policy and Decision Makers in the Indian Ocean Basin. https://www.unescap.org/kp/2024/tsunami-preparedness-within-multi-hazard-context-summary-policy-and-decision-makers-indian.
24 Ibid.

Box 1.4: Comprehensive tsunami risk assessments in Malaysia

The Malaysian Meteorological Department has strengthened its seismic monitoring network and established a National Tsunami Early Warning System.[25] This system includes seismological and tide gauge stations, as well as sirens and warning broadcasts to disseminate alerts quickly to coastal communities. Malaysia has made significant strides in tsunami preparedness through comprehensive risk assessments along its coastlines, identifying high-risk areas and vulnerable populations. This process encompassed geological and bathymetric surveys to understand seafloor topography and its impact on tsunami propagation, analysis of historical data coupled with future scenario modelling, assessment of coastal infrastructure, and evaluation of social vulnerability factors.

Notably, Malaysia adopted a participatory approach, engaging communities to incorporate local knowledge and perspectives, thereby enhancing assessment accuracy and fostering community buy-in for risk reduction measures. The resulting comprehensive risk data have been instrumental in developing targeted mitigation strategies and evacuation plans. In Penang, one of Malaysia's most tsunami-prone areas, these data have been used to designate hazard zones and safe areas, implement structural mitigation measures, develop tailored evacuation plans, and inform land-use planning decisions to reduce long-term tsunami risks.[26] This holistic approach demonstrates the critical importance of detailed risk assessments in building coastal resilience and effective disaster management strategies.

2. REGIONAL EARLY WARNING IMPLEMENTATION AND COORDINATION

Following the 2004 Indian Ocean Tsunami, it became evident that the ASEAN region faced serious challenges in early warning and disaster preparedness.[27] While coordinated early warning at the regional level would be critical for avoiding large-scale disasters in the future, there was little regional coordination among countries in addressing transboundary hazards, leading to inefficiencies in response and preparedness. Countries lacked mechanisms for sharing critical data and information across borders. Warning dissemination methods varied widely across the region, with many remote and vulnerable communities left underserved.

25 EarthScope Consortium (2005). "Malaysian National Seismic Network". Data Services Newsletter. Vol 7, No 2, June. https://ds.iris.edu/ds/newsletter/vol7/no2/319/my-network-providing-seismic-data-from-malaysia/#:~:text=The%20Malaysian%20Meteorological%20Department%20%28MMD,%2C%20Tawau%20and%20Telupid%20%28Sandakan%29.
26 Naim, N.N.N., Mardi, N.H., Malek, M.A., Teh, S.Y., Wil, M.A., Shuja, A.H. and Ahmed, A.N. (2021). "Tsunami inundation maps for the northwest of Peninsular Malaysia and demarcation of affected electrical assets". Environmental Monitoring and Assessment, 193: 405. https://link.springer.com/article/10.1007/s10661-021-09179-8.
27 United Nations (2006). Global Survey of Early Warning Systems. https://www.unisdr.org/2006/ppew/info-resources/ewc3/Global-Survey-of-Early-Warning-Systems.pdf.

Since the IOT, the ASEAN region has made substantial progress in building frameworks and mechanisms that emphasize coordination between governments and regional and international organizations. In particular, the establishment of IOTWMS and RIMES, and the strengthening of regional mechanisms through ASEAN and the ASEAN Agreement on Disaster Management and Emergency Response (AADMER), have contributed to strengthening coordination and cooperation between ASEAN countries.[28] The establishment of IOTWMS and RIMES, though not formed through an ASEAN-specific mechanism, has also significantly contributed to enhancing EWS of the ASEAN countries that are covered by these initiatives.

Implementing and coordinating tsunami EWS at the regional level for Indian Ocean countries is essential due to the transboundary nature of many tsunamis. Many Indian Ocean countries are situated in close proximity to each other, meaning that a tsunami generated near one coastline can impact multiple countries within hours or even minutes. Regional coordination enables the seamless exchange of real-time data, such as seismic and sea-level readings, ensuring that all affected nations receive timely and accurate warnings. This collaborative approach is especially beneficial for countries with fewer resources or lower capacities, which may lack the infrastructure for independent monitoring systems but can benefit from shared expertise and resources provided by regional mechanisms.

Moreover, a regional approach fosters standardization of protocols and communication channels among Indian Ocean countries, enhancing the efficiency of cross-border disaster response efforts. Coordinated drills, training programmes and shared technological platforms ensure that all member countries are aligned in their strategies for issuing warnings and managing evacuations. By working together, ASEAN countries can avoid duplication of effort, reduce costs and ensure comprehensive coverage. This collective preparedness strengthens resilience across the region, ultimately saving lives and reducing the impacts of tsunamis. This section explores some of the regional mechanisms for early warning implementation and coordination that have been established since the Indian Ocean Tsunami.

ICG/IOTWMS

A major initiative driving the implementation of EWS in the Indian Ocean is the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS), which was established in 2005 under the Intergovernmental Oceanographic Commission of UNESCO (UNESCO-IOC) as a response to the 2004 Indian Ocean Tsunami.[29] This has led to the development of an interoperable network connecting national and regional systems for tsunami monitoring, warnings and advisories. This network is strengthened by shared guidelines and best practices for assessing and reducing tsunami risks, alongside initiatives to increase community awareness and readiness.

A key achievement of the ICG/IOTWMS has been the establishment of a Regional Tsunami Service for the Indian Ocean, which became operational in October 2011, with Tsunami Service Providers (TSPs) established by Australia, India and Indonesia assuming the responsibility of providing tsunami advisory services and detailed tsunami threat information to Member States, enabling them to make informed decisions.[30] In order to ensure that all Member States can access critical information in real time, the IOTWMS is interoperable, which enables free, open and functional exchanges of tsunami information.

The ICG/IOTWMS conducts regular meetings to develop and implement work programmes, which are managed by the following Working Groups with members elected by the ICG:

- Working Group 1 (Tsunami Risk, Community Awareness and Preparedness) supports the enhancement of capacities of Member States for tsunami risk assessment and mitigation, and community awareness and preparedness.
- Working Group 2 (Tsunami Detection, Warning and Dissemination) supports the enhancement of national tsunami warning capacities and the monitoring and assessment of Tsunami Service Providers (TSPs) in delivering tsunami threat information to Member States.
- Working Group 3 (Tsunami Ready Implementation) supports the monitoring and assessment of the implementation of the Tsunami Ready programme[31] and related activities in communities.

The ICG/IOTWMS has focused on strengthening regional capacities for tsunami detection and response by facilitating technical cooperation, joint exercises and information sharing among Indian Ocean countries, including those in the ASEAN region. For example, ICG/IOTWMS conducts Indian Ocean-wide tsunami simulation exercises to test and refine the readiness and operational capabilities of the end-to-end IOTWMS.[32] These exercises help identify gaps in national EWS protocols and provide opportunities for countries to improve their coordination mechanisms.

RIMES

The Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) serves as a model for people-centred Early Warning Systems that encompass not only tsunamis, but also floods, storms and other natural hazards. RIMES emerged from a proposal by the Government of Thailand in the aftermath of the 2004

28 ASEAN (2009). ASEAN Agreement on Disaster Management and Emergency Response. https://agreement.asean.org/media/download/20220330063139.pdf.
29 UNESCO-IOC. "Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS)". https://tsunami.ioc.unesco.org/en/indian-ocean/icg-iotwms.
30 UNESCO-IOC (2019). Indian Ocean Tsunami Warning and Mitigation System (IOTWMS): Medium Term Strategy 2019–2024. https://unesdoc.unesco.org/ark:/48223/pf0000370770.locale=fr .
31 The UNESCO-IOC Tsunami Ready Recognition Programme is an international community-based effort aimed at enhancing risk prevention and mitigation measures in coastal regions worldwide. https://tsunami.ioc.unesco.org/en/tsunami-ready.
32 UNESCO-IOC. IOWave Tsunami Exercises. https://tsunami.ioc.unesco.org/en/iowave.

Indian Ocean Tsunami and was officially established in 2009, with support from the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness. RIMES is a regional EWS within a multi-hazard framework, established in order to build capacities for preparedness and response to transboundary hazards, including tsunamis. The founding Member States envisioned RIMES as a forum to promote collective efforts to level the playing field and overcome their dependence on technical and resource support for managing disasters.

RIMES aims to address gaps in the end-to-end early warning information value chain through providing technical support, strategic partnerships and capacity building at all levels.[33] RIMES assists its Member States in establishing and maintaining EWS within a multi-hazard framework, based on each country's needs. It also provides expertise to build regional platforms for data sharing, risk communication and research efforts from a multi-hazard perspective, encompassing climatic, seismic, oceanic and hydro-meteorological hazards. RIMES offers integrated solutions to improve modelling and forecasting capabilities and build Decision Support Systems (DSS) that facilitate rapid response to transboundary hazards.

Since its inception, RIMES has adopted common but differentiated service delivery to cater to the needs of its 22 Member States and 27 Collaborating States with varying levels of capacities in hydrometeorological forecasting and impact-based forecasting services. RIMES' user-centric service delivery includes observation systems, data communication, computing facilities, trained human resources and downscaling, in order to generate and interpret tailor-made forecasts and conduct community outreach programmes. RIMES has supported the implementation of a number of projects with ASEAN countries, including Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Thailand and Viet Nam.[34]

RIMES has demonstrated its ability to deliver high-quality services at a lower cost, making it an attractive and reliable partner for investment by Member and Collaborating States and development agencies.[35] RIMES has been delivering services along the five pillars of the climate information and early warning information services value chain (Figure 1.2) to meet the existing and emerging demands of its Member States, consistent with RIMES' institutional objectives:

1. Improving data availability by facilitating seamless integration of data into platforms that can be easily accessed and used.
2. Enhancing forecast skill and spatial and temporal resolutions through modelling, scientific research and development, and knowledge sharing.
3. Transforming data into usable information through development of Decision Support Systems (DSS) and co-production and co-design of tailored, user-specific climate information and early warning services for resource and risk management.
4. Ensuring that actionable climate information and early warning services are accessible to last-mile communities by enhancing the formats, media and channels used to disseminate and communicate.
5. Enabling institutional and end-users to use climate information and early warning services in risk and resource management policies, plans and operational decisions through training, workshops and awareness-raising.

33 RIMES. "Overview: Regional Integrated Multi-Hazard Early Warning System (RIMES) for Africa and Asia". https://rimes.int/aboutus/overview.

34 RIMES. "Projects sorted by Country". https://rimes.int/project/projects-sorted-country.

35 Expert inputs from RIMES (2024).

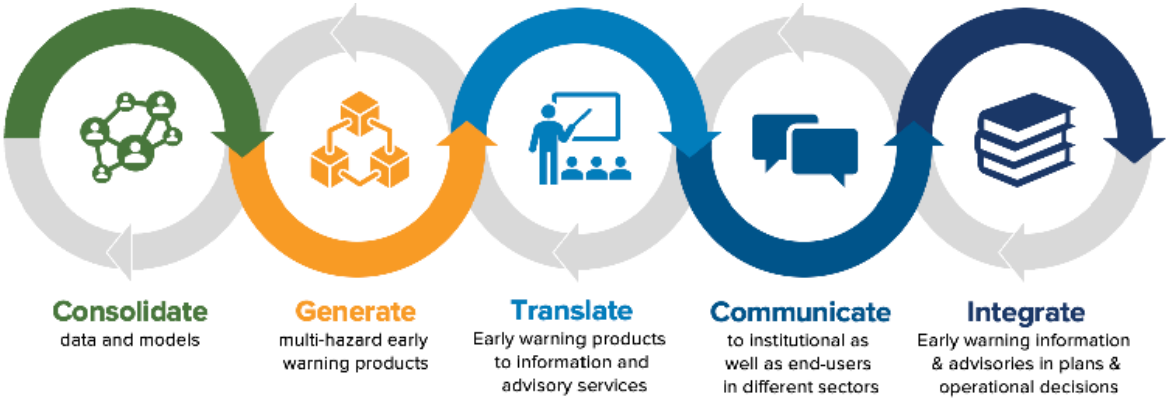


Figure 1.2: Climate information and early warning system services value chain

Source: Expert inputs from RIMES (2024).

Box 1.5: How RIMES pioneered multi-hazard EWS through regional cooperation

RIMES has been proactive in addressing the gaps in end-to-end and people-centred multi-hazard EWS through sharing resources and expertise and effective partnerships and collaboration with ASEAN countries to reduce the gaps in the five pillars of the climate information and early warnings system value chain[36]:

36 Expert inputs from RIMES (2024).

Improving data availability

Technology advancements resulted in significant improvements in the availability, accuracy and reliability of data from monitoring and observation stations. However, many low-capacity countries struggle to maintain these stations and sustain the required technical competencies to operate these stations. To bridge these challenges, RIMES continuously extends its support to National Meteorological and Hydrological Services (NMHS) through:

- Facilitating the enhancement of observing and monitoring systems by establishing and upgrading stations, including telemetered seismic, sea level, deep ocean, weather, water level and agro-meteorological observing systems. Similarly, RIMES operates a 24/7 regional facility for earthquake monitoring and tsunami warning, for which the RIMES system can detect seismic activity and potential tsunamis within minutes, providing crucial lead time for evacuation and other tsunami response actions.
- Assisting NMHS in integrating and unifying diverse data acquisition platforms and in developing a data portal for storage, exchange, dissemination and archiving.
- Supporting data sharing to ensure the availability of local data for improving forecast products. RIMES collects data from NMHS, performs data quality control, distributes quality-checked data to Member States and participating agencies (e.g. the European Centre for Medium-Range Weather Forecasts (ECMWF)) and uses these data to improve RIMES products and for sector-based impact assessment studies.

Enhancing forecast skills and spatial and temporal resolutions

Recent technological advancements have significantly broadened the capabilities of forecasters, who now have access to a suite of advanced tools and a wealth of data (including radar images, satellite pictures and model outputs). While this data-rich environment offers the potential for better forecasting, there are also challenges in optimizing the use of these resources and in the increasing level of technical capacities required from forecasters. Leveraging its innovative competencies and technical expertise, RIMES supports its Member and Collaborating States through:

- Generating high-resolution weather (up to 10 days) and extreme weather information. RIMES' Weather Research Forecasting (WRF) model, originally developed at the U.S. National Center for Atmospheric Research (NCAR), is customized for the African and Asian regions using a horizontal grid spacing of 9x9 km, with 5-minute topography as one of the surface boundary conditions. The model generates daily weather information, with up to 84 hours lead time. RIMES WRF forecast products are provided daily, on demand, to NMHS of RIMES Member States. Whenever severe weather occurs over the region, RIMES integrates the model with higher grid resolution and severe weather information is provided to potentially affected countries.
- Providing downscaled climate projections, RIMES identifies global climate models that are consistent with observed climate data and trends over the region. Dynamical and statistical downscaling techniques are then used to generate climate scenarios for selected time slices for countries.
- Building capacities of scientists, forecasters and technical specialists through in-country training and on-the-job training at RIMES in the areas of climate modelling, numerical weather prediction, weather forecast–based flood forecasting and others.

Transforming data into usable information

Through regular discussions and interactions with NMHS, sectoral agencies and communities, it was found that one of the major gaps in the EWS value chains and climate information was the availability of customized information for different user needs. To address this gap, RIMES built its System Research and Development Team consisting of domain experts and IT experts. Since 2014, this team has been developing various Decision Support Systems (DSS) for different users from different sectors, including disaster management, water resources, agriculture and health, through:

- Developing and customizing DSS to meet the operational requirements of countries through a

co-production approach, working closely with scientists and technical experts from countries. This process also builds capacities and increases the use of DSS and associated tools at the country level. Tool customization integrates forecasts available from the NMHS and user requirements are determined through need assessments.

- Conducting hazard assessments to characterize the hazards that at-risk communities face, which are used as inputs for resilience planning. Earthquake, tsunami and storm surge hazard assessments use probabilistic methodologies that involve modelling. RIMES also supports strong winds and tropical cyclones hazard assessments based on thresholds, flood hazard assessments using hydrological and hydraulic modelling, drought hazard assessment involving calculations of standard precipitation, and drought hazard indices and sea-level rise hazard assessments using trend analysis from long-period historical observation data.

Enabling institutional and end-users, including last mile communities, to access and use climate information and early warning products and services

While countries in the region are working to streamline their early warning services to mitigate the impacts of climate-induced disasters, there is a need to deliver customized DSS and impact-based forecasts to local authorities for effective decision-making and to communicate actionable early warning information to at-risk communities. RIMES facilitates the access and use of climate information and early warning services for institutional and end-users, including last mile communities, through:

- Conducting pilot demonstrations of end-to-end EWS. RIMES formulates and implements people-centred community-based risk management actions, plans and protocols. RIMES provides tools and mechanisms for community-based risk management and builds the capacities to seamlessly use climate information at different timescales in planning and decision-making. Feedback from end-users on the usability of climate information is then used to improve RIMES' climate information products and delivery systems.
- Establishing Forecast Provider–User Forums, which aim to ensure that forecasts (including their uncertainties and limitations) are communicated to and understood by users, to encourage forecast application for mitigating risks in various climate-sensitive sectors (including disaster management and agriculture), to receive user feedback for improving the usability of forecast products and to provide a platform for inter-agency coordination of policies, sectoral plans and programmes for dealing with the potential impacts of hydro-meteorological hazards.

The future of RIMES as a regional integrator and innovation catalyst

RIMES' Institutional Development Plan (IDP) for 2024–2030 envisions being an integrator of services through partnerships. To enable this, RIMES will shift from solely "creating" to "creating and finding" solutions in order to continue to improve its products and services and leverage innovations through institutional partnerships. RIMES acts as an integrator: building partnerships, coordinating and blending expertise, data and systems to co-develop or co-produce innovative solutions for providing enhanced support to its Member States. By co-designing and co-creating solutions through partnerships, RIMES' ambition is for the solutions and interventions to be sustainable, fit-for-purpose and cost effective.

RIMES is a compelling example of a people-centred, multi-hazard, regional-scale EWS. Its success underscores the critical importance of regional cooperation in strengthening resilience to natural hazards in a world increasingly threatened by climate change.

ASEAN

ASEAN itself plays a pivotal role through facilitating the development of legal frameworks that promote regional cooperation for disaster risk reduction and EWS. In particular, the ASEAN Agreement on Disaster Management and Emergency Response (AADMER), which came into effect in 2009, is a legally binding framework that enhances disaster preparedness, response and recovery across ASEAN Member States. AADMER supports collaboration on EWS by promoting data sharing and joint disaster-preparedness exercises and harmonizing EWS across borders.[37] AADMER specifically commits ASEAN countries to enhance early warning capacities at the national and regional levels: Article 7(1) states that "the Parties[38] shall establish, maintain and periodically review national disaster early warning arrangements including: regular disaster risk assessment; early warning information

37 ASEAN (2020). AADMER Work Programme 2021–2025. https://asean.org/wp-content/uploads/2021/08/AADMER-Work-Programme-2021-2025.pdf.
38 The "Parties" in the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) refer to the 10 ASEAN Member States that have ratified the Agreement: Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam.

system; communication network for timely delivery of information and public awareness and preparedness to act upon the early warning information"; and Article 7(2) states that "the Parties shall co-operate to monitor hazards which have trans-boundary effects, to exchange information and to provide early warning information through appropriate arrangements".[39]

The ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre) was established in 2011 to support the operationalization of many of the regional processes outlined in AADMER. In particular, the AHA Centre supports regional EWS through the Disaster Monitoring and Response System (DMRS), which provides real-time information on hazards and disasters in the region, as well as hydrometeorological data, such as wind direction and speed, clouds and sea temperature.[40] Developed in collaboration with the Pacific Disaster Center (PDC) in Hawaii and supported by the U.S. Government, DMRS receives continuous data feeds from the PDC system. Basic maps in DMRS can also display additional layers, such as population density, airport and seaport locations, and key roads and infrastructure. More information on the role that ASEAN and the AHA Centre play in supporting regional collaboration for tsunami preparedness, response and recovery can be found under Lesson 4.

EW4All

Despite the considerable progress in the establishment of EWS for tsunamis in the Asia-Pacific region since the 2004 Indian Ocean Tsunami, gaps persist, posing a continued threat to many vulnerable coastal communities. Even within countries that are served by EWS, they are not always fully inclusive with marginalized communities, and particularly women and persons with disability, disproportionately affected, often not receiving early warning communications due to gender bias, socio-economic barriers, or lack of access to information and communication technologies.[41] A cohesive and comprehensive approach to address these gaps is critical, and will require collaborative efforts among countries, international organizations and communities to increase the resilience of the entire ASEAN region against the persistent threat of tsunamis.

In March 2022, UN Secretary-General, António Guterres, announced the UN would spearhead the Early Warnings for All (EW4All) initiative to ensure every person on Earth is protected by EWS within five years.[42] With only a few years remaining to achieve this aim, there is an urgent need to expedite efforts in Asia and the Pacific. The EW4All Executive Action Plan outlines the four pillars that align with the four elements of People-Centred EWS: 1) Disaster risk knowledge; 2) Detection, observations, monitoring, analysis and forecasting of hazards; 3) Warning dissemination and communication; and 4) Preparedness to respond.

The 2024 assessment of early warning capacities of ASEAN countries conducted resulted in a key recommendation to strengthen and harmonize regional EWS components in order to build an effective and resilient ASEAN end-to-end early warning system, that builds on the notable EWS efforts already undertaken across ASEAN.[43]
This recommendation was supported by four key programmatic areas:

1. Policy enhancement that focuses on refining risk and vulnerability assessments, ensuring interoperability, and improving public education and warning systems.
2. Institutional strengthening that emphasizes data-sharing agreements, knowledge exchange, and leveraging existing regional platforms like the ASEAN Disaster Monitoring and Response System (DMRS).
3. Capacity development that seeks to expand capacities across all four elements of people-centred EWS, particularly in risk and vulnerability assessments, use of cloud technologies for better alerting, and adopting an international Common Alerting Protocol (CAP) standard for message delivery.
4. Technical assistance that supports the implementation of these efforts through expert engagement, cloud hosting of EWS technologies, deploying mobile technologies and implementing the CAP. [44]

The EW4All initiative is an opportunity to take forward these findings and ensure that every person in the ASEAN region is protected by a multi-hazard, end-to-end EWS.

3. NATIONAL POLICY AND LEGAL FRAMEWORKS

The development of robust national policies and legal frameworks is essential for the successful implementation of people-centred EWS in the ASEAN region. Formal legislation plays a crucial role in mandating the establishment and operation of EWS, defining the roles and responsibilities of various institutions and stakeholders, and ensuring public participation in the process. The need for such policy and legal frameworks became clear after the 2004 tsunami when robust systems were found to be lacking in many of the affected countries, particularly in coordinating between local, subnational, national and regional authorities to ensure effective disaster preparedness and response.

Significant progress has been made in the years since the Indian Ocean Tsunami, with ASEAN countries building and strengthening their legal and institutional frameworks to support disaster preparedness and EWS integration, and improving vertical integration between national and local authorities. A key factor has been the development of national disaster management frameworks that clearly delineate the roles and responsibilities of national, subnational and local governments in disaster

39 ASEAN (2009). ASEAN Agreement on Disaster Management and Emergency Response. https://agreement.asean.org/media/download/20220330063139.pdf
40 AHA Centre. "Disaster Monitoring & Response System". https://ahacentre.org/disaster-monitoring/disaster-monitoring-response-system/.
41 UNDP (2016). Gender, Adaptation and Disaster Risk Reduction. https://www.undp.org/publications/gender-adaptation-and-disaster-risk-reduction.
42 United Nations (2022). Early Warnings for All Initiative Executive Action Plan 2023–2027. https://www.preventionweb.net/media/84612/download?startDownload=20250206.
43 ASEAN (2024). Strengthening ASEAN Multi-Hazard end to end Early Warning System for Natural Disasters: An Assessment of Current Capacity. https://asean.org/book/strengthening-asean-multi-hazard-end-to-end-early-warning-system-for-natural-disasters/
44 Ibid.

preparedness and response. Efforts have been made to align these national policies with international frameworks such as the Hyogo Framework for Action (HFA) 2005–2015 and the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030. These frameworks have influenced legal reforms in the ASEAN region through their commitment to building resilient communities and integrating EWS into national disaster risk reduction strategies, and their emphasis on the importance of "last-mile" communication, ensuring that early warnings reach even the most remote and vulnerable communities.

Vertical integration between national and local authorities has been improved in countries in the ASEAN region through policy reforms that have aimed to decentralize disaster management. In many ASEAN countries, disaster management responsibilities have been devolved to subnational and local governments, allowing for more flexibility and responsiveness in the face of emergencies. Local governments across the region now have more authority to allocate resources, implement evacuations and manage relief efforts, with national agencies providing oversight and support.

An example of how national policy and legal frameworks have improved in ASEAN since the Indian Ocean Tsunami can be found in Indonesia, where the enactment of the 2007 Law on Disaster Management marked a fundamental shift from a reactive approach to a comprehensive disaster management framework.[45] This law included the establishment of the National Disaster Management Agency, Badan Nasional Penanggulangan Bencana (BNPB), in 2008, which was tasked with setting guidelines, standardizing disaster response, and coordinating risk reduction efforts at the national levels.

45 Government of Indonesia (2007). Law No. 24/2007 Concerning Disaster Management. https://www.preventionweb.net/media/100015/download?startDownload=20250207

In tandem, the government institutionalized the Regional Disaster Management Agencies, Badan Penanggulangan Bencana Daerah (BPBDs), to decentralize efforts, ensuring that subnational entities could effectively integrate early warning measures into their local development plans.[46] This has been particularly important in regions like Aceh, which are at high risk for near-field tsunamis and require specialized response plans, as there may not be time for an early warning to be issued before a tsunami makes landfall. Local governments across the region now have more authority to allocate resources, implement evacuations and manage relief efforts, with the national and regional disaster management agencies providing oversight and support.

Strengthening the country's risk knowledge and monitoring and warning services was a key priority, particularly through the development of the Indonesian Tsunami Early Warning System (InaTEWS).[47] Originally established with international support, Indonesia's Meteorology, Climatology and Geophysical Agency (BMKG) took over full operation of the system in 2011, enhancing the country's ability to provide rapid warnings within five minutes of an earthquake. Indonesia has measured the progress of aligning the country's national policy and legal frameworks with both the Hyogo Framework for Action (HFA) 2005–2015[48] and the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030.[49]

46 CFE-DM (2015). Indonesia Disaster Management Reference Handbook. https://www.rcrc-resilience-southeastasia.org/wp-content/uploads/2017/12/2015_cfe_disaster_management_reference_handbook_indonesia.pdf.
47 BMKG (Government of Indonesia). InaTEWS: Indonesia Tsunami Early Warning System. https://rtsp.bmkg.go.id/.
48 BNPB (Government of Indonesia) (2014). Indonesia National Progress Report on the Implementation of the Hyogo Framework for Action (2013–2015). https://www.preventionweb.net/files/41507_IDN_NationalHFAprogress_2013-15.pdf.
49 BNPB (Government of Indonesia) (2023). Midterm Review Report of the Implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030 in Indonesia. https://sendaiframework-mtr.undrr.org/media/87566/download?startDownload=20250309

Box 1.6: The tsunami policy and legal framework in Thailand after the Indian Ocean Tsunami

Thailand provides a notable example of how comprehensive policy and legal frameworks have evolved to support more effective disaster risk reduction (DRR) and tsunami EWS. Thailand enacted the Disaster Prevention and Mitigation Act in 2007, which marked a paradigm shift in the country's approach to disaster management,[50] from a focus on relief and rehabilitation to a more proactive approach that integrates mitigation and preparedness.[51] The Act serves as the main framework for DRR and disaster response, and streamlined the country's disaster management systems to connect national agencies with provincial and local governments by clearly defining their roles and the coordinating mechanisms between them. The Act created the National Disaster Prevention and Mitigation Committee, chaired by the Prime Minister, to oversee national policies and strategies, and established the Department of Disaster Prevention and Mitigation (DDPM), under the Ministry of Interior, to coordinate disaster management efforts across all government levels.[52] The country also passed additional regulations and developed a National Disaster Risk Management Plan, which serves as a blueprint for the country's disaster risk management (DRM) and response planning, and is periodically updated.[53]

50 CFE-DM (2022). Disaster Management Reference Handbook – Thailand. https://reliefweb.int/report/thailand/disaster-management-reference-handbook-thailand-january-2022.
51 UNDP (2009). Institutional and Legislative Systems for Early Warning and Disaster Risk Reduction – Thailand. https://www.undp.org/sites/g/files/zskgke326/files/migration/asia_pacific_rbap/RBAP-CPR-2009-EWS-DRR-Thailand.pdf .
52 UNDP (2012). A Global Review: UNDP Support to Institutional and Legislative Systems for Disaster Risk Management. https://www.undp.org/sites/g/files/zskgke326/files/publications/Institutional%20&%20Legislative%20Support%20for%20DRM%20-%20UNDP.PDF.
53 CFE-DM (2022). Disaster Management Reference Handbook – Thailand. https://reliefweb.int/report/thailand/disaster-management-reference-handbook-thailand-january-2022.

Moreover, in response to the 2004 Indian Ocean Tsunami, the National Disaster Warning Center (NDWC) was established under the Prime Minister's order. This directive allowed the NDWC to become operational within just five months of the IOT.[54] Since 2016, the NDWC has been under the jurisdiction of the DDPM, within the Ministry of Interior, in order to create a more unified disaster management structure. The NDWC's primary responsibilities include monitoring and analysing disaster information from both domestic and international sources, assessing the potential consequences of a disaster, and promptly issuing warnings to the public. It is legally obligated to provide recommendations to government officials and relevant agencies on reducing losses, avoiding risks, evacuating affected areas and providing disaster relief. This information is essential for potentially impacted populations to make informed decisions and take appropriate actions.

The impact of this policy and legal framework on tsunami preparedness has been substantial, improving inter-agency coordination by assigning clear roles to different government departments, ensuring that disaster management strategies are integrated into national development plans, enhancing local capacities, ensuring sustainable funding for risk reduction activities, and promoting public awareness and education.[55] This management structure is supported by regular training and capacity-building initiatives that help local officials understand their roles under the national disaster management plan.[56] Thailand has also implemented decentralized EWS, where local governments have the authority to issue localized tsunami warnings based on information from national and regional warning centres. This has been particularly effective in tourist-heavy areas along the Andaman coast, where local officials are empowered to coordinate evacuations and manage response efforts independently, while still maintaining communication with national authorities.

By providing a clear structure for roles, responsibilities and resource allocation, the 2007 Disaster Prevention and Mitigation Act has significantly strengthened Thailand's ability to prepare for and respond to tsunami threats, demonstrating the critical role of comprehensive legislation in building resilience to natural disasters.

54 Pacific Disaster Center (2006). National Disaster Warning Center, Thailand: Concept of Operations. https://nctr.pmel.noaa.gov/education/IOTWS/CONOPS/USTDA_PDC_Thailand_CONOPS.pdf.
55 UNDP (2012). A Global Review: UNDP Support to Institutional and Legislative Systems for Disaster Risk Management. https://www.undp.org/sites/g/files/zskgke326/files/publications/Institutional%20&%20Legislative%20Support%20for%20DRM%20-%20UNDP.PDF.
56 Government of Thailand (2007). Disaster Prevention and Mitigation Act. http://project-wre.eng.chula.ac.th/watercu_eng/sites/default/files/lecture%20intro%202112681%20materials/9%20Disaster%20Prevention%20and%20Mitigation%20Act%202550.pdf.

Despite the progress made since 2004, gaps remain in ensuring vertical integration within countries for effective EWS. In particular, local governments in remote and rural areas in some countries still face significant challenges in maintaining communication with national disaster agencies during emergencies. This is particularly problematic in areas with poor infrastructure or limited access to technology, where local authorities may struggle to receive and act on early warnings in a timely manner. To address this gap, further investments are needed in improving communication infrastructure and enhancing local capacities, particularly in rural and underserved areas. More equitable distribution of resources is needed to ensure that all local governments, regardless of their location, are able to effectively implement national disaster plans and take action to protect people during a tsunami event.

4. PLANNING THE RESPONSE TO AN EARLY WARNING

Issuing a tsunami early warning triggers a number of processes within a country involving a range of institutions at all levels of government. Speed is of the essence, and there are two critical components. Firstly, a response process should have been comprehensively planned far in advance; and all actors within this system must have the capacities and knowledge to be able to act quickly and efficiently to implement that plan to ensure that the early warning message is distributed to all potentially affected communities as soon and as clearly as possible. Secondly, all the intended recipients of the early warning must have been empowered well in advance of the disaster with the knowledge and capabilities to respond to the early warning, so they can evacuate and protect themselves. This section will explore the first of these two components: planning the response to an early earning. The second component is explored below, under "Lesson 3: Empower communities to take action".

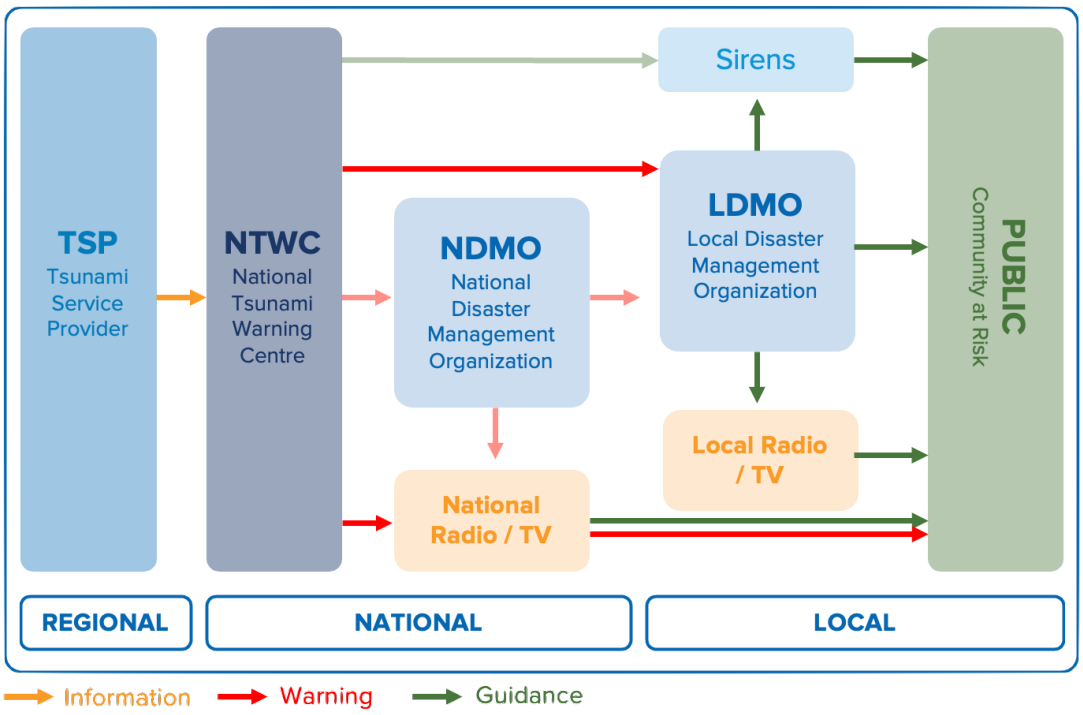


Figure 1.3: *Tsunami warning chain with decision-making for guidance at the local level*

Source: UNESCO-IOC (2015). *Tsunami Risk Assessment and Mitigation for the Indian Ocean: Knowing Your Tsunami Risk – and what to do about it.* IOC Manuals and Guides No. 52. Second Edition. July. Paris: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000184777.locale=en.

Effective EWS require thoughtful planning from the national to the community level, including the development of Standard Operating Procedures (SOPs), evacuation plans and communication strategies. The 2004 Indian Ocean Tsunami revealed that many of these plans were non-existent in affected areas, leading to confusion and delays in responding, and the lack of EWS and disjointed communication between government bodies led to severe delays in evacuations, exacerbating the death toll. The development of the IOTWMS has spurred the creation of national and local plans for tsunami preparation and response, significantly improving preparedness in the region. Once a tsunami early warning is issued, ASEAN countries must coordinate responses from the national to the community level, enabling communication to flow seamlessly from national authorities to local communities.

When a tsunami early warning is issued within a country, the process of communication begins at the national level, typically from the National Tsunami Warning Centre (NTWC) (see Figure 1.3). The NTWC receives advisory information from Tsunami Service Providers (TSPs), which monitor seismic activity and sea-level data to assess potential tsunami threats. The NTWC then passes the received information to the National Disaster Management Organization (NDMO) and local authorities (including Local Disaster Management Organizations – LDMOs), who must ensure swift and effective communication with vulnerable communities. A structured communication process must be in place, governed by SOPs, to ensure that each level of authority, from the national agencies to local disaster management offices, knows exactly what actions to take to save lives.[57]

Subnational and local governments play a crucial intermediary role in translating national alerts into action on the ground, using a variety of channels, such as text messages, radio, television and public alert systems like sirens, to communicate with the public. Special attention must be paid to the "last mile" of communication to ensure that even remote or vulnerable groups, such as the elderly or people with disabilities, can receive and act on warnings. The success of this depends heavily on pre-established SOPs, which dictate how warnings are to be disseminated and what actions local authorities must take to organize evacuations. For example, in the Philippines, which faces tsunami risks from both local and distant sources, the use of mobile phone alerts, social media and community radio has greatly improved the dissemination of tsunami warnings to coastal communities.[58] Indonesia has also implemented an integrated tsunami early warning system (InaTEWS) that uses multiple channels to disseminate warnings, including sirens, text messages, television and radio broadcasts, and mosque loudspeakers.[59] This multi-channel approach ensures that warnings can reach people through various means, increasing the likelihood that everyone receives the alert.

A crucial lesson from the 2004 Indian Ocean Tsunami is that effective planning must include multi-stakeholder involvement across sectors. Governments, civil society, businesses and local communities must work together to develop evacuation protocols, maintain preparedness and coordinate responses. The inclusion of local governments in planning has been especially critical, as

57 ESCAP (2023). Compendium of Multi-Hazard Early Warning Cooperation. https://repository.unescap.org/handle/20.500.12870/5683.

58 GSMA (2022). Early Warning Systems in the Philippines: Building resilience through mobile and digital technologies. https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/wp-content/uploads/2022/06/PhilippinesEWS_R_Web.pdf.

59 BMKG (Government of Indonesia). InaTEWS: Indonesia Tsunami Early Warning System. https://rtsp.bmkg.go.id/.

they often have the most direct role in managing on-the-ground evacuation and sheltering operations. Viet Nam's implementation of planning for its response to a tsunami early warning exemplifies a comprehensive, multi-stakeholder approach to disaster preparedness.[60] The system integrates the expertise of the Viet Nam Earthquake and Tsunami Warning Center, the coordinating role of the National Committee for Natural Disaster Prevention and Control, the crucial involvement of local governments, active community participation and the dissemination capabilities of media outlets. To ensure effective coordination among these diverse stakeholders, Viet Nam has instituted clear SOPs, conducts regular joint exercises and has established integrated communication systems. Viet Nam also regularly conducts tsunami evacuation drills in coastal provinces, improving the readiness of local communities to respond to warnings. These drills involve not only practising evacuation procedures but also testing the effectiveness of warning dissemination systems and the coordination between different agencies involved in disaster response.[61]

At the community level, the emphasis should be on immediate evacuation and adherence to pre-planned evacuation routes. In 2004, many coastal communities were unaware of the tsunami threat due to insufficient public awareness of the signs of an oncoming tsunami. Since then, public education programmes in ASEAN countries have expanded significantly, including regular drills and the integration of tsunami preparedness into school curricula in some countries.[62] Despite these improvements, rural and hard-to-reach communities remain less informed and are often the most vulnerable.[63] Ensuring equitable access to information and resources, including installing early warning sirens and SMS alert systems, is essential for safeguarding these communities.

Planning the response to early warnings, along with other risk reduction measures, is an iterative process. Regular updates are essential as countries' early warning capacities are strengthened, but also because an approach that currently works may become less effective in the future as conditions evolve. For example, Thailand has continuously refined its tsunami warning system over the years to overcome several technical challenges that emerged after the system was established.[64] During one exercise, officials did not receive the warning message due to a signal interruption, and on another occasion an incomplete warning message led to confusion. To address these types of challenges, a protocol was established to test the alarm system by regularly playing the national anthem from tsunami warning towers along the Andaman coast in the morning, which verifies that the system is functioning correctly without causing unnecessary alarm.[65] This regular testing and troubleshooting approach has become a valuable part of Thailand's ongoing efforts to strengthen its EWS, and is a good example for other ASEAN countries to follow.[66]

Another example of iterative improvement of EWS is how the Japan Meteorological Agency (JMA) revised its warning protocols after learning from the experience of the 2011 Great East Japan Earthquake and tsunami (GEJE).[67] The JMA operates a nationwide earthquake EWS that has demonstrated significant efficacy in disaster response. This system alerted the population within seconds of the initial earthquake detection during the 2011 Great East Japan Earthquake. Its integration with multiple communication channels, including television, radio and mobile phones, ensures comprehensive dissemination of warnings. However, the Great East Japan Earthquake, measuring 9.0 on the Richter scale, triggered a massive tsunami that ravaged the country's eastern coastline, claiming over 15,000 lives and causing unprecedented destruction, challenging even Japan's world-renowned disaster preparedness systems, but providing crucial lessons for reducing future disaster risks.

The 2011 GEJE revealed limitations in the initial tsunami height predictions. JMA initially issued a tsunami warning predicting wave heights of 3 metres for Fukushima and Iwate Prefectures.[68] However, these estimates were later revised to 6 metres, as more data became available. Unfortunately, actual observed heights varied significantly, with some areas in Fukushima experiencing over 9 metres and locations in Iwate reaching up to 16 metres. This underestimation led to delays in evacuation, as many residents perceived the initial predictions as less threatening and did not evacuate promptly. Learning from this experience, JMA has since reviewed and updated its approach to express early warnings in qualitative terms to alert people to the emergency. For example, if a Major Tsunami Warning (the highest category of tsunami warning in Japan) with the term "Huge" is issued, residents are advised to evacuate immediately to higher ground.

Japan prioritizes continuous improvement and adaptation of its tsunami preparedness. Following the 2011 GEJE disaster, Japan undertook comprehensive reviews of its disaster management systems and implemented various improvements, not only refining tsunami warning messaging, but also updating hazard maps and strengthening evacuation planning procedures.[69] When

60 UNESCO-IOC (2018). Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (SCS-WG), Seventh Meeting, Hanoi, Viet Nam, 6–8 March 2018. https://unesdoc.unesco.org/ark:/48223/pf0000264577/PDF/264577eng.pdf.multi.
61 UNDP (2022). "Students, teachers, and local communities in coastal Quang Nam join tsunami and multi-disaster response drills". 23 August. https://www.undp.org/vietnam/press-releases/students-teachers-and-local-communities-coastal-quang-nam-join-tsunami-and-multi-disaster-response-drills.
62 Rafliana, I. (2012). "Disaster Education in Indonesia: Learning How It Works from Six Years of Experience After Indian Ocean Tsunami in 2004". *Journal of Disaster Research*, 7(1): 83–91. https://www.researchgate.net/publication/293474274_Disaster_Education_in_Indonesia_Learning_How_It_Works_from_Six_Years_of_Experience_After_Indian_Ocean_Tsunami_in_2004.
63 CFE-DM (2015). Indonesia Disaster Management Reference Handbook. https://www.rcrc-resilience-southeastasia.org/wp-content/uploads/2017/12/2015_cfe_disaster_management_reference_handbook_indonesia.pdf.
64 Interview with Dr Tavida Kamolvej, Deputy Governor of Bangkok, September 2024.
65 The Phuket News (2024). "Phuket ramps up tsunami warning 'readiness'." 7 July. https://www.thephuketnews.com/phuket-ramps-up-tsunami-warning-readiness-84832.php.
66 Interview with Dr Tavida Kamolvej, Deputy Governor of Bangkok, September 2024.
67 Japan Meteorological Agency (JMA), Government of Japan (2013). Lessons learned from the tsunami disaster caused by the 2011 Great East Japan Earthquake and improvements in JMA's tsunami warning system. https://www.data.jma.go.jp/eqev/data/en/tsunami/LessonsLearned_Improvements_brochure.pdf.
68 JMA (2013). Start of New Tsunami Warning System Operation. 7 March. https://www.data.jma.go.jp/svd/eqev/data/en/tsunami/tsunamiwarning-leaflet.pdf.
69 Government of Japan (2016). White Paper: Disaster Management in Japan 2016. https://www.bousai.go.jp/kyoiku/panf/pdf/WP2016_DM_Full_Version.pdf.

the Noto Peninsula Earthquake struck in 2024, JMA issued a Major Tsunami Warning, marking the first such warning since the GEJE, and broadcasts emphasized the urgency of prompt evacuation.[70] This example underscores the significance of continuously refining warning systems to better protect lives and swiftly respond to evolving risks, with a focus on ensuring that the intended meaning behind early warning messages is effectively understood by the at-risk populations.

5. SUSTAINABLE FINANCING FOR EWS

The 2004 Indian Ocean Tsunami made clear the urgent need for tsunami early warning systems in the ASEAN region. Such EWS had not already been established by 2004. At the time, countries viewed the upfront financial costs as too high given the lower perceived risk of tsunamis in the Indian Ocean compared to the Pacific.[71] In the aftermath of the tsunami, an outpouring of donor funding helped establish or upgrade many of the region's early warning systems.

Still, finance is a critical component in ensuring the sustainability and effectiveness of people-centred EWS in the ASEAN region, and a reliance on external funding is unsustainable over the long term. Maintaining and improving these systems without substantial, predictable and dedicated financial resources has been a challenge, particularly in terms of upgrading monitoring and communication infrastructure, capacity building, and community outreach.

To ensure the continued longevity and effectiveness of people-centred EWS, ASEAN countries should develop long-term financing strategies. This requires a combination of prioritizing the funding of EWS through national budgets, as well as identifying other sources of financing where possible, such as international support, regional risk pooling and innovative financing mechanisms, such as public–private partnerships (PPPs). Governments must view EWS not as a short-term investment but as a critical, ongoing commitment to disaster risk reduction and community resilience. By diversifying funding sources and prioritizing disaster risk reduction within national development agendas, ASEAN countries can ensure that their EWS remain functional, effective and responsive to the needs of at-risk populations.

One example of progress in financing EWS can be found in Indonesia, where the government allocates a portion of its annual national budget to disaster preparedness activities, including maintaining and upgrading the Indonesian Tsunami Early Warning System (InaTEWS), under the Meteorology, Climatology and Geophysical Agency (BMKG).[72] This approach ensures that critical maintenance, including replacing ageing or lost equipment and upgrading warning dissemination technologies, does not depend solely on the changing priorities of external donors.

However, this does not preclude the procurement of additional external financing through bilateral partnerships where possible. InaTEWS was originally established with financial support from the Germany's Federal Ministry of Education and Research (BMBF) through the GITEWS Project (German-Indonesian Tsunami Early Warning System for the Indian Ocean).[73] Since the operation of InaTEWS was fully handed over to BMKG in 2011, Germany has continued to provide capacity development, training and operational support to BMKG through the PROTECTS project (PROject for Training, Education and Consulting for Tsunami Early Warning Systems)[74] and through the GFZ Helmholtz Centre for Geosciences.[75]

One of the challenges that ASEAN countries have faced in securing sustainable financing for EWS is competition for limited public funds. Disaster risk reduction, including EWS, often competes with other urgent national priorities such as health care, education and infrastructure development. To overcome this, ASEAN governments could prioritize disaster risk reduction as a key investment in national security and sustainable development. Demonstrating the cost-effectiveness of EWS could help secure more consistent funding streams, particularly by highlighting their life-saving potential and the benefits of reducing the economic costs of disasters, as early warnings allow communities to evacuate and protect key assets before disasters strike—a key lesson from the 2004 Indian Ocean Tsunami.

Public–private partnerships present an opportunity for financing EWS in the ASEAN region.[76] By leveraging private sector expertise and investment, governments could reduce the financial burden of maintaining complex systems like seismic sensors, communication networks and evacuation infrastructure. In Japan, for example, telecommunications companies have partnered with the government to enhance tsunami warning dissemination by sending alerts directly to mobile phones in threatened areas. While there are advocates for using PPPs to expand the reach and efficiency of early warning systems, in other areas PPPs have been used to conceal public borrowing, while providing long-term state guarantees for profits to private companies.[77] It therefore remains unclear to what extent PPPs are applicable or cost-effective for financing EWS, as they are essential public goods that do not necessarily generate revenue.

70 Nakamaru, K. and Nakayama, J. (2024). "Prompt Report on 'A New Approach to Announcements for Saving Lives' and 'Disaster-Related Deaths' in the Wake of the 2024 Noto Peninsula Earthquake". *The NHK Monthly Report on Broadcast Research*, 74(4): 2–31. https://www.jstage.jst.go.jp/article/bunken/74/4/74_2/_article/-char/en.
71 Jegillos, S.R. (unpublished). The Region Remains in Danger, But Is Better Prepared. UNDP internal document.
72 UN DESA. Indonesia Tsunami Early Warning System (InaTEWS). https://sdgs.un.org/partnerships/indonesia-tsunami-early-warning-system-inatews.
73 GITEWS (2014). German-Indonesian Tsunami Early Warning System for the Indian Ocean. https://www.gitews.de/en/homepage/.
74 GITEWS (2014). PROTECTS – PROject for Training, Education and Consulting for Tsunami Early Warning Systems. https://www.gitews.de/en/protects/.
75 GFZ. INDOS: InaTEWS seismic Network and Data centre Operations Support. https://www.gfz-potsdam.de/en/section/seismology/projects/completed-projects/indos-2014-2024.
76 UNDRR (2022). "COP27: The French Government hosts a high-level event on public-private approaches in response to the 'Early Warning for All' initiative". 8 November. https://www.undrr.org/news/cop27-french-government-hosts-high-level-event-public-private-approaches-response-early.
77 PSIRU (2015). Why Public-Private Partnerships Don't Work: The many advantages of the public alternative. https://publicservices.international/resources/news/publication-why-public-private-partnerships-dont-work?id=8644&lang=en.

Conclusion

The devastation caused by the 2004 Indian Ocean Tsunami changed the field of disaster risk reduction forever. Nowhere is this clearer than with EWS, and countries in the ASEAN region have made huge leaps forward in the last 20 years. From the groundbreaking efforts on tsunami monitoring and conducting risk assessments that have been spearheaded by regional institutions like RIMES and ICG/IOTWMS, to the national policies and legal frameworks that have been established by ASEAN countries, to the comprehensive planning and SOPs put in place for when an early warning is issued, communities in the region are significantly less at risk from tsunamis today that they were 20 years ago.

Despite the significant progress made since 2004, there are still gaps to be addressed and opportunities for further improvement in tsunami EWS. Firstly, there is a need to address emerging risks, with a need to continuously update risk assessments and EWS to account for changing hazard patterns as the impacts of climate change become more pronounced. This also includes considering compounding and cascading risks, where tsunamis may occur in conjunction with other hazards such as sea-level rise, extreme weather events or pandemics.[78] Risk assessments and early warning protocols should be regularly updated to account for these climate change impacts and emerging risks, which may involve developing more sophisticated multi-hazard risk models that can capture the complex interactions between different types of disasters.

Finance is another area of concern. While initial investments have been made in establishing EWS, ensuring their long-term financial sustainability for maintenance, upgrades and capacity building remains a challenge. Likewise, while regional mechanisms and cooperation have made meaningful progress, there is still room for further enhanced data sharing, joint research and coordinated response planning between ASEAN countries. It is also critical that efforts are made to empower communities with the knowledge and tools to respond effectively when an early warning is issued, through measures such as conducting regular tsunami evacuation drills and embedding a culture of preparedness through public awareness campaigns (as will be explored in Lesson 3).

By addressing these gaps, Indian Ocean countries can further strengthen their tsunami EWS, ultimately saving lives, and reducing the impacts of future disasters. The journey from the devastating 2004 tsunami to the present day demonstrates the power of collective action and international cooperation in building resilience to natural hazards. As we look to the future, continued commitment to people-centred EWS will be crucial in creating safer, more resilient coastal communities across the region.

78 UNDP (2020). Recovering from COVID-19: Lessons from Past Disasters in Asia and the Pacific. https://www.undp.org/publications/recovering-covid-19-lessons-past-disasters-asia-and-pacific.

PHOTO: UNDP SOLOMON ISLANDS

Lesson 2: Establish the foundations for Resilient Recovery

Introduction

'Resilient Recovery' is a proactive approach to disaster management that focuses on establishing—well in advance of a disaster occurring—the enabling factors for recovery processes and outcomes that will build long-term resilience for affected countries and communities. In the context of recovering from the impacts of tsunamis, Resilient Recovery emphasizes the need to establish pre-disaster the robust institutions, planning, implementation and financing capacities long before a tsunami strikes. This proactive approach helps communities and nations recover more swiftly and effectively after a tsunami has struck, while also ensuring that recovery processes have a long-term perspective that looks to rebuild communities, infrastructure and livelihoods to be able to better withstand future disasters.

The Resilient Recovery approach takes forward the core principles and ambitions of Build Back Better (BBB)—to not only restore but improve on pre-disaster conditions to mitigate future risks, including addressing the underlying causes of vulnerability that increase the impacts of disasters—but with the additional focus on proactively putting the enabling factors for recovery in place before a disaster strikes. This is particularly important for ensuring equitable, sustainable and resilient outcomes over the long-term: throughout history, the collective shock and disarray that occurs during and in the immediate aftermath of crises—whether caused by natural hazards, economic shocks, political turmoil or conflict—have been exploited to rapidly implement policies and reforms that might otherwise have faced public opposition and resistance.[79] Establishing the foundations for Resilient Recovery before a disaster—when conditions are stable—helps prevent the recovery process being hijacked in this way. Instead, a holistic Resilient Recovery approach aims to catalyse system-wide action that can shift development trajectories after a disaster to more resilient, sustainable and inclusive pathways.

79 Klein, N. (2007). *The Shock Doctrine: The Rise of Disaster Capitalism.* Metropolitan Books/Henry Holt and Company.

Box 2.1: How 'Build Back Better' emerged after the Indian Ocean Tsunami

The 2004 Indian Ocean Tsunami was as an inflection point in the disaster management discourse. The concept of Build Back Better (BBB) emerged as a transformative approach to post-disaster recovery, emphasizing resilience, sustainable development and risk reduction as essential goals in the reconstruction of affected communities.[80] BBB is defined as a strategy to ensure that post-disaster recovery efforts not only restore but improve on pre-disaster conditions to mitigate

80 Kennedy, J., Ashmore, J., Babister, E. and Kelman, I. (2008). "The Meaning of 'Build Back Better': Evidence from Post-Tsunami Aceh and Sri Lanka". *Journal of Contingencies and Crisis Management,* 16(1): 24–36. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1468-5973.2008.00529.x.

future risks. Rather than solely focusing on rapid reconstruction, BBB urges careful planning, risk-informed decision-making, and a commitment to enhancing the safety and quality of life for vulnerable communities. Examples of the BBB approach in action include:[81]

- Reconstructing infrastructure (e.g. homes, schools, hospitals and roads) to be more resilient to future disasters, such as by using better materials, updating building codes, and considering the risks of natural hazards in the design and location of new construction.
- Incorporating sustainable practices in recovery efforts to ensure that reconstruction is environmentally friendly and contributes to long-term sustainability, such as by using renewable energy sources, efficient water management systems and sustainable land-use planning.
- Engaging local communities in the planning and decision-making process to ensure that recovery efforts meet their needs and the local contexts, as well as help build local capacities.
- Ensuring that recovery efforts are inclusive and equitable, and address the needs of all segments of the population, including vulnerable groups such as women, children, the elderly and persons with disabilities.
- Supporting the recovery of local economies by restoring livelihoods, creating jobs and providing financial assistance to businesses.
- Integrating disaster risk reduction measures into the recovery process to reduce the impact of future disasters, such as by enhancing early warning systems, improving disaster response plans, and promoting public awareness and education on disaster risks.
- Building the capacities of local and national institutions to manage disaster risks and implement effective recovery and reconstruction programmes, such as by conducting trainings, developing policies and frameworks, and improving coordination mechanisms.

BBB became a cornerstone of the recovery strategy in the aftermath of the 2004 Indian Ocean Tsunami, which exposed significant vulnerabilities in the built environment and in early warning systems across the ASEAN region. Its wide adoption in disaster management discourse reflects a growing recognition that effective disaster recovery must go beyond restoration, to addressing and reducing the underlying causes of vulnerability that increase the impacts of disasters.

Initially coined informally by leaders in the recovery field, the BBB approach grew from lessons from previous recovery efforts, where hasty, unplanned reconstruction led to persistent vulnerabilities and increased risks. Bill Clinton, serving as the UN Secretary-General's Special Envoy for Tsunami Recovery, championed the need for long-term, resilience-focused recovery, warning against the dangers of rebuilding things to be the same way they were before a disaster.[82] Through such advocacy, BBB evolved into a structured concept that influenced both policy frameworks and practical guidelines in post-disaster contexts worldwide, embedding resilience and long-term improvement in sustainable development outcomes into the ethos of disaster recovery planning.[83]

Since the Indian Ocean Tsunami, the BBB approach has been integrated into international frameworks on disaster risk reduction, notably through the Hyogo Framework for Action (HFA) 2005–2015 and, subsequently, the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030. ASEAN Member States, which were severely affected by the 2004 tsunami, have since adopted and operationalized BBB principles within national and regional disaster management policies, leading to significant improvements in disaster preparedness, early warning systems, and resilient infrastructure.[84] These frameworks have guided and accelerated the implementation of BBB in practice, reinforcing that recovery from disasters must not only restore but actively strengthen at-risk communities, aiming to prevent the recurrence of similar catastrophes.

81 Jegillos, S.R. (2024) (unpublished). The Indian Ocean Tsunami of 2004: The beginning of reforms in policy, institutional and legislative systems in disaster reduction and recovery in Asia. UNDP internal document.
82 Clinton, W.J. (2006). Lessons Learned from Tsunami Recovery: Key Propositions for Building Back Better – A Report by the United Nations Secretary-General's Special Envoy for Tsunami Recovery, William J. Clinton. https://www.preventionweb.net/files/2054_VL108301.pdf.
83 Fernandez, G. and Ahmed, I. (2019). "Build back better" approach to disaster recovery: Research trends since 2006. ***Progress in Disaster Science***, 1(3): 100003. https://www.researchgate.net/publication/333110069_Build_back_better_approach_to_disaster_recovery_Research_trends_since_2006.
84 ASEAN (2017). ASEAN Vision 2025 on Disaster Management. https://asean.org/wp-content/uploads/2018/01/45.-December-2017-ASEAN-Vision-2025-on-Disaster-Management-1.pdf.

By implementing the Resilient Recovery approach, countries and communities can achieve several critical outcomes. Firstly, they can reduce the time and resources required for recovery by having pre-established disaster recovery institutions, plans and policies, implementation and coordination mechanisms, and accessible financial resources in place, thereby reducing delays, resource misallocation or duplication of efforts.[85] Secondly, they can enhance long-term resilience by avoiding recoveries that restore the conditions and vulnerabilities that existed before the disaster.[86] Thirdly, they can ensure a more equitable and inclusive recovery process by considering the needs of all community members through their participation in pre-disaster planning,[87] and by establishing transparent and accountable implementation processes that prevent vested interests from being able to subvert the recovery effort.[88]

The scale of the devastation caused by the 2004 Indian Ocean Tsunami, one of the deadliest disasters in recent history, forced ASEAN countries to reassess their approaches to recovery. With over 227,000 lives lost, countries realized that rebuilding communities with the same unsafe conditions and insecure livelihoods as before the tsunami would inevitably expose them to further disaster risks in the future. In response, ASEAN countries developed and adopted strategies based on the BBB principles. Each of the following enabling factors proactively increases the ability of affected countries and communities to recover swiftly and effectively after a tsunami event.

85 UNDP (2012). A Global Review: UNDP Support to Institutional and Legislative Systems for Disaster Risk Management. https://www.undp.org/sites/g/files/zskgke326/files/publications/Institutional%20&%20Legislative%20Support%20for%20DRM%20-%20UNDP.PDF
86 UNISDR (2017). Build Back Better in Recovery, Rehabilitation and Reconstruction. https://www.unisdr.org/files/53213_bbb.pdf
87 UNDP (2012). Guidance Note on Recovery: Gender. https://www.undp.org/india/publications/guidance-note-recovery-gender.
88 Klein, N. (2007). *The Shock Doctrine: The Rise of Disaster Capitalism.* Metropolitan Books/Henry Holt and Company.

PHOTO: UNDP INDONESIA

Enabling factors for Resilient Recovery

The improvements in recovery in the ASEAN region have been advanced through four key enabling factors:

- Established institutions for recovery
- Comprehensive and inclusive planning and policies
- Effective implementation and coordination
- Proactive recovery finance mechanisms.

1. ESTABLISHED INSTITUTIONS FOR RECOVERY

The 2004 Indian Ocean Tsunami highlighted the critical need for organized institutional frameworks to manage large-scale recoveries. Institutions form the backbone of disaster recovery: guiding, coordinating and sustaining recovery initiatives in the wake of catastrophic events. However, many of the countries most affected by the IOT lacked robust institutional frameworks for managing large-scale disasters.[89] In particular, dedicated disaster management and response agencies either did not exist (like in Indonesia) or existed but were underprepared to manage the response to a disaster on such a scale (like in Thailand).

Fortunately, such institutions were established quickly in the aftermath of the IOT to manage the recovery process, and over time they became sustainable and focused vehicles for long-term resilience building. For example, Indonesia's approach to coordinating the Aceh reconstruction through its disaster recovery agency (BRR) that was established after the IOT has been widely recognized as a successful model for managing complex recovery efforts, demonstrating the importance of a dedicated, empowered body for managing recovery.[90] This section will focus on the lessons from the recovery from the IOT in Indonesia in particular, as it was the country that suffered the biggest impacts from the tsunami, both in the number of deaths, and the economic losses, which totalled USD 4.5. billion.[91]

In the immediate aftermath of the Indian Ocean Tsunami, countries such as Indonesia faced considerable challenges as the lack of prepared institutional arrangements led to delays in mobilizing aid, coordinating local authorities, and meeting the needs of affected communities effectively.[92] The fragmented nature of early response efforts, marked by delays and resource misallocation, underscored the importance of having robust institutional arrangements established prior to a disaster. Roles and responsibilities among different government agencies were often unclear, leading to confusion and inefficiency in response efforts. Weak coordination mechanisms between national and local levels hampered effective communication and resource allocation. There were limited capacities for managing complex, long-term recovery processes. Moreover, inadequate systems for coordinating international aid and support resulted in inefficient use of resources and sometimes duplication of efforts, with external agencies and local governments operating independently.[93]

The establishment of centralized recovery institutions, such as Indonesia's Badan Rehabilitasi dan Rekonstruksi (BRR) NAD-Nias (Agency for the Rehabilitation and Reconstruction of Aceh and Nias), demonstrated the critical role of streamlined authority for disaster recovery. Formed in April 2005 under a Presidential mandate, BRR was tasked with coordinating and implementing reconstruction in Aceh and Nias with Ministerial-level authority, consolidating recovery operations under a single, cohesive structure. This centralization allowed for decisive action, strategic resource allocation and better coordination among local, national and international stakeholders, including international donors, NGOs and local communities. For example, BRR implemented a 'one-stop shop' for project approval, significantly reducing the time required for initiating recovery projects.[94] This approach allowed for rapid implementation of critical infrastructure projects, such as the reconstruction of the Banda Aceh-Meulaboh road, a vital transportation artery for the region. BRR's authoritative control over funding and accountability directly to the President enhanced trust among local communities and international donors, who valued the agency's transparent approach to fund management and its community-oriented focus.[95] By reducing inefficiencies and providing a clear framework for all participating actors, BRR's model illustrated the benefits of centralized oversight in complex recovery settings.

While centralized leadership provides critical strategic direction, decentralization within recovery institutions ensures responsive, culturally informed decision-making at the local level. This principle was also evident in Indonesia, where BRR established regional offices across Aceh, empowering local leaders to address the unique needs of each affected community and fostering a sense of ownership.[96] Decentralization enabled these offices to tailor recovery activities to local social, cultural

89 UNDP (2009). Institutional and Legislative Systems for Early Warning and Disaster Risk Reduction: Indonesia. https://www.undp.org/asia-pacific/publications/institutional-and-legislative-systems-early-warning-and-disaster-risk-reduction-in-donesia.
90 BRR (Government of Indonesia) (2009). *10 Management Lessons for Host Governments Coordinating Post-Disaster Reconstruction.* https://www.preventionweb.net/media/83616/download?startDownload=20250206.
91 Athukorala, P-C. and Resosudarmo, B. (2005). "The Indian Ocean Tsunami: Economic Impact, Disaster Management, and Lessons". *Asian Economic Papers*, 4(1): 1–39. https://www.researchgate.net/publication/314787881_The_Indian_Ocean_Tsunami_Economic_Impact_Disaster_Management_and_Lessons.
92 IFRC (2005). World Disasters Report 2005. https://reliefweb.int/report/world/world-disasters-report-2005.
93 UNDP (2021). Handbook on Recovery Institutions: A Guidebook for Recovery Leaders and Practitioners. November. https://www.undp.org/publications/handbook-recovery-institutions-guidebook-recovery-leaders-and-practitioners.
94 BRR (Government of Indonesia) (2009). *10 Management Lessons for Host Governments Coordinating Post-Disaster Reconstruction.* https://www.preventionweb.net/media/83616/download?startDownload=20250206.
95 Shaw, R. (ed.) (2015). *Recovery from the Indian Ocean Tsunami: A Ten-Year Journey.* Tokyo: Springer Japan. https://link.springer.com/book/10.1007/978-4-431-55117-1.
96 UN-Habitat (2007). *People's Process in Post-Disaster and Post-Conflict Recovery and Reconstruction.* https://unhabitat.org/sites/default/files/2020/09/peoplesprocess.pdf.

and environmental contexts, thereby facilitating a more inclusive recovery process. By decentralizing certain functions, BRR allowed local leaders to make timely, context-sensitive decisions, which helped to build trust within communities and expedite service delivery. Moreover, this decentralized approach helped counter local scepticism toward the central government, especially in conflict-affected areas, by fostering stronger community engagement and transparency in recovery operations.

In Aceh, the community-driven approach embraced several key aspects to ensure local ownership and sustainability. Village-level planning sessions were conducted to identify priorities, enabling direct input from those most affected. Small-scale infrastructure projects were implemented through community contracting, fostering local engagement and capacity building. In housing reconstruction efforts, traditional Acehnese architecture was incorporated, preserving cultural heritage while meeting modern safety standards. Moreover, the approach provided support for community-based livelihood recovery initiatives, empowering residents to rebuild their economic foundations. This multifaceted strategy not only addressed immediate reconstruction needs but also strengthened community resilience and social cohesion in the long term. For example, the Rekompak programme, which focused on housing reconstruction, allowed communities to form groups that made decisions on house designs and managed construction funds.[97] This approach not only expedited the rebuilding process but also ensured that the new homes met local cultural and environmental needs.

Institutional and governance frameworks that prioritize transparency and accountability are fundamental in securing and maintaining donor confidence, which can be essential for securing the international funding for long-term recovery after major disasters like the IOT. Indonesia, grappling with pre-existing issues of corruption, took significant steps to embed anti-corruption measures within BRR, reinforcing the agency's integrity.[98] BRR established an Anti-Corruption Unit and enforced rigorous auditing processes to ensure the ethical use of funds, which reassured international donors and encouraged additional financial support. By upholding high standards of accountability and regularly disclosing financial and operational progress, BRR's transparency measures strengthened its credibility, allowing Indonesia to secure ongoing international support.[99] Strong institutional governance not only mitigates corruption risks but also fosters a trust-based relationship with stakeholders.

A robust legal framework is essential for effective institutional functioning, providing the authority and operational clarity necessary for managing complex recovery operations. Indonesia's recovery efforts were underpinned by Presidential Regulation No. 34/2005, which formally established BRR's authority and defined its responsibilities.[100] This legal mandate empowered BRR to engage with local authorities, international donors and civil society organizations, fostering collaboration while maintaining a clear operational framework. The regulation also set boundaries that minimized jurisdictional conflicts and overlapping roles, reinforcing BRR's legitimacy and enabling it to execute its duties effectively. Legal mandates not only clarify roles within recovery institutions but also set the tone for transparency, accountability and public trust, which are particularly essential in post-disaster settings. Ensuring that this kind of legal framework has been established before a disaster can allow for the rapid activation of recovery institutions, ensuring that essential recovery activities commence promptly under structured, accountable conditions.

The transition from the initial recovery phase to a focus on long-term sustainable development outcomes is critical, and institutional structures play a vital role in ensuring this shift is effective and lasting. By embedding resilience within established local institutions, BRR helped ensure that the benefits of recovery were preserved in the long term. For ASEAN countries, a clear transition strategy that shifts responsibilities to local governments from the affected areas can bridge the gap between emergency response and rapid recovery efforts in the immediate aftermath of a disaster, to a sustained focus on building back better for long-term resilience, securing recovery gains and reinforcing local ownership.

BRR operated under a four-year mandate with a sunset clause that outlined its responsibilities and allowed for a structured handover to local authorities once recovery milestones were achieved, preventing a dependency on temporary structures.[101] BRR's largely successful efforts highlighted the need for a permanent centralized institution for disaster management in Indonesia, and BRR was subsequently subsumed into Indonesia's National Disaster Management Agency, Badan Nasional Penanggulangan Bencana (BNPB) in 2008, ensuring the crucial institutional memory and experience from BRR was not lost. BNPB fosters greater cohesion in disaster management actions, unifying the efforts across various government agencies, thereby enhancing proactiveness, effectiveness and efficiency. In readiness for future disasters, BNPB works to empower local governments, particularly in disaster-prone regions like Aceh, North Sumatra and West Sumatra, to develop their disaster risk management plans and respond more effectively to the specific needs and risks of their communities. For instance, in Aceh, the local government has developed a comprehensive tsunami hazard map that guides urban planning and building regulations to minimize exposure to future tsunamis.[102] Beyond Indonesia's national borders,

97 World Bank (2012). "Indonesia: Community-Based Settlement Rehabilitation and Reconstruction Project". 16 April. https://www.worldbank.org/en/results/2012/04/16/indonesia-community-based-settlement-rehabilitation-and-reconstruction-project-rekompak.
98 UNDP (2021). Case Studies on Institutional Arrangements for Recovery. https://recovery.preventionweb.net/publication/case-studies-institutional-arrangements-recovery.
99 ODI (2013). Disaster as opportunity? Building back better in Aceh, Myanmar and Haiti. HPG Working Paper. L. Fan. November. https://media.odi.org/documents/8693.pdf.
100 UNDP (2021). *Case Studies on Institutional Arrangements for Recovery.* https://recovery.preventionweb.net/publication/case-studies-institutional-arrangements-recovery.
101 UNDP (2021). Case Studies on Institutional Arrangements for Recovery. https://recovery.preventionweb.net/publication/case-studies-institutional-arrangements-recovery.
102 GTZ IS and GITEWS (2009). Guidebook: Tsunami Hazard Mapping for the

BNPB has played a leading role in fostering regional cooperation on disaster management, sharing its expertise in coordinating post-disaster recovery with neighbouring countries through regional knowledge-sharing events.[103]

Similarly, in Thailand, the Indian Ocean Tsunami exposed some gaps in the existing disaster preparedness and recovery systems. The centralized disaster management institution, the Department of Disaster Prevention and Mitigation (DDPM), had already been established in 2002 under the Ministry of Interior, and it was widely acknowledged that the Government of Thailand led an effective emergency response to the disaster.[104] However, there was recognition of gaps in the country's disaster risk reduction and recovery frameworks, such as limited early warning capacities and evacuation preparedness, which led to further institutional reforms. One important development was the establishment of the National Disaster Warning Center (NDWC) in 2005 to monitor and issue real-time warnings for tsunamis, storms and other disasters.[105] To create a more unified disaster management structure, the NDWC was later integrated into the DDPM in 2014 to better coordinate early warning systems with national disaster management and recovery efforts.

Despite these advancements, several institutional challenges remain in ASEAN countries. There is a need for better integration of disaster risk reduction into the mandates of sectoral ministries in order to ensure a whole-of-government approach. In particular, improving coordination between disaster management agencies and climate change adaptation bodies and more collaboration between disaster management agencies and other agencies responsible for education, finance, transportation and other sectors, both are crucial for addressing interlinked risks and vulnerabilities. Enhancing local institutional capacities, especially in remote or vulnerable areas, remains a priority to ensure effective ground-level response and recovery. Moreover, strengthening regional institutional mechanisms for transboundary disaster management offers the potential for more effective regional responses (for more information, see "Regional Capacity Building for Resilient Recovery" under Lesson 4).

2. COMPREHENSIVE AND INCLUSIVE PLANNING AND POLICIES

The 2004 Indian Ocean Tsunami revealed that many Indian Ocean countries lacked comprehensive disaster recovery plans, especially for large-scale events like the 2004 tsunami. The region had limited historical experience dealing with tsunamis of this magnitude, leading to insufficient risk assessment and scenario planning for extreme events. There was a notable lack of integration between disaster management and development planning, compounded by inadequate involvement of local communities in disaster preparedness.[106] This absence of coordinated policies and pre-established frameworks led to an ad hoc recovery response that often exacerbated existing vulnerabilities. In Indonesia's Aceh province, for example, local and international efforts were undertaken on a massive scale but were hindered by inconsistent and overlapping roles among numerous governmental and non-governmental actors.[107] The initial confusion revealed a critical gap: the need for an overarching planning and policy framework to govern recovery, define stakeholder roles and ensure efficient resource allocation.

Significant progress has been made in disaster recovery planning and policy since 2004. At the national level, countries have developed comprehensive national and local disaster management plans, integrating tsunami risks into multi-hazard assessments, and have passed legislation that has created the legal foundations for improved disaster preparedness and management. For example, in Thailand's Phang Nga province, one of the areas worst hit by the 2004 tsunami, there was no pre-existing plan for managing a disaster of this scale, leading to initial confusion and delays in the response. Phang Nga province now has a detailed tsunami response plan, developed with input from local communities and based on various tsunami scenarios. Examples of comprehensive national-level disaster management legislation that ASEAN countries have passed that were inspired by the lessons from the IOT include the 2007 Law on Disaster Management in Indonesia,[108] the 2007 National Disaster Prevention and Mitigation Act in Thailand,[109] the 2005 Disaster Management Act in Sri Lanka,[110] and the 2013 Law on Natural Disaster Prevention and Control in Viet Nam.[111] There has also been an increased focus on scenario-based planning for various disaster scales, and a greater involvement of local communities in the planning process. These advancements have greatly enhanced the region's preparedness for future disasters.

Countries have developed comprehensive disaster management plans, providing robust frameworks for disaster risk reduction and recovery. The integration of Build Back Better principles into recovery plans has become widespread, ensuring that reconstruction efforts

District Level. https://www.gitews.de/tsunami-kit/en/E1/tool/Guidebook%20Tsunami%20Hazard%20Mapping%20for%20the%20District%20Level.pdf.
103 World Bank (2016). *Becoming A Knowledge-Sharing Organization: A Handbook for Scaling Up Solutions through Knowledge Capturing and Sharing.* https://documents1.worldbank.org/curated/en/306761478498267644/pdf/109809-PUB-Box396311B-PUBLIC-DOCDATE-11-2-16.pdf.
104 UNDP Thailand (2005). *Tsunami Thailand One Year Later: National Response and Contribution of International Partners.* https://www.gfdrr.org/sites/default/files/publication/Tsunami%20Thailand%2C%20One%20Year%20Later%2C%20National%20Response%20and%20the%20Contribution%20of%20International%20Partners.pdf.
105 Pacific Disaster Center (2006). National Disaster Warning Center, Thailand: Concept of Operations. https://nctr.pmel.noaa.gov/education/IOTWS/CONOPS/USTDA_PDC_Thailand_CONOPS.pdf.
106 IFRC (2005). World Disasters Report 2005. https://reliefweb.int/report/world/world-disasters-report-2005.
107 Shaw, R. (ed.) (2015). *Recovery from the Indian Ocean Tsunami: A Ten-Year Journey.* Tokyo: Springer Japan. https://link.springer.com/book/10.1007/978-4-431-55117-1.
108 Government of Indonesia (2007). Law No. 24/2007 Concerning Disaster Management. https://www.preventionweb.net/media/100015/download?startDownload=20250207.
109 Government of Thailand (2007). Disaster Prevention and Mitigation Act B.E. 2550. http://project-wre.eng.chula.ac.th/watercu_eng/sites/default/files/lecture%20intro%202112681%20materials/9%20Disaster%20Prevention%20and%20Mitigation%20Act%202550.pdf.
110 Government of Sri Lanka (2005). Sri Lanka Disaster Management Act, No. 13 of 2005. https://www.preventionweb.net/files/60321_srilankadmamendmentactnov2011.pdf.
111 Government of Viet Nam (2013). Law on Natural Disaster Prevention and Control. https://climate-laws.org/documents/law-on-natural-disaster-prevention-and-control_ea8a?id=law-on-natural-disaster-prevention-and-control-no-33-2013-qh13-and-decree-no-66-2021-nd-cp_9d06.

aim to enhance long-term resilience.[112] For example, the Indonesian government developed the Reconstruction Master Plan,[113] in combination with the Aceh Recovery Framework (ARF).[114] This comprehensive plan outlines strategies for rebuilding infrastructure and housing, restoring livelihoods, and implementing disaster risk reduction measures. The plan also emphasizes community participation and the integration of disaster preparedness into spatial planning to enhance resilience.

112 UNISDR (2017). Build Back Better in Recovery, Rehabilitation and Reconstruction. https://www.unisdr.org/files/53213_bbb.pdf.
113 Government of Indonesia (2005). Master Plan for the Rehabilitation and Reconstruction of the Regions and Communities of the Province of Nanggroe Aceh Darussalam and the Islands of Nias, Province of North Sumatra. https://www.refworld.org/legal/decreees/natlegbod/2005/en/121319.

114 Government of Indonesia (2009). Aceh Recovery Framework 2008–2011. https://recovery.preventionweb.net/media/83610/download?startDownload=20241104.

PHOTO: UNDP SRI LANKA

Box 2.2: Owner-driven housing reconstruction in Indonesia

Owner-driven housing reconstruction (ODHR) is defined as a process in which the house owners themselves (with or without land ownership certificates) make decisions about the materials, building design type, management and implementation of the reconstruction of their home, in compliance with government regulations, and with socio-technical support and conditional financial assistance that ensures homes are built back better.[115] House owners may carry out rebuilding or repairing themselves, involving only their own family members, or may choose to involve the entire community; they may employ local labourers, procure materials or choose to receive help from an NGO or community-based organization (CBO). The widely recognized advantages of ODHR include a greater sense of self-reliance and empowerment for disaster-affected people, the generation of new livelihood opportunities, improved quality of life and increased long-term resilience.

The ODHR approach to reconstruction of housing was prioritized in Indonesia's Reconstruction Master Plan, which embraced rehabilitation and reconstruction efforts for housing by the surviving victims themselves in the location where they lived before the tsunami. The Plan also set out the financial contributions the government would provide, depending on whether a house had been completely destroyed (and needed to be completely rebuilt) or moderately destroyed (and could be renovated).[116] Compared with other approaches to housing reconstruction after a disaster that rely on government contractors, this approach was widely recognized for being more responsive to the needs of the victims, based on their cultural, livelihood and other diverse needs.

115 UNDP (2021). Handbook on Owner-Driven Housing Reconstruction. https://www.undp.org/sites/g/files/zskgke326/files/2022-01/UNDP_Handbook_on_Owner_Driven_Housing_Reconstruction.pdf.
116 Wegelin, E.A. (2006). "Post-Tsunami Reconstruction in Indonesia". https://www.globalurban.org/GUDMag06Vol2Iss1/Wegelin.htm. *Global Urban Development Magazine* 2(1). March.

The absence of risk-sensitive land use planning and resilient building codes before the 2004 tsunami exposed coastal communities to increased risk.[117] In response, ASEAN countries began implementing and enforcing land-use regulations, stricter building codes and establishing no-build buffer zones along high-risk coastlines. In Aceh, for example, policies were introduced to improve coastal resilience by integrating mangrove restoration into land use planning, reducing the exposure of coastal villages to future storm surges.[118] Similarly, the resilience of Japan's infrastructure was tested during the 2011 Great East Japan Earthquake and tsunami. While the tsunami caused extensive damage, many buildings designed to withstand earthquakes remained intact after the initial shock. This resilience can be attributed to Japan's strict building codes and infrastructure design standards, which include provisions for seawalls and evacuation buildings.[119] Risk-sensitive land use policies must be paired with infrastructure investment and community education to ensure compliance, but such policies enable ASEAN countries to address the dynamic risks of coastal development while preparing communities to withstand future disasters.

Land tenure and access can be contentious issues in the aftermath of a major disaster like the 2004 tsunami. The Aceh Recovery Framework (ARF) took into account how different people had been affected by the 2004 tsunami, which included those who were rendered landless due to the permanent submergence of their land after the tsunami, as well as former tenants.[120] In agreement with the Aceh provincial government, the BRR issued policy guidelines that facilitated reinstatement on the original land wherever possible, and resettlement where the land had become unsuitable for reconstruction. This was achieved through a cost-sharing mechanism between BRR and the provincial government. Tenants were included by way of new planning guidelines for community-based reconstruction that involved financial support and participation in the recovery planning process for tenants.

The application of disaster-related data on the occurrences and impacts of disasters is critical for ensuring recovery plans and policies are evidence-based. Such data are collected and analysed by National Disaster Management Organizations (NDMOs) and relevant line ministries to derive insights to contribute to policy, planning, budgeting and decision-making for disaster risk reduction and recovery. Disaster-related data are captured in national disaster loss and damage databases that record disaggregated data at subdistrict levels on the impacts of disasters on different population groups and key sectors, including transportation, agriculture, environment, health and infrastructure. Since 2002, UNDP has been supporting countries, including those affected by the Indian Ocean Tsunami, to establish national disaster loss and damage databases.[121] Indonesia, with support from UNDP, has been enhancing the InaRISK system (the national geospatial digital platform) to store, process and analyse a wide range of risk data, integrating the Micro Risk Assessment and the STEP-A (School Tsunami and Earthquake Preparedness Assessment) application (see Lesson 3 for more).[122] InaRISK has integrated ACeBS, an application that enables rapid assessment of the condition of residential buildings and one-storey houses, including whether a structure is earthquake-resistant, based on the government's technical guideline for building construction permits (PUPR No.5/2016).[123] After a disaster, such data provide a useful baseline for governments to compare the pre-disaster context with post-disaster conditions, providing an understanding of how the affected population lived and worked before the disaster. Having such baseline information is critical for conducting recovery needs assessments after a disaster, including Post-Disaster Needs Assessments.

Recovery planning is a crucial step in the national recovery process. It serves as the foundation for establishing a shared vision for recovery, defining clear objectives and intended outcomes, providing a roadmap, setting an implementation timeline and estimating the recovery costs.[124] Recovery planning is a complex process involving numerous national and international institutions, as well as the affected communities. Planning must occur at both the national and local levels, spanning multiple sectors and organizations. For planning efforts to be successful, it is paramount to ensure coordination and foster trust among all the stakeholders involved in the recovery process, working collaboratively across various sectors. This is important because recovery, especially from a large-scale disaster, is demanding and complex. It requires a rapid and well-considered development of a recovery programme, swift and careful decision-making that involves various functions and capacities (such as procurement, planning, engineering and development activities), and efforts across different sectors. Therefore, having a recovery plan before a disaster that outlines and enables understanding of the recovery process can help expedite the recovery, ensure effective and efficient support from relevant government departments, and ensure that recovery efforts build resilience.

Recovery plans also need to be flexible and responsive: overly static plans can prove to be inadequate for meeting the fluid, evolving demands of affected communities during the recovery from a major disaster. Reconstruction requires considerable time, even with substantial resources. Realistic planning can expedite reconstruction and can also identify gaps where specific resources, capacity-building efforts and targeted skills training programmes are needed. For major disasters, a recovery

117 ADB Institute (2023). *Navigating Resilient Post-Disaster Recovery in Asia and the Pacific.* https://www.adb.org/sites/default/files/publication/924121/navigating-resilient-postdisaster-recovery-asia-and-pacific.pdf.
118 UNDRR (2021). "In the aftermath of a tsunami, mangrove forests in Indonesia protect lives and livelihoods". 20 October. https://www.undrr.org/news/aftermath-tsunami-mangrove-forests-indonesia-protect-lives-and-livelihoods.
119 Government of Japan (2012). White Paper on Land, Infrastructure, Transport and Tourism in Japan, 2012. https://www.mlit.go.jp/english/white-paper/2012.pdf.
120 Government of Indonesia (2009). Aceh Recovery Framework 2008–2011. https://recovery.preventionweb.net/media/83610/download?startDownload=20241104.
121 As of 2024, UNDP has supported more than 35 countries globally, and more than 100 countries have developed similar databases with support from UNDRR and other partners.
122 BNPB (Government of Indonesia). InaRISK. https://inarisk2.bnpb.go.id.
123 United Nations (2021). Climate and Disaster Resilient Infrastructure: Building Resilience to Future Uncertainties and Shocks. https://www.preventionweb.net/media/73007/download?startDownload=20250206.
124 UNDP (2017). National Post-Disaster Recovery Planning and Coordination. A Guidance Note. https://www.undp.org/publications/recovery-guidance-note.

planning cycle of four to five years is often realistic.[125] Recovery frameworks across ASEAN are now evolving to prioritize responsiveness, with countries creating policies that incorporate continuous assessments to dynamically guide recovery efforts in response to unanticipated challenges and community-specific needs.

The capacity to respond to future disasters is strengthened when recovery policies are community-led, and actively invest in local capacity building, equipping community-based organizations with the skills to manage resources and coordinate efforts. In the wake of the 2004 tsunami, UNDP's Strong Places initiative in Sri Lanka underscored the potential of strengthening local governance structures by training CBOs in project management and governance.[126] This approach allowed local organizations to play a proactive role in recovery, fostering communities' sustainable resilience. In Indonesia, the Kecamatan Development Project (KDP) devolved decision-making to communities through kecamatans, or councils: an administrative committee made up of representatives of multiple villages.[127] These kecamatans oversaw infrastructure reconstruction, significantly improving recovery outcomes and community resilience. Similarly, participatory recovery planning, as exemplified by Aceh's Rekompak programme following the 2004 tsunami, ensures that reconstruction efforts align with local needs and cultural contexts.[128] ASEAN-wide policies can build on such models by integrating capacity-building programmes within disaster recovery frameworks, enabling local actors to take on leading roles in disaster response. Investing in CBOs and community engagement not only allows local insights and priorities to shape recovery, resulting in measures that directly address issues on the ground, but also embeds recovery skills within communities, creating a robust foundation for future disaster preparedness and response.

125 UN-Habitat (2011). Turning Around the Tsunami: UN-Habitat Working in Partnership with Sri Lanka. https://unhabitat.org/sites/default/files/download-manager-files/Turning%20Around%20the%20Tsunami.pdf.
126 UNDP Sri Lanka (2007). Sustaining Tsunami Recovery by Organizations Networking at the Grassroots level through Promoting Local Accountability and Capacity Enhancement Systems (STRONG PLACES) Project: Final Report. August. https://erc.undp.org/evaluation/documents/download/1864.
127 World Bank (2003). Kecamatan Development Project. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/456051468044145054/kecamatan-development-project.
128 World Bank (2005). Reconstruction of Aceh Land Administration System Project. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/471081468050634900/indonesia-reconstruction-of-aceh-land-administration-system-project.

Box 2.3: Responsive, community-informed policy change in Indonesia

A good example of how recovery policies benefit from being responsive and informed by community needs is the rollback of a rigid 'no-build zone' policy along the shoreline in Indonesia.[129] Based on the risk of future tsunamis and the geological changes that had altered tidal levels in some villages, an initial government policy proposed that housing reconstruction for affected communities should not take place within a demarcated zone extending from the new shoreline, generally defined as between 300 and 1,000 metres. However, based on feedback from the affected communities, it soon became clear that this guideline was overly restrictive and practically unenforceable, given communities' dependence on the sea for their livelihoods, and this policy was replaced with more flexible guidelines. The revised policy informed communities that, while reconstructing housing at the original location was generally preferred, it needed to be balanced against the significant risk of future flooding and the importance of adequate tsunami protection. In numerous cases, this led villagers to make collective decisions to relocate their communities, where land availability allowed, further from the new shoreline, or at a minimum, to integrate safe tsunami evacuation routes into the redesign of village layouts.

129 Wegelin, E.A. (2006). "Post-Tsunami Reconstruction in Indonesia". https://www.globalurban.org/GUDMag06Vol2Iss1/Wegelin.htm. *Global Urban Development Magazine* 2(1). March.

Disaster recovery policies across ASEAN must continue to ensure gender and social inclusivity. Following the 2004 tsunami, some recovery efforts neglected the specific needs of women and marginalized communities, resulting in unequal access to resources and recovery programmes. Aceh, Indonesia, for instance, saw delayed recovery among women-led households, as work and care responsibilities increased dramatically for women survivors after the tsunami, and their lack of mobility and risks to their security were additional constraints that reduced their access to information and ability to attend community meetings. Recovery projects had to find practical ways to help women overcome these barriers. For example, in Nias, Indonesia, a predominantly Christian island, projects relayed information through the Sunday church services to reach women and improve their access to recovery information.[130] These church services were heavily attended by women, during which notices were read out and designated facilitators shared information with women about opportunities for housing reconstruction. Moreover, women-only meetings were held to encourage women to participate in decision-making, sometimes including a small travel stipend to cover attendance and incentives such as lottery tickets to women who spoke at meetings. Likewise, social protection policies specifically for disaster-affected populations have been created, addressing the needs of vulnerable groups during recovery.[131] Such policies reflect the evolution of disaster recovery planning toward greater inclusivity,

130 UNDP (2020). *Guidelines for Community Participation in Disaster Recovery.* https://www.gfdrr.org/sites/default/files/Guidelines%20for%20Community%20Participation%20in%20Disaster%20Recovery.pdf.
131 ILO (2011). *Social Protection Floor for a Fair and Inclusive Globalization*. https://www.ilo.org/sites/default/files/wcmsp5/groups/public/%40dgreports/%40dcomm/%40publ/documents/publication/wcms_165750.pdf.

recognizing that building resilient communities requires input from diverse social perspectives. Future policies should continue to focus on gender and social equity, embedding inclusive planning processes that ensure all voices are represented in recovery efforts.

Progress on planning and policy for Resilient Recovery since the Indian Ocean Tsunami was supported by several key global and regional initiatives. In particular, the international adoption of the Hyogo Framework for Action (HFA) 2005–2015 and later the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030 provided a policy roadmap for integrating disaster risk reduction (DRR) into national and local planning processes. Regional initiatives such as the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) have fostered cooperation on recovery planning. For example, the ASEAN Disaster Recovery Reference Guide (ADRRG) was created in partnership with UNDP in 2016.[132] The ADRRG outlines major elements of disaster recovery arrangements, identifies the types of interventions needed for participatory and sustainable recovery, proposes key principles and approaches for effective disaster recovery that includes reducing future risks, and showcases examples of recovery practices from the ASEAN region that could be replicated and scaled up. The ADRRG also provides a deep dive on policies and planning for recovery, establishing the institutional framework for recovery, post-disaster assessments, resource mobilization and financial management for recovery, as well as implementation, coordination, communication and monitoring for recovery. ASEAN also holds ASEAN Disaster Recovery Forums, which provide a venue for the exchange of good practices in disaster damage and loss assessments, country-level disaster recovery guidelines, and resilient infrastructure for recovery.[133]

Despite this progress, challenges remain in disaster recovery planning. There is a need for more frequent updating of plans to reflect changing risks and vulnerabilities.[134] Further integration of recovery planning with long-term sustainable development goals is necessary.[135] Moreover, there is room for enhanced use of technology and data in risk assessment and planning,[136] and for better alignment between disaster recovery policies and climate change adaptation strategies to address the interconnected nature of these challenges. Strengthening cross-border and regional planning for transboundary disasters is another area of potential improvement. Resilient Recovery approaches should be particularly intentional about addressing pre-disaster vulnerabilities, such as poor land use planning and outdated building codes, that can contribute to the potential dangers of a hazard and undermine the overall resilience of a community. Countries should have a long-term outlook on resilience, focusing on systemic risks by taking a multi-hazard forward-looking perspective using available disaster and climate risk data and tools for pre-disaster recovery planning. Policies addressing long-term psychosocial recovery needs also represent an area that would benefit from further attention.[137]

Looking ahead, there are opportunities for planning and policy improvement in the ASEAN region. Developing more integrated policies that address multiple hazards and long-term stressors could enhance overall resilience. Capacity building for policy implementation at all levels of government will be crucial for responsive planning, and will help support the translation of policy into practice. Stronger mechanisms for public participation in disaster policy development and review can ensure that policies are relevant, effective and widely accepted.

132 ASEAN and UNDP (2016). *ASEAN Disaster Recovery Reference Guide.* April. https://www.undp.org/sites/g/files/zskgke326/files/migration/asia_pacific_rbap/RBAP-RSD-2016-ASEAN-Disaster-Recovery-Reference-Guide.pdf.
133 ASEAN (2020). AADMER Work Programme 2021–2025. https://asean.org/wp-content/uploads/2021/08/AADMER-Work-Programme-2021-2025.pdf.
134 UNDRR (2019). Global Assessment Report on Disaster Risk Reduction 2019. https://www.undrr.org/publication/global-assessment-report-disaster-risk-reduction-2019.
135 GFDRR (2015). Resilient Recovery: An Imperative for Sustainable Development. https://www.preventionweb.net/files/44171_resilientrecoveryanimperativeforsus.pdf.
136 ESCAP (2019). Asia-Pacific Disaster Report 2019: The Disaster Riskscape Across Asia-Pacific. https://www.unescap.org/sites/default/d8files/knowledge-products/Asia-Pacific%20Disaster%20Report%202019_full%20version.pdf.
137 WHO (2022). "Mental Health in Emergencies". 6 May. https://www.who.int/news-room/fact-sheets/detail/mental-health-in-emergencies.

Box 2.4: Ban Nam Khem village – from disaster to resilience

Approximately 50 percent of all Thai casualties during the Indian Ocean Tsunami were from the small village of Ban Nam Khem, in Thailand's Phang Nga province. As well as the huge loss of life, as a fishing community, assets and livelihoods were also badly affected. More than 1,500 buildings were destroyed, with only 49 buildings left standing in the village after the tsunami.[138] Despite this overwhelming tragedy, the community slowly rebuilt itself, both physically and in spirit.

The Thai government implemented comprehensive recovery and disaster risk reduction efforts in Bam Nam Khem, in collaboration with UNDP, the Asian Disaster Preparedness Center (ADPC), and other organizations. This included the development of an end-to-end early warning system and the promotion of community-based disaster risk management (CBDRM) practices for catalysing the transformation of the tsunami-affected villages into disaster-resilient communities.

As the village had been almost completely destroyed by the tsunami, the government, in collaboration with local communities, relocated parts of the village to higher ground and

138 UNDP (2014). "Baan Nam Khem: A resilient fishing community in Thailand". 22 December. https://reliefweb.int/report/thailand/baan-nam-khem-resilient-fishing-community-thailand.

implemented stricter zoning regulations along the coast. These efforts were intended to prevent the same level of destruction if another tsunami strikes in the future.

Working with the Department of Disaster Prevention and Mitigation (DDPM) and the Thai Red Cross, the village developed emergency evacuation plans and continues to organize periodic tsunami evacuation drills. The Tsunami Memorial in Ban Nam Khem complements these efforts, serving as a reminder of the tragedy, with annual commemoration events helping to build a culture of preparedness. These efforts continue to reinforce the lessons from the 2004 tsunami, making Ban Nam Khem one of the most disaster-aware communities in Thailand.

Over the last two decades, Ban Nam Khem has earned a reputation of being a hub for disaster preparedness training and knowledge sharing on learning on community-based disaster preparedness response and recovery efforts.[139] Drawing from the experiences of the village, community disaster centres have been established in other places in Thailand, providing access to location-specific hazard data, disaster maps and evacuation plans.

139 UNDRR (2014). "A decade after Indian Ocean Tsunami, lessons learned". 26 December. https://www.undrr.org/news/decade-after-indian-ocean-tsunami-lessons-learned.

3. EFFECTIVE IMPLEMENTATION AND COORDINATION

Implementation and coordination of recovery efforts were major challenges in the aftermath of the 2004 tsunami. The lack of pre-established coordination mechanisms for large-scale recovery led to inefficiencies and delays in response efforts. There were significant challenges in coordinating across different sectors and levels of government, leading to fragmented recovery efforts, as well as difficulties in managing the influx of international aid and development organizations, often resulting in duplication of efforts and uneven distribution of resources. Harmonizing these diverse contributions is essential to achieving effective recovery, as a well-integrated and responsive implementation framework can reduce redundancies and strengthen the efficacy of each project, ensuring that recovery aligns with the specific needs of affected communities.

Strong leadership within coordinating bodies was a critical factor for successful post-disaster recovery. In Aceh, the BRR's leadership was instrumental in managing the complex web of responsibilities and aligning them with both community needs and donor expectations. By prioritizing a "crisis mindset" that focused on quick and effective action, the BRR was able to maintain the sense of urgency that drove significant progress in the face of logistical and operational challenges.[140] This crisis-focused leadership ensured that time-sensitive priorities, such as housing reconstruction and infrastructure rehabilitation, received immediate attention. Furthermore, BRR's leaders worked diligently to build credibility among stakeholders, which was essential for securing continued donor support and cooperation. Leadership in post-disaster contexts goes beyond administrative duties; it requires the ability to inspire confidence, navigate complex relationships, and make decisive, often high-stakes, decisions to advance recovery goals.

The sheer diversity of stakeholders in post-disaster recovery can pose significant challenges for effective implementation and coordination. During the tsunami recovery, thousands of organizations, from NGOs to international agencies, worked independently, which led to a lack of alignment in project approaches and, in some cases, wasted resources. In response to the 2004 tsunami, the influx of international aid brought with it numerous donor-driven approaches, which did not always align with local needs or preferences, and did not adequately involve communities in decision-making processes. This lack of local engagement led to integration challenges, with many beneficiaries of support struggling to adapt to their new environments, having been relocated to unfamiliar areas without meaningful consultation.[141] This illustrates the risks of top-down recovery models, which may overlook the social and cultural factors essential for sustainable rebuilding. Effective recovery requires sensitivity to local contexts and the flexibility to adapt programmes to meet community needs.

The integration of local communities into the recovery process is vital for creating long-term resilience and ensuring that reconstruction aligns with community needs. In Sri Lanka, UNDP's support for establishing Community Development Councils (CDCs) provided affected groups with a platform to participate actively in their own recovery.[142] The CDCs facilitated community-led initiatives that reduced dependency on external assistance and leveraged local knowledge to address specific needs effectively. For example, they played a crucial role in prioritizing infrastructure projects, tailoring them to the unique conditions of each locality, and mobilizing community members to contribute to the reconstruction effort. This approach highlights the benefits of empowering communities to take charge of the implementation of their recovery, which can lead to more durable and contextually appropriate outcomes.

140 BRR (Government of Indonesia) (2009). 10 Management Lessons for Host Governments Coordinating Post-Disaster Reconstruction. https://www.preventionweb.net/media/83616/download?startDownload=20250206.

141 UN-Habitat (2011). Turning Around the Tsunami: UN-Habitat Working in Partnership with Sri Lanka. https://unhabitat.org/sites/default/files/download-manager-files/Turning%20Around%20the%20Tsunami.pdf.

142 UNDP Sri Lanka (2015). *An Integrated Approach to Disaster Recovery: A Toolkit on Cross-Cutting Issues.* https://www.undp.org/sites/g/files/zskgke326/files/publications/Integrated%20Approach%20to%20Disaster%20Recovery-%20A%20toolkit%20on%20Cross-cutting%20Issues%20-%20Lessons%20from%20the%20Tsunami%20Recovery%20Unit.pdf.

Similarly, strong community networks and social capital facilitate faster and more effective recovery processes. In Indonesia, community-based organizations played a crucial role in supporting economic recovery at the household and village levels. For instance, in Aceh province, pre-existing community structures such as women's savings groups (arisan) and traditional community councils (tuha peut) were instrumental in distributing recovery assistance and re-establishing local economies.[143] These grassroots organizations provided platforms for coordinating aid efforts, managing community resources, and ensuring that recovery initiatives aligned with local needs and cultural contexts. The involvement of local actors in recovery implementation and coordination also fosters a sense of ownership, increasing the likelihood that communities will maintain and build upon these efforts in the future.

The post-tsunami recovery process brought about a paradigm shift in disaster response, with the adoption of the Build Back Better (BBB) approach. This philosophy advocates not simply restoring communities to their pre-disaster conditions but instead increasing their resilience to future shocks by tackling the underlying causes of vulnerability.[144] In Aceh, for example, BRR introduced robust housing designs, incorporating stronger materials and elevated foundations to reduce vulnerability to future disasters. Moreover, BRR implemented a gender-sensitive land-titling programme, allowing women to be recognized as property owners, thus promoting social equality alongside physical resilience.[145] Supporting local livelihoods is also crucial for economic recovery and community resilience, as demonstrated by Thailand's initiatives to revive fishing industries. Such measures illustrate how recovery and rebuilding efforts can be leveraged to address underlying vulnerabilities and social inequalities. BBB is not solely about physical improvements but also about addressing social vulnerabilities by creating more inclusive communities and resilient livelihoods.

Transparent and accountable fund management throughout the implementation of recovery is essential, as it underpins donor trust and ensures that financial resources are used effectively, with open data on spending and project status strengthening stakeholder confidence and facilitating ongoing support.[146] The BRR's commitment to rigorous financial oversight set a precedent for responsible fund management, with a transparent monitoring system that allowed stakeholders and the public to track project progress and expenditure.[147] This approach not only helped prevent corruption but also increased donor confidence, leading to sustained support throughout the reconstruction phase. In disaster recovery contexts, financial transparency can act as a safeguard, ensuring that funds are directed to the areas where they are most needed and reducing the risk of mismanagement. However, achieving high levels of accountability requires more than just financial audits; it necessitates a culture of transparency and a commitment to stakeholder engagement. Future recovery efforts should consider adopting similar financial accountability measures, as they can improve the efficacy of recovery programmes and build public trust in the recovery process.

To ensure accountability and transparency in post-disaster recovery implementation, a robust monitoring and evaluation strategy is essential.[148] Monitoring should be an ongoing process, with the alignment of implementation to the planned outcomes consistently assessed at every stage. Both quantitative and qualitative methods should be used to capture comprehensive insights. Participatory monitoring by affected communities should be encouraged to obtain feedback on and verification of progress, and to help foster local ownership of recovery efforts. This can be achieved through regular community forums, surveys or, in specific cases like infrastructure projects, by establishing structured community monitoring systems from the start. To promote transparency and downward accountability, monthly monitoring reports and progress updates should be publicly accessible in all relevant languages via multiple channels, such as websites, local offices and community boards. Additional formats like leaflets, exhibitions and open discussions can further broaden public access to information. Media involvement in covering project updates can also enhance transparency, ensuring that recovery efforts are visible and institutions are held accountable.

143 Thorburn, C. (2009). "Livelihood recovery in the wake of the tsunami in Aceh". *Bulletin of Indonesian Economic Studies*, 45(1): 85–105. https://www.tandfonline.com/doi/full/10.1080/00074910902836171.

144 Fernandez, G. and Ahmed, I. (2019). "Build back better" approach to disaster recovery: Research trends since 2006. *Progress in Disaster Science*, 1(3): 100003. https://www.researchgate.net/publication/333110069_Build_back_better_approach_to_disaster_recovery_Research_trends_since_2006.

145 BRR (Government of Indonesia) (2009). 10 Management Lessons for Host Governments Coordinating Post-Disaster Reconstruction. https://www.preventionweb.net/media/83616/download?startDownload=20250206.

146 Clinton, W.J. (2006). Lessons Learned from Tsunami Recovery: Key Propositions for Building Back Better – A Report by the United Nations Secretary-General's Special Envoy for Tsunami Recovery, William J. Clinton. https://www.preventionweb.net/files/2054_VL108301.pdf.

147 BRR (Government of Indonesia) (2009). *10 Management Lessons for Host Governments Coordinating Post-Disaster Reconstruction*. https://www.preventionweb.net/media/83616/download?startDownload=20250206.

148 UNDP Sri Lanka (2015). *An Integrated Approach to Disaster Recovery: A Toolkit on Cross-Cutting Issues*. https://www.undp.org/sites/g/files/zskgke326/files/publications/Integrated%20Approach%20to%20Disaster%20Recovery-%20A%20toolkit%20on%20Cross-cutting%20Issues%20-%20Lessons%20from%20the%20Tsunami%20Recovery%20Unit.pdf.

Box 2.5: Implementation and coordination in Indonesia

In Indonesia, the efforts of BRR to coordinate the recovery efforts of over 80 national and international NGOs and donors along with various government departments were crucial. These partnerships provided both financial and technical support, enabling Indonesia to learn from global best practices for planning and implementing the recovery from the Indian Ocean Tsunami. For example, UNDP worked closely with the Indonesian government to ensure that recovery projects not only addressed immediate needs but also built long-term resilience, enabled through the development of comprehensive community recovery programmes that focused on rebuilding infrastructure, restoring livelihoods, and enhancing local capacities for disaster preparedness.[149] The World Bank also played a critical role in financing and implementing recovery projects. Through the Global Facility for Disaster Reduction and Recovery (GFDRR), the World Bank supported the rehabilitation of critical infrastructure and the development of risk-informed housing projects in areas affected by the tsunami.[150] The World Bank's involvement in financing long-term recovery projects helped ensure that efforts were sustainable and that future risks were mitigated.

149 UNDP (2021). *Case Studies on Institutional Arrangements for Recovery.* https://recovery.preventionweb.net/publication/case-studies-institutional-arrangements-recovery.
150 World Bank and GFDRR (2016). *Building Indonesia's Resilience to Disaster: Experiences from Mainstreaming Disaster Risk Reduction in Indonesia Program*. https://documents1.worldbank.org/curated/en/318951507036249300/pdf/106245-REVISED-PUBLIC-Building-Indonesia-s-Resilience-to-Disaster.pdf.

Box 2.6: Sharing lessons learned through the International Recovery Platform

The International Recovery Platform (IRP) was established in 2005 following the Second UN World Conference on Disaster Reduction, held in Kobe in the Hyōgo Prefecture in Japan.[151] It served as a key pillar for implementing the Hyogo Framework for Action (HFA) 2005–2015, by addressing the gaps and constraints experienced in the context of post-disaster recovery. After a decade of functioning as an international source of knowledge on good recovery practice, IRP now acts as an international mechanism for sharing experiences and lessons focused on Building Back Better (BBB). Members of the IRP Steering Committee include the Government of Japan, the Government of Italy, UN agencies, ASEAN and the ADB.[152]

Thailand's recovery efforts were bolstered by its active engagement in regional and international cooperation through the IRP. Thailand has played a crucial role in sharing its experiences, lessons learned and best practices from its recovery efforts to other disaster-prone countries, particularly within the ASEAN region. This knowledge-sharing has helped neighbouring countries enhance their disaster risk reduction strategies, focusing on Building Back Better and incorporating resilience into recovery planning. For example, Thailand has shared its successes in community-based disaster risk management (CBDRM) programmes, which empower local communities to take active roles in disaster preparedness and recovery.

151 UNISDR (2005). *World Conference on Disaster Reduction, 18–22 January 2005, Kobe, Hyogo, Japan: Proceedings of the Conference.* https://www.preventionweb.net/files/3800_WCDRproceedings1.pdf.
152 IRP. "IRP Steering Committee Organizations". https://recovery.preventionweb.net/about-irp/steering-committee.

4. PROACTIVE RECOVERY FINANCE MECHANISMS

Resources will often flow into the most affected countries after a disaster, but that is not the time to start planning how to organize or mobilize funds: planning for how to finance a recovery before a disaster, when conditions are stable, is essential to prevent both delays and resource wastage.[153] The financial response to the 2004 Indian Ocean Tsunami highlighted the limited capacity of ASEAN countries to mobilize funds swiftly and effectively, underscoring the need for proactive financial strategies and mechanisms. As one of the deadliest disasters in history, the IOT overwhelmed national governments, which initially struggled to gather the necessary funds to support comprehensive recovery efforts in impacted regions such as Aceh, Indonesia, and coastal areas of Thailand and Sri Lanka.[154] There was a notable lack of dedicated disaster recovery funds at the national and local levels, forcing governments to reallocate resources from other critical areas.[155] The limited use of risk transfer mechanisms, such as insurance for public assets, left governments bearing the full financial burden of recovery.[156] The reliance on

153 UN-Habitat (2011). Turning Around the Tsunami: UN-Habitat Working in Partnership with Sri Lanka. https://unhabitat.org/sites/default/files/download-manager-files/Turning%20Around%20the%20Tsunami.pdf.

154 Tsunami Evaluation Coalition (2006). *Joint Evaluation of the International Response to the Indian Ocean Tsunami: Synthesis Report.* July. https://www.preventionweb.net/files/2097_VL108905.pdf.
155 IMF (2016). Natural Disasters and Food Crises in Low-Income Countries: Macroeconomic Dimensions. https://www.elibrary.imf.org/view/journals/001/2016/065/001.2016.issue-065-en.xml.
156 OECD (2013). Disaster Risk Financing in APEC Economies: Practices and Challenges. https://www.financialprotectionforum.org/publication/disaster-risk-financing-in-apec-economies-practices-and-challenges

ad hoc funding mechanisms was a significant limitation, with government agencies often dependent on delayed international pledges and disjointed contributions from various aid organizations.[157] This hindered the recovery process, resulting in uneven disbursement of aid that often bypassed smaller communities. The delays and inefficiencies demonstrated a crucial gap in regional disaster finance preparedness, revealing the vulnerability of ASEAN countries to similar disasters without the establishment of robust funding structures.

The overwhelming volume of donor contributions from international aid following the tsunami led to unintended consequences, resulting in inefficiencies and a focus on high-visibility projects rather than those of greatest need. Although financial contributions exceeded the total economic impact of the tsunami, much of this aid focused on prominent infrastructure rebuilding while neglecting essential support for local livelihoods and community-based recovery initiatives.[158] The competition between aid agencies for visibility contributed to these imbalances, with agencies prioritizing donor-friendly projects over nuanced, needs-based programming.[159] The gap between financial resources and effective application of these funds highlighted the limitations of conventional disaster aid models and the need to prioritize context-sensitive, locally driven projects. Unprecedented pledges and flow of aid from international donors was reported in the media in the aftermath of the 2004 tsunami. However, national governments and communities in countries affected by the tsunami invested substantially from their own resources, especially for the immediate relief efforts, and this local self-help assistance provided by communities and private remittances by nationals were not only sizeable but also timely and effective.[160]

In the years following the 2004 tsunami, ASEAN countries have made marked progress in disaster finance preparedness, spurred by the realization that Resilient Recovery depends on having stable and pre-arranged financial resources. There has also been increased awareness of the economic impacts of disasters on national development, driving political will for better financial preparedness.[161] The Philippines, for example, has developed a multilayered disaster risk financing strategy that includes budgetary allocations, contingent credit and catastrophe risk insurance, providing a comprehensive approach to financial resilience.[162] The Philippines established the National Disaster Risk Reduction and Management Fund (NDRRMF) in 2010, which allocates a specific portion of the national budget for DRR activities, including preparedness measures and quick response mechanisms.[163] The Philippines has also established the Local Disaster Resilience Insurance Fund, which is owned and managed by Local Government Units (LGUs), and provides quick payouts based on clear rules that allow local governments to receive predictable financing, usually within weeks of a disaster.[164]

Other ASEAN countries have also established national disaster funds to proactively finance recovery. A notable example is Indonesia's national Disaster Pooling Fund (Pooling Fund Bencana (PFB)) that is responsive, sustainable and complementary to the State Budget, and which aims to finance most of Indonesia's disaster financing needs in the future.[165] Such initiatives exemplify a shift from reactive to proactive funding, reducing dependence on delayed international aid and enabling faster mobilization of local resources. Moreover, these frameworks allow ASEAN countries to integrate disaster risk reduction into their fiscal policies, reinforcing their overall resilience.

Innovative financing mechanisms for disaster recovery are an emerging area in the ASEAN region. In particular, the Southeast Asia Disaster Risk Insurance Facility (SEADRIF) is a promising regional platform for increasing financial preparedness to disasters.[166] SEADRIF is an ASEAN+3[167] initiative in partnership with the World Bank that provides ASEAN Member States with access to rapid financing in the aftermath of disasters, enabling faster recovery and rebuilding efforts.[168] SEADRIF offers parametric insurance products tailored to the needs of its member countries. For now, SEADRIF insurance only covers flood events, but SEADRIF is working with its member countries to develop additional products that will protect the region against other hazards. SEADRIF determines the payout amount based on predefined estimations of the severity of flood using its Flood Risk Monitoring Tool, which provides near real-time assessments of the magnitude of a flood and its potential impact.

157 Tsunami Evaluation Coalition (2006). *Joint Evaluation of the International Response to the Indian Ocean Tsunami: Synthesis Report.* July. https://www.preventionweb.net/files/2097_VL108905.pdf.
158 Shaw, R. (ed.) (2015). *Recovery from the Indian Ocean Tsunami: A Ten-Year Journey. Tokyo: Springer Japan.* https://link.springer.com/book/10.1007/978-4-431-55117-1.
159 Tsunami Evaluation Coalition (2006). *Joint Evaluation of the International Response to the Indian Ocean Tsunami: Synthesis Report.* July. https://www.preventionweb.net/files/2097_VL108905.pdf.
160 ADB Institute (2006). Post-Tsunami Recovery: Issues and Challenges in Sri Lanka. Research Paper Series No. 71. January. https://www.adb.org/sites/default/files/publication/157220/adbi-rp71.pdf.
161 ESCAP (2019). Economic and Social Survey of Asia and the Pacific 2019: Ambitions Beyond Growth. https://www.unescap.org/publications/economic-and-social-survey-asia-and-pacific-2019-ambitions-beyond-growth.
162 Government of Philippines (2018). Developing a Disaster Risk Finance and Insurance Strategy for the Philippines. https://doe.gov.ph/sites/default/files/pdf/announcements/a_plenary_04_developing_disaster_risk_finance.pdf.
163 Disaster Risk Reduction Network Philippines (2010). Primer on the Disaster Risk Reduction and Management (DRRM) Act of 2010. https://downloads.caraga.dilg.gov.ph/Disaster%20Preparedness/DRRM%20Act%20Primer.pdf.
164 Government of Philippines and World Bank (2016). Philippines Local Disaster Resilience Insurance Fund. https://www.financialprotectionforum.org/sites/default/files/Philippines_LGU_pool.pdf.
165 Government of Indonesia (2023). "Indonesia Increases Adaptive Disaster Management Funding". 10 July. https://fiskal.kemenkeu.go.id/publikasi/siaran-pers-detil/507.
166 SEADRIF. "Discover the SEADRIF Initiative". https://www.seadrif.org/.
167 ASEAN+3 consist of 10 ASEAN Member States and the People's Republic of China, Japan and the Republic of Korea.
168 SEADRIF (2023). SEADRIF Insurance Company: Providing Catastrophe Risk Insurance Coverage to ASEAN Member Countries. Brochure. https://seadrif.org/wp-content/uploads/2023/11/SDI_Brochure_Nov2023.pdf.

Box 2.7: Parametric insurance for disaster recovery

Parametric insurance is a type of insurance that provides payouts based on the occurrence of a specific event, rather than covering losses for actual damages incurred. Instead of assessing individual claims, it uses predefined parameters or 'triggers' (such as the magnitude of an earthquake or the level of rainfall) to determine if and when a payout is made. If the trigger conditions are met, the insurer pays the agreed-upon amount automatically, without needing to directly inspect the damages. This type of insurance is particularly helpful when used in disaster-prone areas and for disaster events that are difficult to measure directly, such as droughts, floods, cyclones and earthquakes. By setting clear criteria, parametric insurance can help speed up recovery by providing faster, predictable funds to policy holders.

Catastrophe bonds are another innovative financial instrument which can raise funds that are immediately available for response and recovery efforts in the event of a disasters like tsunamis. They operate through a mechanism where investors purchase the bond, providing upfront capital to a country. In the event of a qualifying disaster (which is determined by predefined parameters), a portion or all of the principal is released to the government for immediate disaster response and recovery efforts. If no qualifying event occurs during the bond's term, investors receive their principal plus interest. This arrangement has a number of benefits: it enables rapid access to funds within days of a disaster, unlike traditional aid which often faces lengthy mobilization periods; it transfers a portion of the financial risk to global capital markets, alleviating pressure on national budgets; and it incentivizes detailed risk assessment and planning as part of the bond structuring process.[169] The Philippines government has partnered with the World Bank to issue catastrophe bonds, providing the country with financial protection against losses from disasters. The Philippine catastrophe bond issued in 2019 offers up to USD 225 million in protection against losses from major typhoons and earthquakes.[170]

Despite these advancements, financial support for recovery in ASEAN remains uneven, with significant gaps in meeting the specific, localized needs of disaster-impacted communities. Following the 2004 tsunami, some rural areas and smaller communities in Indonesia and Sri Lanka received limited direct funding for individual household recovery, as larger, high-profile reconstruction projects dominated aid allocations.[171] This discrepancy left smaller communities reliant on ad hoc aid from non-governmental organizations and community groups, which was not always sufficient for rebuilding local livelihoods. There is a need for more inclusive financial mechanisms that better address local recovery needs, particularly in rural or marginalized areas, and that prioritize the resilience of all citizens, not just those in high-visibility locations. These gaps in recovery support persist today in many ASEAN countries, as fiscal resources continue to prioritize broader national initiatives. A shift towards decentralized financial mechanisms, such as local disaster funds or community-managed financing models, could help address this disparity.

Other financial challenges for recovery remain. The adoption of disaster insurance, especially for private properties and small businesses, remains limited in many areas. There is a need for more innovative financing mechanisms to address slow-onset disasters and cascading risks, which often fall outside traditional insurance models. Sustaining long-term investment in disaster risk reduction continues to be challenging, particularly in resource-constrained environments. The use of public–private partnerships (PPPs) in recovery financing is a potential strategy for ASEAN countries, addressing some of the limitations of traditional government funding. Stronger partnerships between governments, the private sector, the insurance industry and international financial institutions can drive innovation and expand coverage.

169 World Bank (2022). The Philippines: Transferring the Cost of Severe Natural Disasters to Capital Markets. Case Study. https://thedocs.worldbank.org/en/doc/58d421407f57c5eb8d0f35ad843ae474-0340012022/original/case-study-Philippines-CAT-bond.pdf.
170 World Bank (2019). "World Bank Catastrophe Bond Transaction Insures the Republic of Philippines against Natural Disaster-related Losses Up to US$225 million". 24 November. https://www.worldbank.org/en/news/press-release/2019/11/25/world-bank-catastrophe-bond-transaction-insures-the-republic-of-philippines-against-natural-disaster-related-losses-up-to-usd225-million.
171 Tsunami Evaluation Coalition (2006). *Joint Evaluation of the International Response to the Indian Ocean Tsunami: Synthesis Report.* July. https://www.preventionweb.net/files/2097_VL108905.pdf.

Conclusion

The lessons from the 2004 Indian Ocean Tsunami have been instrumental in shaping the disaster recovery discourse, first through the Building Back Better approach, and now through taking forward the lessons for the more proactive Resilient Recovery approach. By establishing strong foundations in these enabling factors—established institutions, comprehensive and inclusive planning and policies, effective implementation and coordination, and proactive finance mechanisms—before a tsunami strikes, countries and communities can significantly enhance their ability to recover effectively and build long-term resilience.

The experiences of ASEAN countries in responding to and recovering from the 2004 tsunami have led to significant improvements in regional disaster management frameworks and cooperation. These efforts continue to evolve, strengthening the region's resilience to future tsunami events and other natural disasters. Moving forward, it is crucial to continue investing in these enabling factors for Resilient Recovery, adapting strategies based on new knowledge and emerging challenges, and fostering strong regional and international cooperation in disaster risk reduction and recovery, in order to foster more resilient communities.

PHOTO: UNDP PAKISTAN

PHOTO: UNDP THAILAND

Lesson 3: Empower communities to take action

Introduction

Empowering communities to be resilient to tsunamis is vital for safeguarding vulnerable populations. This requires an inclusive approach that ensures the involvement of all groups, in line with the UN's Leave No One Behind (LNOB) agenda.[172] A core component of the Sustainable Development Goals (SDGs), the LNOB agenda highlights the importance of reaching marginalized groups and empowering them with the knowledge and tools to respond effectively to tsunami risks.[173] In practice, this means not only engaging community members in disaster risk reduction measures but also ensuring that tsunami preparedness and response can accommodate the capacities and needs of all community members, especially those who are most vulnerable or marginalized. By embedding tsunami resilience strategies into community-level planning and recognizing the role of vulnerable populations, such as women, the elderly and persons with disabilities, communities can better respond during a tsunami event.[174] As well as enhancing local capacities and resilience, and enabling faster and more effective tsunami responses, such community-focused efforts can also improve social cohesion through the process of communities coming together on disaster preparedness.

Preparedness is the cornerstone of tsunami resilience, as it equips communities with the ability to anticipate and mitigate the impacts of tsunamis. Tsunamis can strike at any time—day or night, in good or bad weather, and without any predictable season—underscoring the importance of community awareness and preparedness to mitigate impacts.[175] The speed of the response is especially critical for communities located close to an earthquake's epicentre, as local tsunamis can reach shores in minutes, often before an early warning is issued. During the 2004 Indian Ocean Tsunami, for example, the proximity of some Aceh communities to the earthquake's epicentre left residents with less than 10 minutes to respond, making swift, informed action essential. A lesson learned from the 2011 Great East Japan Earthquake was that people should not be too dependent on early warning systems: they should be able to react based on their own judgement, and they can do this only if they have been made aware of the risks and how to respond.[176]

The 2004 tsunami was a wake-up call, exposing critical weaknesses in community preparedness and response capabilities across the affected countries, particularly the insufficient public awareness about tsunami risks and inadequate evacuation plans. Many communities were caught completely off guard, with no knowledge of how to recognize the signs of an impending tsunami or where to seek safety.

172 United Nations General Assembly (2015). Transforming our world: the 2030 Agenda for Sustainable Development. A/RES/70/1. 21 October. https://docs.un.org/en/A/RES/70/1.
173 UNDP (2018). What Does It Mean To Leave No One Behind?: A UNDP discussion paper and framework for implementation. July. https://www.undp.org/sites/g/files/zskgke326/files/publications/Discussion_Paper_LNOB_EN_lres.pdf.
174 UNESCO-IOC (2015). *Tsunami Risk Assessment and Mitigation for the Indian Ocean: Knowing Your Tsunami Risk – and what to do about it.* IOC Manuals and Guides No. 52. Second Edition. July. Paris: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000184777.locale=en.
175 State of Hawai'i (2011). Tsunami Safety Booklet. https://repository.library.noaa.gov/view/noaa/36038/noaa_36038_DS1.pdf.
176 UNDP (2019). Regional Guide for Schools to Prepare for Tsunamis. https://www.undp.org/asia-pacific/publications/regional-guide-schools-prepare-tsunamis

Community empowerment in tsunami risk reduction involves equipping and enabling local populations with the knowledge, skills, material resources and decision-making power to plan, respond and recover from tsunami events. This approach recognizes that community members, and their local institutions and organizations, must play an essential role in disaster risk management, and that they are not merely recipients of support after a disaster occurs. Significant progress has been made in empowering communities to better prepare for and respond to tsunami threats in the years since the Indian Ocean Tsunami, and the key enabling factors for this are explored below.

Enabling factors for empowered communities

Significant progress has been made in empowering communities to better prepare for and respond to tsunami threats in the years since the 2004 Indian Ocean Tsunami through the following five enabling factors:

- Engagement of communities in risk assessments
- Clear and accessible evacuation plans
- Institutionalized tsunami drills and preparedness in school curricula
- A culture of preparedness through public awareness campaigns
- Inclusive planning to leave no one behind.

1. ENGAGEMENT OF COMMUNITIES IN RISK ASSESSMENTS

Engaging communities in risk assessments is a critical component of tsunami preparedness. The 2004 Indian Ocean Tsunami exposed major weaknesses in disaster preparedness, particularly in the way risk assessments were conducted. Communities were often left out of the planning process, and there was limited understanding of local vulnerabilities. This lack of engagement contributed to delayed evacuations, confusion and ultimately, the high death toll. Since then, there has been significant progress in integrating communities into disaster risk assessments, empowering them to take ownership of their safety.

Where risk assessments did exist in 2004, they were often top-down, with limited input from communities themselves, leading to evacuation plans that were not tailored to the needs of specific communities. Evacuation routes and safe zones were often poorly defined or unknown to the local population, with many communities unsure where to go when the tsunami struck. Local knowledge of tsunami risks, historical events and natural warning signs were often overlooked.

Box 3.1: How engaging communities strengthens risks assessments

As tsunami events are unpredictable, it is necessary to understand the magnitude and spatial distribution of disaster risk in order to produce effective tsunami and evacuation plans. Inundation and local hazard maps are produced through the tsunami monitoring and risk assessments processes, including computer modelling and forecasting, as outlined under “Lesson 1: Create an enabling environment for people-centred EWS”.

The next stage in the risk assessment process is to incorporate each community’s vulnerability to a tsunami inundation and to estimate the potential loss of life and damage to the built and natural environments in the event of various tsunami scenarios. Through integrating this information on the physical nature of tsunami inundation with local knowledge from communities on the specific vulnerabilities of people and exposure of assets to the impacts of a potential tsunami, these risks can be assessed and the information stored geospatially as an exposure map and database.

As well as a community’s inherent geographical exposure to a tsunami, there are also intangible characteristics that contribute to its risks, including its governance and institutional capacities, which affect a community’s awareness of the dangers of tsunamis, as well as their knowledge and capacities for how they should respond during a tsunami event. The resulting risk assessment provides governments with the evidence they need to prioritize and implement effective DRR interventions in at-risk communities.

One of the key enabling factors supporting progress since 2004 has been facilitating the involvement of communities in conducting risk assessments. The Community-Based Disaster Risk Management (CBDRM) approach has been widely adopted across the ASEAN region, allowing local communities to participate in the risk assessment process, which involves local residents mapping out their own evacuation routes and safe zones.[177] This participatory approach ensures that risk assessments are grounded in local realities and take into account the specific vulnerabilities of each community. This process not only empowers communities with knowledge but also fosters a sense of ownership over their disaster preparedness plans. This local knowledge is then combined with modern early warning systems to create a more comprehensive tsunami detection and response framework.

Despite the progress made, there are still gaps in community involvement in risk assessments, particularly in remote and marginalized communities. In many cases, these communities are harder to reach with disaster preparedness programmes, and they often lack the capacities to support regular risk assessments. Moreover, there is a need for more inclusive approaches that ensure vulnerable groups, such as the elderly and persons

177 UNESCO-IOC (2015). *Tsunami Risk Assessment and Mitigation for the Indian Ocean: Knowing Your Tsunami Risk – and what to do about it.* IOC Manuals and Guides No. 52. Second Edition. July. Paris: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000184777.locale=en.

with disabilities, are not left behind in risk assessments and evacuation planning. There are opportunities for governments and international organizations to invest more in outreach programmes and capacity building.

Going forward, one of the key opportunities for improving community engagement in risk assessments is the development and application of technology-enabled participatory tools. Mobile applications that allow communities to participate in hazard mapping, report vulnerabilities and provide real-time feedback could significantly enhance the reach and effectiveness of these assessments. Expanding access to training programmes for local communities on conducting risk assessments, particularly in rural and remote areas, will also be critical to building more resilient communities. Ultimately, involving local communities in risk assessments not only enhances preparedness but also contributes to fostering a culture of resilience that empowers people to better protect themselves and their livelihoods from future tsunamis.

PHOTO: UNDP INDONESIA

Box 3.2: The STEP-A application for assessing school tsunami preparedness in Indonesia

In Indonesia, the STEP-A (School Tsunami and Earthquake Preparedness Assessment) application has significantly contributed to tsunami preparedness in schools, especially in high-risk areas.[178]

STEP-A was built on a tool that was originally developed in 2006 by various organizations including LIPI (the Indonesian Institute of Sciences) and UNESCO to measure the level of preparedness of communities, schools and governments for both earthquakes and tsunamis.[179] In 2017, the tool was upgraded into a mobile and web-based application named STEP-A, as part of UNDP's regional Tsunami Project, funded by the Government of Japan. STEP-A was integrated with the InaRISK system (the national geospatial digital platform) to ensure that preparedness data are accessible to national and local authorities, aiding in broader disaster risk management efforts.[180] By leveraging user-friendly technology, STEP-A makes the assessment process more accessible, faster and scalable, allowing schools to self-assess their preparedness efficiently, enabling more effective data collection and analysis.[181]

STEP-A supports Indonesia's Comprehensive School Safety (CSS) Programme, which is part of the global initiative under the Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector (GADRRRES).[182] There are three pillars under the CSS Programme: Pillar 1 – Safe Learning Facilities; Pillar 2 – School Disaster Management; and Pillar 3 – Risk Reduction and Resilience Education. STEP-A supports Pillars 2 and 3 by assessing schools' tsunami preparedness capacities and helping the government identify and provide relevant support to enhance them.

In Indonesia, over 200 schools in tsunami-prone areas have participated in the STEP-A initiative, making it a vital first step in ensuring that schools are equipped to handle future disasters. The process involves students, teachers and school administrators in a series of questionnaires, which are then compiled to generate an overall preparedness index.[183] In Aceh, one of the regions hardest hit by the 2004 Indian Ocean Tsunami, several schools have been actively involved in drills and preparedness assessments applying the STEP-A framework, which have helped to foster a culture of preparedness within schools.
A key benefit of STEP-A is its role in promoting self-reliance in disaster preparedness. By focusing

178 STEP-A. About STEP-A. https://inarisk2.bnpb.go.id/step-a/about.
179 Rafliana, I., Amri, A., Erawan, A., Kodijat, A.M., Sinandang, D.N.B, Muzaki, J., Yunus, R., Triyono, Hanifa, R., Koswara, A., Hartana, P., Irwan, Damayanti, R. and Udrekh (2018). STEP-A: Indonesian Contribution to the First Step in Assessing and Strengthening School Disaster Preparedness.
180 STEP-A. STEP-A Home. https://inarisk2.bnpb.go.id/step-a/.
181 STEP-A. About STEP-A. https://inarisk2.bnpb.go.id/step-a/about.
182 Plan International Indonesia (2023). The Journey and Ambition: A Comprehensive School Safety (CSS). https://reliefweb.int/report/indonesia/journey-and-ambition-comprehensive-school-safety-css-program-experiences-yayasan-plan-international-indonesia.
183 Rafliana, I., Amri, A., Erawan, A., Kodijat, A.M., Sinandang, D.N.B, Muzaki, J., Yunus, R., Triyono, Hanifa, R., Koswara, A., Hartana, P., Irwan, Damayanti, R. and Udrekh (2018). STEP-A: Indonesian Contribution to the First Step in Assessing and Strengthening School Disaster Preparedness.

on self-assessment, schools can identify gaps in their disaster response strategies and develop targeted improvements. The collaboration between local governments, NGOs and school communities in implementing the STEP-A initiative in Indonesia highlights its potential as a scalable model for other tsunami-prone regions across the Asia-Pacific region.

Box 3.3: Leveraging disaggregated data for inclusive Micro Risk Assessments

Indonesia has seen a sharp rise in the occurrence of disasters over the last five years, with the National Agency for Disaster Management (BNPB) reporting a two- to threefold increase.[184] As of 2023, there have been over 2,700 disaster incidents, largely driven by climate-related events such as the recent El Niño phenomenon. Disparities in access to resources, whether due to geographic or social limitations, severely undermine the ability of affected populations to manage these crises effectively. If not addressed, disasters risk deepening the existing inequalities and pushing vulnerable populations further into poverty.

A significant obstacle in responding to and recovering from disasters has been the lack of detailed, disaggregated data. Understanding the interplay between disasters and inequality is essential to developing effective policies that promote resilience. In 2020, the Government of Indonesia, through BNPB and National Statistics Indonesia (BPS- Statistics Indonesia), developed Satu Data Bencana Indonesia (SDBI), or Indonesia One Disaster Data, guided by the 2019 Presidential Regulation Number 39.

Indonesia One Disaster Data synthesizes existing international guidelines on disaster-related statistics to enhance the country's ability to analyse trends across different disaster events and improve the overall quality of risk assessments.[185] Indonesia One Disaster Data offers a comprehensive collection of data on disaster risks, historical events and their impacts on lives, infrastructure and economic losses. On an operational level, BNPB has also implemented a digitized Disaster Information Management System (DIMS) to provide reliable and up-to-date disaster data, supporting more effective planning and resilience efforts. This system includes platforms like Indonesian Disaster Data and Information (DIBI) and InaRISK, the country's digital geospatial platform for disaster risk information.

UNDP has worked closely with the Indonesian government to make DIMS more inclusive. Through the DX4Resilience project, UNDP and BNPB developed a Micro Risk Assessment that enables the collection and analysis of disaster risk data at the household level.[186] This extends beyond the pre-existing methodology, which focused on collecting and analysing risk data at the national and district levels, to provide more granular data. Local communities are directly involved in data collection using the InaRISK application, which allows for rapid data analysis and visualization. This engagement also helps build local capacities to understand and assess risks in their own neighbourhoods.

One of the key innovations of the Micro Risk Assessment is its ability to disaggregate risk data by gender, age, disability, income and education level. This granularity enables communities to identify their vulnerabilities during the development phase and implement strategies to reduce their disaster risks.

Furthermore, having accurate and reliable data about the locations and specific needs of vulnerable groups, such as persons with disabilities, the elderly and children, ensures these populations are prioritized during disaster preparedness, response and recovery efforts, which helps prevent the worsening of existing inequalities or the creation of new ones after a disaster. The process has also fostered greater community participation by using accessible technologies for data collection, with local data collectors reporting high levels of interest from fellow villagers who were keen to learn about the risks they face.

2. CLEAR AND ACCESSIBLE EVACUATION PLANS

184 UNDP (2023). "Inclusive Micro Risk Assessment: The power of disaggregated data to reduce inequality towards resilient futures". Haryanti Sunarta. 16 October. https://www.undp.org/indonesia/blog/inclusive-micro-risk-assessment-power-disaggregated-data-reduce-in-equality-towards-resilient-futures.
185 Government of Indonesia (2020). *Indonesia One Disaster Data.* https://www.preventionweb.net/media/83299/download?startDownload=20241025.
186 UNDP. DX4Resilience: UNDP/Japan Project to Accelerate Digitalization in DRR. https://www.undp.org/asia-pacific/dx4resilience.

Developing clear and accessible evacuation plans with primary and alternative routes is an essential component of community empowerment for tsunami preparedness. These plans must be practical, easily understood, and adaptable to the unique circumstances of each community. Primary and alternative routes should be safe, wide enough to allow for a huge influx of people evacuating simultaneously, and accessible for persons with disabilities and other vulnerable groups. Moreover, routes should avoid areas prone to flooding or containing hazardous materials, such as exposed electric wires.[187]

A key lesson from the 2004 Indian Ocean Tsunami was the absence of coherent and widely accessible evacuation routes, which led to confusion and delayed evacuations, costing lives. Since then, much progress has been made in ensuring that communities, especially in high-risk areas, are equipped with well-structured evacuation plans that can be easily followed during an emergency. By tailoring plans to local conditions, ensuring inclusivity, and involving communities in the planning and testing process, these plans become practical tools that can save lives during a tsunami. The ongoing refinement of evacuation plans, supported by regular drills and public awareness campaigns, ensures that communities remain resilient and capable of responding effectively to future tsunamis.

One critical factor in the success of evacuation plans is tailoring them to the specific geography and topography of the area. For example, some locations in countries with low-lying coastal areas only a few metres above sea level may not have enough inland space for evacuation and may lack access to higher ground due to the prevalence of low-rise buildings, while other coastal areas may have limited escape routes or natural barriers, such as rivers and mountains. In urban areas, where space is limited and large populations need to evacuate quickly, plans could incorporate tall buildings as vertical evacuation sites. Where appropriate, these structures are predesignated in the evacuation plans, with signage clearly indicating them as safe zones.[188]

Evacuation plans should also be flexible and include backup options. In regions prone to heavy rainfall or landslides, evacuation routes may become blocked, necessitating alternative routes or strategies. In some cases, communities have also developed contingency plans for when communication networks fail, such as the sounding of drums or whistles to signal evacuations.[189] A successful example comes from Japan during the 2011 Great East Japan Earthquake, where evacuation plans have been highly localized to address both natural and human-made barriers. In some coastal towns, narrow roads or complex terrain limit the options for horizontal evacuation. As a result, communities are trained to use vertical evacuation by moving to the highest floors of reinforced concrete buildings, which are marked as safe havens on evacuation maps.[190] This approach has been instrumental in reducing evacuation times in areas where moving inland quickly is not feasible.

Community involvement is crucial to the development of evacuation plans. In many ASEAN countries, evacuation plans are created through community-based disaster risk management (CBDRM) initiatives. Once a community's exposure and vulnerabilities have been mapped through conducting an inclusive risk assessment (see Engagement of communities in risk assessments in Lesson 3, Enabling Factor 1), such CBDRM initiatives empower residents to participate in the mapping of evacuation routes and safe zones, ensuring that local knowledge and expertise are integrated into more effective and realistic evacuation plans. For example, in the Philippines, CBDRM plans, such as those mandated by the country's Disaster Risk Reduction and Management Act of 2010, ensure that tsunami preparedness measures and evacuation plans are tailored to local contexts while aligning with broader strategies.[191]

Clear communication is another essential component of effective evacuation plans. Maps and signage must be simple, multilingual (where appropriate), and strategically placed to guide people to safety. Maps showing tsunami evacuation routes and tsunami safe areas need to be made available as required by the community. In particular, maps should be displayed in public areas in communities that are at risk from tsunamis, as well as in tourist facilities, workplaces and public buildings. High-use coastal areas should prominently display evacuation maps as part of tsunami information boards. These maps should be provided together with tsunami signage that clearly shows the evacuation zones and routes on the ground. In addition, the appearance and colours of evacuation zones on maps, the symbols used, and the instruction messages and supporting information on maps should be nationally consistent in order to ensure common understanding across communities. In some areas, particularly where tourism is a significant sector, signs should be printed in multiple languages to cater to non-native speakers. In Thailand, for instance, tsunami evacuation signs are available in Thai, English and other languages, ensuring that both locals and tourists can quickly understand evacuation instructions, along with arrows that direct people to safe zones.

Evacuation plans must clearly outline the steps communities and individuals should immediately take, whether after an early warning is issued or upon observing the natural signs that may precede a tsunami. For example, community-based early action protocols, such as those implemented by the Red Cross in Viet Nam, provide pre-agreed plans that outline specific actions to be taken

187 UNISDR (2010). Guidance Notes: School Emergency and Disaster Preparedness. https://www.preventionweb.net/files/15655_1msshguidenotesprefinal0313101.pdf.
188 UNESCO-IOC (2015). *Tsunami Risk Assessment and Mitigation for the Indian Ocean: Knowing Your Tsunami Risk – and what to do about it.* IOC Manuals and Guides No. 52. Second Edition. July. Paris: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000184777.locale=en.
189 UNDP (2019). Regional Guide for Schools to Prepare for Tsunamis. https://www.undp.org/asia-pacific/publications/regional-guide-schools-prepare-tsunamis.
190 GNS (2012). Tsunami evacuation: Lessons from the Great East Japan earthquake and tsunami of March 11th 2011. GNS Science Report 2012/17. April. https://recovery.preventionweb.net/media/96181/download?startDownload=20241030.
191 Government of Philippines (2010). Philippine Disaster Risk Reduction and Management Act of 2010. https://www.officialgazette.gov.ph/2010/05/27/republic-act-no-10121/.

upon receiving a tsunami warning, thereby saving crucial time during emergencies.[192] The establishment of local disaster response teams, such as Malaysia's Community Emergency Response Team programme, further bolsters immediate response capacities by training and equipping community members to provide first aid, assist with evacuations and support professional responders.[193] Plans can also include a resource mobilization component. For example, effective resource management at the community level, as demonstrated by the Philippines' barangay-level disaster risk reduction and management committees, enables the identification and mobilization of local resources during tsunami emergencies, ensuring a swift and coordinated response.[194]

Evacuation plans must be inclusive to ensure that no one is left behind. Plans must be developed in consultation with and in accommodation of vulnerable groups, such as the elderly, persons with disabilities and children, who may face additional challenges during an evacuation. Different types of disabilities—such as visual impairment, hearing disabilities or physical disabilities—should be considered, as each requires different kinds of support.[195] This requires careful planning and collaboration with health services and social support systems. In some schools in Indonesia, the Philippines and Thailand, provisions have been made to ensure that students with disabilities are able to evacuate safely. In these cases, plans include the use of wheelchairs and the buddy system, where non-disabled students are paired with those who need assistance, ensuring that no one is left behind during an evacuation[196]

The process of developing evacuation plans involves ongoing coordination between local authorities, national government agencies, NGOs and local communities. These partnerships help ensure that appropriate evacuation routes are not only identified initially but also regularly updated, taking into account changes in infrastructure, population growth or environmental conditions. Evacuation routes should also be tested regularly through conducting tsunami drills (see Box 3.4 and 3.5) with lessons incorporated in the updated evacuation plans and routes. [197] Involving the community in these exercises helps ensure that evacuation plans are practical guides that everyone understands and can use during an emergency, and the iterative process of evaluating and updating evacuation plans ensures that they remain relevant and effective.

3. INSTITUTIONALIZED TSUNAMI DRILLS AND PREPAREDNESS IN SCHOOL CURRICULA

Tsunami drills are a powerful tool for building community resilience and preparedness for future tsunamis. By regularly conducting drills, communities can simulate realistic disaster scenarios, allowing individuals, families and local institutions to practice safe and efficient evacuation procedures. They provide a practical and hands-on way for individuals to understand the risks they face and take action to mitigate them. By involving a broad range of stakeholders, from local authorities and schools to businesses and vulnerable groups, these drills ensure that everyone in the community is equipped with the knowledge and skills to respond effectively when a tsunami strikes. These drills not only increase awareness of the appropriate actions to take during a tsunami but also help foster a culture of preparedness. A key lesson from the 2004 Indian Ocean Tsunami was that many communities were not aware of the tsunami risk and did not know how they should respond during the crisis, leading to devastating consequences. Since then, tsunami drills have become an integral part of disaster risk reduction efforts across the ASEAN region and beyond.

Conducting drills in schools has proven to be an invaluable entry point for increasing overall community preparedness. For example, UNDP's regional Tsunami Project on school tsunami preparedness in the Asia-Pacific region has successfully conducted drills in 520 schools across 24 countries (see Box 3.4) along with providing education on tsunamis to students. The drills were designed not only to test the schools' evacuation procedures but also to increase awareness among parents and local residents, many of whom joined the exercises to better understand the risks they face and how to respond.[198] For example in Thailand, teachers who participated in the drills reported that they began identifying safety issues for evacuating students, including potential challenges during rainy seasons, and applied their knowledge to plan evacuations with their own families.[199] In some countries, such as Maldives, where each island typically has only one school, preparing a school means preparing the entire community, as everyone becomes involved and aware on the day of the drill. Drills must be inclusive: drills should account for the specific needs of vulnerable groups, such as persons with disabilities, the elderly and young children, who often face the greatest challenges during a tsunami (see Enabling Factor 5).

School drills are a key enabling factor for wider community tsunami preparedness, and the effectiveness of drills is increased by involving local government agencies, as well as local police, fire departments, health services, disaster management authorities, and international organizations and NGOs. In many cases, local governments provide essential resources such as evacuation maps, sirens and communication tools, while NGOs contribute by educating the public on disaster risk reduction strategies. For example, in Krabi, Thailand, the Office of the Basic

192 German Red Cross (2018). Introducing Forecast-based Financing to an Urban Setting. Update #2. November. https://www.forecast-based-financing.org/wp-content/uploads/2018/12/2018-11-2_Update2_UrbanFbF.pdf.
193 Mercy Malaysia (2019). Resilient Hospital Pulau Pinang: Community Emergency Response Team (CERT) Training. Program Report. 29–30 April. https://www.preventionweb.net/files/68119_68119resilienthospitalpulaupinangan.pdf.
194 Government of Philippines (2010). Implementing Rules and Regulations of the Philippine Disaster Risk Reduction and Management Act of 2010. https://laws.chanrobles.com/republicacts/102_republicacts.php?id=10260.
195 UNESCO (2014). Stay Safe and Be Prepared: A Teacher's Guide to Disaster Risk Reduction. https://unesdoc.unesco.org/ark:/48223/pf0000228963.
196 UNDP (2023). "Leaving no child behind: how UNDP is promoting equality and resilience through its inclusive tsunami preparedness programme". 24 July. https://www.undp.org/geneva/blog/leaving-no-child-behind-how-undp-promoting-equality-and-resilience-through-its-inclusive-tsunami-preparedness-programme.
197 UNDP (2019). Regional Guide for Schools to Prepare for Tsunamis. https://www.undp.org/asia-pacific/publications/regional-guide-schools-prepare-tsunamis.
198 UNDP (2019). Regional Guide for Schools to Prepare for Tsunamis. https://www.undp.org/asia-pacific/publications/regional-guide-schools-prepare-tsunamis.
199 UNDP (2024) (unpublished). Report on Tsunami Evacuation Drill in Ammartpanichnukul School (UNDP internal document).

Education Commission (OBEC), the provincial Department of Disaster Prevention and Mitigation (DDPM), the Red Cross and UNDP collaborated to strengthen Ammartpanichnukul School's preparedness for tsunamis and conduct a tsunami drill.[200] Trainers from OBEC who specialize in school disaster preparedness delivered a session on basic tsunami knowledge and survival skills for students. Officers from the Phang Nga provincial DDPM provided information to students on tsunami warning systems in the Andaman Sea. Furthermore, personnel from the Red Cross and local hospitals taught students and school staff how to administer emergency treatments, such as cardiopulmonary resuscitation (CPR), and how to assist injured students and community members during an evacuation. By involving multiple stakeholders, communities can ensure that the necessary resources and expertise are available to support large-scale evacuations in a real tsunami event.

Another key factor in the success of tsunami drills is the involvement of local businesses. Communities that integrate local businesses, such as hotels, shops and restaurants, into their tsunami drills have shown greater overall preparedness. For example, in Bali, Indonesia, eight hotels signed an agreement with the local government to use their buildings as safe areas for the neighbouring community in the event of a tsunami, marking a shift from school preparedness to whole-of-society preparedness.[201] By involving all sectors of the community, these drills promote a more cohesive and coordinated response, which is essential during an actual tsunami event.

Tsunami drills should not be just one-time events: they are part of a broader, ongoing effort to empower communities to take ownership of their tsunami preparedness. Post-drill evaluations are crucial. After each drill, communities, schools and local authorities should conduct debriefs to assess what went well and what needs improvement.[202] There are two types of debriefs: a hot debrief, where the assessment is conducted immediately after the drill exercise to generate initial feedback, and a cold debrief, where the assessment is conducted within four weeks of the exercise. They complement each other, with the hot debrief providing immediate feedback while the drill is still fresh, and the cold debrief allowing time for reflection and greater insights. For example, during the first drills held in Bali, Indonesia, students struggled with dehydration and exhaustion from running up several flights of stairs to reach the safe evacuation point; after these issues were identified, schools improved their preparedness by ensuring water and snacks were provided at the assembly area.[203]

Through these debriefs and the incorporation of the lessons in subsequent drills, evacuation drills can also play a critical role in helping communities assess the effectiveness of their early warning systems and communication networks. In many tsunami-prone areas, drills have revealed gaps in the dissemination of warnings, such as inadequate sirens or poor coordination between local authorities and community members. This iterative process of testing, identifying gaps and improving systems can strengthen communities' overall preparedness.[204]

Maintaining momentum and ensuring drills are conducted regularly is of crucial importance. For drills to remain effective, they must be updated to reflect new risks, improved early warning technologies and evolving community dynamics, with continuous engagement with communities helping to integrate tsunami preparedness into the daily lives of residents. This regular participation in drills ensures that the community's knowledge of evacuation routes, safe zones and warning systems remains fresh. Moreover, involving each new generation of children in these drills ensures that tsunami preparedness becomes a long-term, sustainable part of a community's culture. In schools, for instance, younger students are taught how to recognize tsunami risks and practice evacuation routes from an early age, and they are encouraged to share this knowledge with their families and the wider community. As a result, the entire community benefits from this intergenerational approach to preparedness.

Japan has demonstrated a long-standing commitment to public education on and awareness of disasters, which was evident in the immediate response of citizens during

200 Ibid.
201 UNDP (2017). "Hotels in Tsunami-prone Bali Sign MOU to Become Evacuation Points". 29 August. https://reliefweb.int/report/indonesia/hotels-tsunami-prone-bali-sign-mou-become-evacuation-points.
202 UNDP (2019). Regional Guide for Schools to Prepare for Tsunamis. https://www.undp.org/asia-pacific/publications/regional-guide-schools-prepare-tsunamis.
203 Ibid.
204 Ibid.

PHOTO: UNDP VIETNAM

the 2011 Great East Japan Earthquake and tsunami. The country's approach includes regular drills, disaster preparedness days and the integration of disaster education into school curricula, which have fostered a culture of preparedness. The importance of regular drills was further emphasized during the 2024 Noto Peninsula earthquake, where communities that conducted frequent drills demonstrated quicker and more collaborative evacuations. As one resident noted, "everyone could have died if no training had been conducted regularly; it was not a miracle, the drills paid off."[205]

While conducting tsunami drills in schools is a key entry point for increasing tsunami preparedness among school children and communities, disparities remain between increased tsunami awareness in individual schools and communities and the need to mainstream tsunami preparedness in countries at the national policy level, which is critical for ensuring that all schools and communities are empowered to take action during a tsunami event. While there has been commendable progress in the ASEAN region, including through UNDP's regional Tsunami Project, the translation of this raised tsunami awareness into tangible policy frameworks remains inconsistent, with many countries lacking comprehensive and enforceable policies that prioritize tsunami preparedness and response. This is of great concern.

Addressing this gap requires a concerted effort to translate heightened awareness into national policy actions. In particular, tsunami education and drills should be institutionalized through embedding tsunami preparedness in countries' national school curricula. This would ensure that every child that lives in exposed coastal areas is taught about tsunamis and is given first-hand experience of what to do through participating in a tsunami drill each school year. The famous case of Tilly Smith provides validation that this low-cost approach of educating students about the signs and dangers of tsunamis can directly save lives: the British schoolgirl had learned about the signs of tsunami in a geography lesson two weeks before her family came to Thailand on holiday in 2004.[206] When she saw the signs of the oncoming Indian Ocean Tsunami, she was able to persuade her parents, younger sister and other tourists to flee their beach and hotel. Thanks to her knowledge, no one was killed on the beach she was on.

In Viet Nam, catalysed by tsunami drills and awareness events, the Ministry of Agriculture and Rural Development (MARD) and the Ministry of Education and Training signed and launched a five-year programme and plan (2018–2023) to incorporate disaster education and drills into the national school curriculum.[207] In Palau, acknowledging the importance of preparedness programmes, including school drills, Presidential Proclamation No. 19-269 marked September as National Preparedness Month and mandated all schools to conduct evacuation drills annually.[208] Ideally, drills should be conducted on a National Tsunami Awareness Day that occurs each year, during which there can be wider remembrance activities that ensure that the catastrophic dangers of tsunamis and the lessons of the 2004 Indian Ocean Tsunami are never forgotten.

Overall, the experience of conducting tsunami drills has highlighted the critical need for ongoing, community-wide engagement in preparedness activities. These drills are not just about practising evacuation procedures but also about fostering a mindset of readiness and resilience within the community. Regular participation in drills empowers individuals to take responsibility for their own safety and the safety of others, but drills also serve as an invaluable opportunity for communities to review and refine their preparedness strategies, ensuring that they remain relevant and effective in the face of evolving risks.

205 *Arab New Japan* (2024). "Evacuation drills paid off in tsunami-hit Noto area in Japan". 6 January. https://www.arabnews.jp/en/japan/article_112892/.

206 *BBC News* (2005). "Award for tsunami warning pupil". 9 September. http://news.bbc.co.uk/2/hi/uk_news/4229392.stm.

207 UNDP (2018). "Viet Nam to Integrate Disaster Prevention Education in the National School Curriculum". 30 August. https://www.undp.org/asia-pacific/news/viet-nam-integrate-disaster-prevention-education-national-school-curriculum.

208 UNDP (2022). "'A Lasting Legacy': Palau's National Preparedness Month". 13 September. https://www.undp.org/asia-pacific/news/lasting-legacy-palaus-national-preparedness-month.

Box 3.4: How UNDP's Regional Tsunami Project supports tsunami preparedness in schools

UNDP's Regional Tsunami Project,[209] funded by the Government of Japan, has been instrumental in building community tsunami preparedness and resilience in the ASEAN region.[210] One of the project's primary objectives has been to strengthen school preparedness for tsunamis across 24 Asia-Pacific countries. This involved conducting tsunami evacuation drills, updating school emergency plans, and integrating these plans into national disaster management frameworks. Over 520 schools participated in the drills, engaging more than 218,000 students, teachers and local officials, raising awareness not only among students but also among teachers, school staff and local communities. These efforts have increased community preparedness and readiness, ensuring that schools are equipped to act swiftly during tsunami emergencies.

A key outcome of the project was the development of tailored tsunami evacuation drills that were contextually relevant for each participating country. For example, in the Philippines, the project focused on empowering local communities through educational initiatives and drills. More

209 The Regional Tsunami Project is officially titled, "Partnerships for Strengthening School Preparedness for Tsunami in the Asia-Pacific Region".

210 UNDP Asia and the Pacific. "Regional Tsunami Project". https://www.undp.org/asia-pacific/projects/tsunami.

than 20 schools in tsunami-prone Eastern Visayas participated in these efforts, reaching over 19,000 students. By educating students on tsunami warning signs and evacuation protocols, the project ensured that children—who are often vulnerable during disasters—are better prepared to respond quickly and appropriately in real-life scenarios. In Fiji, the integration of technology significantly improved the effectiveness of the tsunami drills: the use of the GeoBing app during drills allowed for real-time collection of geotagged data, which were transmitted to emergency operations centres, enhancing the coordination of emergency responses. The drills in Fiji involved over 3,400 participants, and the lessons learned from these exercises have informed national disaster management strategies.

The project also made notable advancements in inclusive disaster preparedness. In Thailand, tsunami drills were designed to ensure students with disabilities could evacuate safely and effectively. An expert from the Disability Council of Thailand was invited to train school authorities on disability inclusive disaster risk reduction (DiDRR) and share practical ways on how to involve students with disabilities in the planning process and evacuation drills. An instructional drill video that was produced includes the importance of supporting students with disabilities or injuries so that no one is left behind.[211] The UNDP-led project also developed the "National Guidelines for Tsunami Evacuation Plans and Drills for Schools" in Thailand, which is now a critical resource for schools in tsunami-prone areas, helping ensure that no one is left behind during emergency evacuations.[212]

The project's focus on institutionalization ensured the long-term sustainability of these tsunami preparedness efforts. To support this focus, the project has been working closely with Ministries of Education, National Disaster Management Organizations (NDMOs), and other relevant ministries and government departments. In Papua New Guinea, for example, local authorities have mandated annual tsunami evacuation drills in all schools across Milne Bay Province. This policy shift highlights the long-term ambitions of the Regional Tsunami Project, which has moved beyond short-term interventions to aiming to permanently embed tsunami preparedness into national disaster management strategies and school curricula.

The key lessons from the project include the effectiveness of using schools as hubs for building community-wide tsunami preparedness and resilience, the multiplier effect of empowering children and young people as disaster preparedness champions, the crucial role of regular drills and practical exercises in maintaining preparedness, and the importance of adapting preparedness strategies to local contexts and integrating them into existing systems to enhance their effectiveness and sustainability. Through continuous collaboration with governments, schools and communities, UNDP's Regional Tsunami Project has achieved success in empowering people to be able to respond effectively to tsunamis. By creating a framework that promotes community engagement, inclusivity and sustainability, the project has aimed to ensure that tsunami preparedness becomes a key component of the ASEAN region's resilience efforts.

Looking ahead, the project continues to support countries in institutionalizing tsunami drills and embedding tsunami education into school curricula at the national level, to help ensure that students and communities are better prepared for future tsunamis and to avoid the tragic loss of life witnessed during the Indian Ocean Tsunami two decades ago.

211 UNDP Thailand (2018). "Strengthening School Preparedness for Tsunamis in Thailand". Video. English version. https://www.youtube.com/watch?v=Wiyu5XaFma4.
212 UNDP Thailand (2020). National Guidelines for Tsunami Evacuation Plans and Drills for Schools. Thai version. https://www.undp.org/thailand/publications/national-guidelines-tsunami-evacuation.

PHOTO: UNDP INDONESIA

Box 3.5: The "Miracle of Kamaishi" in Japan

There is a long history of tsunami evacuation drills in Japan, particularly through the country's annual Disaster Prevention Day. This event, initiated in 1960 by the Japanese Prime Minister, takes place every 1 September, on the anniversary of the 1923 Great Kanto earthquake. The drills involve nationwide participation from all sectors of society, including specific provisions for persons with disabilities. Jointly funded by national, prefectural and local governments, these exercises have significantly enhanced public awareness and preparedness against tsunamis.

A prominent example of the impact of regular tsunami drills in schools is the "Miracle of Kamaishi" in Japan during the 2011 Great East Japan Earthquake and Tsunami.[213] Kamaishi East Junior High School was able to save more than 3,000 lives during the devastating tsunami. When a magnitude 9.0 earthquake occurred, the school's students and staff immediately evacuated from the school buildings and moved to the assembly area. Students and staff followed the procedures which they had learnt through the school's tsunami disaster prevention education. The evacuation of the school also prompted neighbouring schools and local residents living in the city to evacuate as well. During the evacuation, students from the high school helped younger students make their way to the assembly area safely. While 1,000 people in the city still lost their lives, only five of them were school-age children, and they were not at school when the earthquake occurred. This case highlights the importance of embedding preparedness in school curricula and demonstrates how engaging young people in drills can have ripple effects throughout the wider community.

213 UNDP (2019). Regional Guide for Schools to Prepare for Tsunamis. https://www.undp.org/asia-pacific/publications/regional-guide-schools-prepare-tsunamis.

Box 3.6: Embedding disaster risk reduction in education in Indonesia

The 2004 Indian Ocean Tsunami marked a turning point for disaster preparedness and education in Indonesia.[214] In the immediate aftermath, awareness of tsunamis and other natural disasters was critically low, particularly among school communities in affected regions like Aceh and Nias. In response, initiatives were launched that aimed to integrate disaster risk reduction (DRR), including tsunami preparedness, into school curricula. LIPI (the Indonesian Institute of Sciences), in collaboration with the Ministry of Education, was a leading force in these efforts, creating disaster education programmes and training volunteers to teach children about natural hazards. However, early assessments revealed significant gaps in preparedness, with schools ranking among the least prepared institutions in their communities.

Over the next several years, disaster education in Indonesia evolved from basic awareness-raising activities to more structured, process-based interventions. Despite improvements in awareness and knowledge, the assessments showed that this did not immediately translate into practical disaster readiness. Schools struggled to implement policies, emergency plans and warning systems, indicating that a more holistic approach was needed. LIPI's updated model of school-based disaster preparedness emerged from these findings, emphasizing the importance of engaging both students and teachers in experiential learning. The preparedness assessment framework developed by LIPI and UNESCO highlighted five key parameters for disaster preparedness in Indonesian schools:[215]

- Knowledge and Attitudes – The level of understanding and awareness of disaster risks and the importance of preparedness among students, teachers and school staff.
- Emergency Planning – The existence and quality of emergency response plans within schools, including evacuation procedures and roles during disasters.
- Policy Statements – Formal policies or decrees at the school level that institutionalize disaster preparedness as part of the school's operations.
- Warning Systems – The presence and functionality of systems to warn students and staff about impending disasters, such as alarms or communication protocols.
- Resource Mobilization Capacity – The school's ability to gather and use resources (financial, human and material) to enhance disaster preparedness and respond effectively to emergencies.

214 Rafliana, I. (2012). "Disaster Education in Indonesia: Learning How It Works from Six Years of Experience After Indian Ocean Tsunami in 2004". *Journal of Disaster Research,* 7(1): 83–91. https://www.researchgate.net/publication/293474274_Disaster_Education_in_Indonesia_Learning_How_It_Works_from_Six_Years_of_Experience_After_Indian_Ocean_Tsunami_in_2004.
215 Ibid.

The integration of DRR into Indonesia's education system has since become more comprehensive, with national policies encouraging schools to develop their own preparedness models. The Consortium for Disaster Education (CDE), founded in 2006, has been crucial in uniting efforts and resources to promote disaster education and preparedness in Indonesia. Established during the commemoration of the International Disaster Reduction Day, the CDE was created to provide a platform for various organizations—more than 60 members, ranging from international agencies to local NGOs—to share lessons, collaborate and advocate together for embedding DRR into school curriculums and community initiatives. The CDE has also actively supported national policy development, supporting the Indonesian Ministry of Education to develop strategies for mainstreaming DRR into formal education.

Today, Indonesia continues to refine its approach to disaster education, aiming to build resilient communities through informed, proactive school systems.

4. A CULTURE OF PREPAREDNESS THROUGH PUBLIC AWARENESS CAMPAIGNS

Public awareness campaigns are essential in building a culture of tsunami preparedness. While early warning systems and technological innovations are crucial, long-term resilience can only be achieved if communities understand the risks they face and are committed to tsunami preparedness. This requires continuous investment in public education campaigns, regular community drills and the integration of disaster preparedness into school curricula. This is particularly important in areas prone to near-field tsunamis, a tsunami generated by an event that occurs close to a coast and arrives onshore in a short amount of time. Communities in these areas may need to be able to act independently at the initial signs of an oncoming tsunami because they could be struck before an early warning is issued. In Indonesia, for example, the government has made significant strides in educating children about tsunami risks through school programmes, which have become a model for other countries in the region.[216] Expanding these awareness campaigns to include all members of society will help ensure that communities are fully prepared to respond to future tsunami threats. These public awareness campaigns often involve distributing educational materials, conducting workshops, holding public memorial events and engaging with community leaders to ensure that information reaches all levels of society. Continuous education is critical, as each new generation must be taught the importance of tsunami preparedness.

The 2004 Indian Ocean Tsunami tragically demonstrated the importance of public awareness and education in disaster preparedness. In the immediate aftermath, it became clear that in many of the affected areas, communities lacked even basic knowledge about tsunamis, their warning signs and how to respond, because tsunamis were not part of the collective experience in these communities, and there had been little or no formal education on the topic. In particular, many people did not recognize the natural signs of an impending tsunami, such as the receding sea or unusual animal behaviour. This gap in public awareness contributed to the high death toll, as many people remained on the coastlines or delayed evacuations, not understanding the gravity of the situation. For example, in Aceh, Indonesia, where the tsunami hit hardest, areas like Jantang on the mainland suffered many casualties as many people remained on the beaches when the water receded, unaware that this was a warning of an approaching tsunami. By contrast, the island of Simeulue had far fewer casualties, due to an oral history of a tsunami that occurred in 1907 that had been passed down through the generations, and which had taught people to run to the hills immediately after feeling significant shaking.[217] This community knowledge acted as a powerful mitigation tool that saved countless lives where even a modern early warning system with a 15-minute response time would have been ineffective.

Compounding the issue was the fact that few, if any, educational campaigns about tsunamis had been conducted prior to 2004. In many ASEAN countries, disaster preparedness efforts were focused on other hazards, such as earthquakes, floods and typhoons, with little emphasis on tsunamis. As a result, there was a general lack of knowledge about what tsunamis are, how they are generated and the steps individuals should take to protect themselves. This knowledge gap, combined with the absence of an early warning system in many affected areas, left populations unprepared and extremely vulnerable.

In the aftermath of the 2004 tsunami, there was a significant shift in the focus of disaster preparedness efforts, with educational campaigns and public awareness programmes becoming a key priority for governments and international organizations. Many ASEAN countries launched national public awareness campaigns to ensure that communities were better informed about tsunami risks and how to respond to early warnings. For example, in Thailand the Thai Public Broadcasting Service (Thai PBS) launched initiatives to increase public disaster awareness.[218] One example is the TV documentary

216 Rafliana, I. (2012). "Disaster Education in Indonesia: Learning How It Works from Six Years of Experience After Indian Ocean Tsunami in 2004". *Journal of Disaster Research*, 7(1): 83–91. https://www.researchgate.net/publication/293474274_Disaster_Education_in_Indonesia_Learning_How_It_Works_from_Six_Years_of_Experience_After_Indian_Ocean_Tsunami_in_2004.

217 McAdoo, B.G., Dengler, L., Prasetya, G. and Titov, V. (2006). "Smong: How an Oral History Saved Thousands on Indonesia's Simeulue Island during the December 2004 and March 2005 Tsunamis". *Earthquake Spectra,* 22(S3): 661–669. https://www.researchgate.net/publication/237970601_Smong_How_an_Oral_History_Saved_Thousands_on_Indonesia's_Simeulue_Island_during_the_December_2004_and_March_2005_Tsunamis.

218 Leelawat, N., Latcharote, P., Suppasri, A., Sararit, T., Srivichai, M., Tang, J., Chua, T., Kumnetrut, D., Saengtabtim, K. and Imamura, F. (2019). "Today in Thailand:

programme, titled "Ru Su Phai", which was first aired in 2012 and provided comprehensive information on all phases of disaster preparedness and response. Many leading experts from academic institutions were invited to participate on the programme and share their expertise to educate the public. In addition, the Disaster Communication Centre was established to train news reporters from both domestic and international news media on how to accurately communicate about the risks of natural disasters in their reporting. These efforts have been instrumental in raising awareness and building a culture of preparedness in the country.

Technology can be leveraged to enhance public awareness campaigns. Mobile applications, social media and digital platforms can be powerful tools for disseminating information about tsunami risks and preparedness.

Multidisciplinary Perspectives on the Current Tsunami Disaster Risk Reduction". *Geological Society, London, Special Publications*, 501(3): SP501-2019-97. https://www.researchgate.net/publication/338452195_Today_in_Thailand_Multidisciplinary_Perspectives_on_the_Current_Tsunami_Disaster_Risk_Reduction.

Expanding these technologies to include educational content—such as videos, infographics and interactive drills—could help reach a broader audience, particularly younger people who are more likely to engage with digital content.

Despite the progress made, there are still gaps in public awareness and education, particularly in reaching remote and marginalized communities. In many rural coastal areas, disaster awareness programmes may not be as widespread or well-funded as in urban areas. Moreover, outreach and advocacy initiatives may require targeted efforts to reach certain vulnerable groups, such as the elderly, persons with disabilities and ethnic minorities. Awareness materials should be made available in multiple languages and formats to accommodate diverse populations.[219]

219 UNESCO-IOC (2020). *Preparing for Community Tsunami Evacuations: From Inundation to Evacuation Maps, Response Plans and Exercises.* https://unesdoc.unesco.org/ark:/48223/pf0000373019.

Box 3.7: World Tsunami Awareness Day

In December 2015, the United Nations General Assembly designated 5 November as World Tsunami Awareness Day (WTAD), inviting countries, international organizations and civil society to raise awareness of tsunami risks and promote ways to reduce them. This day was inspired by Japan's long history with tsunamis, which has provided the country with its expertise in tsunami early warning systems, public preparedness and building back better after disasters. WTAD has inspired people around the world to organize events that raise awareness about tsunami risks and promote preparedness. Activities such as evacuation drills, symbolic walks along tsunami evacuation routes, educational seminars and contests provide hands-on ways for communities to understand the risks and learn how to stay safe.[220] For example, UNESCO-IOC's video contest in 2021[221] and the 2022 High School Students Summit in Japan[222] have helped to engage students and communities in learning about tsunami safety in creative and impactful ways.

220 UNDRR. World Tsunami Awareness Day 5 November. Updates. https://tsunamiday.undrr.org/news-type/updates.
221 UNDRR (2021). "Indian Ocean Youth Short Video Competition on Tsunami Awareness". 16 October. https://tsunamiday.undrr.org/2023/news/indian-ocean-youth-short-video-competition-tsunami-awareness.
222 UNDRR (2022). "Young people for resilience: the global gathering resumes". 20 October. https://www.undrr.org/news/young-people-resilience-global-gathering-resumes.

5. INCLUSIVE PLANNING TO LEAVE NO ONE BEHIND

The 2004 Indian Ocean Tsunami exposed significant weaknesses in tsunami preparedness, particularly in the protection of vulnerable groups, such as children, women, the elderly and persons with disabilities. Many of these groups were disproportionately affected due to physical, social and information barriers that limited their ability to respond effectively during the disaster. In the immediate aftermath, it became clear that tsunami preparedness and response plans did not sufficiently consider the unique needs of these populations, resulting in higher casualty rates among vulnerable groups. For example, approximately 70 percent of fatalities in the 2004 tsunami were women, with many not surviving, possibly for cultural reasons, because they prioritized the safety of other family members over their own, or because they were less aware of self-protection measures.[223] Likewise, almost two thirds of the victims of the 2011 Great East Japan Earthquake and tsunami were older persons, primarily due to their reduced mobility and lower physical strength and delayed evacuations.[224]

In 2004, some vulnerable individuals were left behind during evacuations because evacuation routes were not accessible. Special provisions, such as accessible evacuation routes and targeted communication strategies, are essential to ensure that these populations can respond quickly to a tsunami warning. People were often so overwhelmed by the disaster that was unfolding around them that they could only focus on their own immediate survival and were not able to provide assistance to others who were in need, particularly those with physical limitations. This is why it is crucial to ensure vulnerable groups are included in emergency planning, so that in a crisis everyone understands how they should instinctively evacuate together with those who are most at risk, and the evacuation routes have been planned with diverse needs in mind.

223 Rahiem, M.D.H., Rahim, H. and Ersing, R. (2021). "Why did so many women die in the 2004 Aceh Tsunami? Child survivor accounts of the disaster". *International Journal for Disaster Risk Reduction*, Volume 55, March: 102069. https://www.sciencedirect.com/science/article/abs/pii/S2212420921000352#

224 HelpAge International (2013). "Displacement and older people: The case of the Great East Japan Earthquake and Tsunami of 2011". 31 December. https://reliefweb.int/report/japan/displacement-and-older-people-case-great-east-japan-earthquake-and-tsunami-2011

While tsunamis affect all, they often impact boys and girls differently, due to physical, social or cultural factors that influence vulnerability. For instance, adolescent girls may face unique challenges during evacuations, such as the need for hygiene provisions and privacy, which should be anticipated in preparedness planning. Schools and communities can adopt a gender-sensitive approach by ensuring that girls, female teachers and female community members are well-represented in disaster preparedness committees, and that safety and privacy considerations for both boys and girls are incorporated into evacuation protocols and preparedness plans.[225]

Since 2004, there has been a concerted effort by governments, NGOs and international organizations to ensure that inclusive planning is a central component of tsunami preparedness. For example, the dissemination of tsunami early warnings have been redesigned to be more inclusive, incorporating both visual and audible warnings to reach people with hearing or visual impairments. In terms of infrastructure, governments have made evacuation routes more accessible for persons with disabilities and the elderly, which has involved retrofitting existing routes to include ramps and handrails or developing alternative evacuation strategies for individuals who may not be able to use standard routes, such as transportation options for the elderly and people with mobility impairments. ASEAN countries should continue to prioritize this work of ensuring tsunami evacuation plans are inclusive, in order to ensure that no one is left behind during the next tsunami event.

Often the challenges facing people with differing needs are uncovered in the process of conducting tsunami evacuation drills, underlining the importance of carrying out thorough debriefs after drills, and incorporating the lessons into the next drill. For example, through the process of conducting drills, the evacuation routes at Phraratchatharn Thublamu School in Thailand were upgraded to become more wheelchair-friendly, and Ban Bang Niang School, also in Thailand, established a "buddy system", in which students with disabilities are accompanied to the evacuation zone by designated classmates and teachers.[226]

One of the key factors enabling progress in inclusive tsunami preparedness planning has been the involvement of community-based organizations and NGOs in risk reduction efforts. In many ASEAN countries, NGOs have worked closely with local governments and communities to identify the specific needs of vulnerable groups and to develop tailored solutions. For example, in Cambodia, Save the Children and UNDP collaborated to conduct a Training of Trainers module developed for teachers that incorporates children and teachers with disabilities as a component of the drill planning process.[227]

International funding and technical support have also been critical in enabling progress. Governments in the ASEAN region have received support from international organizations to implement more inclusive disaster preparedness strategies, and capacity-building programmes have provided trainings for local government officials and community leaders on how to incorporate the needs of vulnerable groups into disaster planning. Such efforts have been guided through robust legal frameworks at the regional level, including the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) and the ASEAN Regional Framework on Protection, Gender, and Inclusion in Disaster Management 2021–2025 (ARF-PGI), which both offer a foundation for inclusive disaster management.[228]

225 UNESCO (2014). Stay Safe and Be Prepared: A Teacher's Guide to Disaster Risk Reduction. Paris: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000228963

226 The Nation (2018). "Schools on Andaman coast on alert with regular drills". 26 December. https://www.nationthailand.com/in-focus/30361138

227 UNDP (2018). "UNDP Trains Teachers to Lead Emergency Evacuations During Disasters in Cambodia". 27 April. https://www.undp.org/cambodia/stories/undp-trains-teachers-lead-emergency-evacuations-during-disasters-cambodia

228 The ASEAN Magazine (2024). "No One Left Behind: Advancing Disability-Inclusive Disaster Risk Reduction". 8 October. https://theaseanmagazine.asean.org/article/no-one-left-behind-advancing-disability-inclusive-disaster-risk-reduction/

PHOTO: UNDP THAILAND

Conclusion

The journey from the devastating 2004 Indian Ocean Tsunami to the present day demonstrates the critical importance of community empowerment in building resilience to tsunami risks. By being actively engaged in all aspects of tsunami preparedness and response planning—from risk assessments to drills and public awareness campaigns to ensuring no one is left behind—communities not only enhance their capacities to face future tsunamis, but also create more sustainable and context-appropriate solutions.

However, there continue to be challenges in leveraging these enabling factors. In particular, sustaining community focus and participation in disaster preparedness activities when conditions are stable (i.e. before a disaster hits) remains a challenge, though there are opportunities to integrate preparedness into broader community development efforts to enable ongoing engagement. The impacts of climate change, most notably rising sea levels and changing weather patterns, may alter tsunami risks, and it is important that communities are empowered with the knowledge and tools to adapt their preparedness strategies to the changing conditions. Continued investment in community-based disaster risk management programmes is crucial to leverage the enabling factors described above and overcome these remaining challenges, to ensure that no one is left behind. By doing so, the ASEAN region can create a future where communities are not just beneficiaries of disaster risk reduction efforts, but active agents in building their own resilience.

PHOTO: UNDP BRH

Lesson 4: Strengthen regional cooperation

Introduction

The catastrophic 2004 Indian Ocean Tsunami served as a stark reminder of the critical importance of regional cooperation in disaster risk reduction (DRR), particularly for transboundary hazards like tsunamis. This devastating event, which affected multiple Indian Ocean countries, exposed significant gaps at the regional level in preparedness and early warning systems, coordinated response mechanisms and recovery capacities.

In the aftermath of the 2004 tsunami, the international community has increasingly recognized the value of regional cooperation in DRR through various frameworks and agreements. The Hyogo Framework for Action (HFA) 2005–2015 and the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030, which succeeded it, both emphasize the importance of regional organizations in implementing DRR strategies.[229] The SFDRR specifically calls for enhanced regional cooperation to address shared risks and build collective resilience. Similarly, the 2030 Agenda for Sustainable Development, particularly Sustainable Development Goal (SDG) 17 on partnerships, underscores the need for regional and international cooperation to strengthen resilience to disasters.[230]

The 2004 tsunami has been regarded as a catalyst for the enhancement of cooperation among countries in the ASEAN region, particularly through the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) and the ASEAN Coordinating Centre for Humanitarian Assistance on disaster management (AHA Centre) . Ratified in 2009, AADMER provides a comprehensive legally binding regional framework for cooperation, coordination, technical assistance and resource mobilization in all aspects of disaster management.[231] This agreement has been instrumental in enhancing the region's collective capacity to prepare for and respond to disasters, including tsunamis. Building on AADMER, the ASEAN Committee on Disaster Management (ACDM) developed the AADMER Work Programme, a five-year strategic plan that outlines specific actions and targets for implementing AADMER. The current Work Programme (2021–2025) focuses on enhancing regional resilience through integrated, cohesive and people-centred approaches to disaster management.[232] The United Nations is supporting the implementation of the AADMER Work Programme 2021–2025 through the ASEAN–UN Joint Strategic Plan of Action on Disaster Management IV (JSPADM) 2021–2025, with Priority Programme 4 (Resilient Recovery) being led by UNDP.[233]

The establishment of the AHA Centre in 2011 also marked a significant moment in improving regional disaster management processes.[234] The AHA Centre has been invaluable in operationalizing many of the regional processes outlined in AADMER and its Work Programme. The AHA Centre's primary functions are to facilitate regional cooperation for disaster management,

229 United Nations General Assembly (2015). Sendai Framework for Disaster Risk Reduction 2015–2030. A/RES/69/283. 23 June. https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_69_283.pdf.
230 United Nations General Assembly (2015). Transforming our world: the 2030 Agenda for Sustainable Development. A/RES/70/1. 21 October. https://docs.un.org/en/A/RES/70/1.
231 ASEAN (2009). ASEAN Agreement on Disaster Management and Emergency Response. https://agreement.asean.org/media/download/20220330063139.pdf.
232 ASEAN (2020). *AADMER Work Programme 2021–2025*. https://asean.org/wp-content/uploads/2021/08/AADMER-Work-Programme-2021-2025.pdf.
233 ASEAN (2021). *ASEAN-UN Joint Strategic Plan of Action on Disaster Management IV 2021–2025*. https://asean.org/wp-content/uploads/2021/10/ASEAN-UN-Joint-Strategic-Plan-of-Action-on-Disaster-Management-IV-2021-2025-Final.pdf.
234 AHA Centre. About the AHA Centre. https://ahacentre.org/about-us/.

to facilitate joint emergency preparedness and response, and to operationalize regional coordination mechanisms for emergency preparedness and response.

The One ASEAN, One Response initiative exemplifies ASEAN's commitment to enhancing disaster management and humanitarian response within and beyond its borders.[235] Officially adopted through the ASEAN Declaration in 2016, it is a unifying framework designed to mobilize ASEAN Member States, regional bodies and external partners to act collectively with speed, scale and solidarity. Operationalized by the AHA Centre, this initiative leverages ASEAN's disaster response tools (such as the ASEAN Emergency Response and Assessment Team (ASEAN-ERAT) and the Disaster Emergency Logistic System for ASEAN (DELSA), which are discussed below under "Rapid regional mobilization for tsunami response"), to ensure efficient coordination and deployment of resources. One of its key strengths lies in its scalability, allowing it to mobilize resources based on the scale of the disaster. By fostering inclusive collaboration, One ASEAN, One Response reduces the burden on affected countries, strengthens regional resilience and showcases ASEAN's solidarity in times of crisis, making it a model for cooperative disaster response.

The Standard Operating Procedure for Regional Standby Arrangements and Coordination of Joint Disaster Relief and Emergency Response Operations (SASOP) is a critical framework established by ASEAN to operationalize AADMER. SASOP facilitates a coordinated regional response to disasters by outlining the mechanisms for mobilizing and utilizing earmarked assets and capacities of ASEAN Member States. It incorporates key processes such as disaster notification, joint assessments and the deployment of resources, while promoting interoperability among participating entities. By enabling structured and timely responses, SASOP enhances regional resilience, minimizes disaster impact and fosters a collective approach that embodies the ASEAN spirit of solidarity and cooperation. Its practical impacts include more efficient disaster relief operations, strengthened capacities of national disaster management organizations, and improved integration of regional and international assistance efforts.

Regional cooperation for tsunami preparedness, response and recovery offers numerous benefits and has significantly enhanced resilience to tsunamis in the ASEAN region:

- **Shared resources and expertise:** Pooling resources, knowledge and technical capabilities enables countries to overcome their individual limitations and achieve more comprehensive DRR strategies. For example, countries with limited financial or technical capacities can benefit from the expertise and resources of their more developed neighbours.
- **Standardized approaches:** Regional cooperation promotes the development and implementation of standardized methodologies for risk assessment, early warning and response protocols. This standardization ensures consistency in approaches across the region, facilitating smoother coordination during crises.
- **Economies of scale:** Collaborative efforts often lead to cost-effective solutions, particularly in establishing, maintaining and upgrading expensive technologies like early warning systems. By sharing the costs, countries can implement more advanced and comprehensive DRR measures than they could do so individually.
- **Coordinated responses:** In the event of a transboundary disaster like a tsunami, regional cooperation facilitates a more efficient and effective coordinated response. Pre-established protocols and communication channels enable rapid mobilization of resources and personnel across borders.
- **Knowledge exchanges:** Regular regional dialogues and joint exercises foster continuous learning and improvement in DRR strategies and tsunami preparedness. This exchange of experiences and best practices helps countries refine their approaches and avoid repeating mistakes.

The following sections explore the enabling factors that have supported the ASEAN region's collective progress in increasing resilience to tsunamis since the Indian Ocean Tsunami.

235 AHA Centre (2018). *Operationalising One ASEAN, One Response.* https://aha-centre.org/wp-content/uploads/2018/03/AHA-GDE-One-ASEAN-One-Response-FINAL-1810318-1.pdf.

Enabling factors for regional cooperation

Regional cooperation has been strengthened in ASEAN over the last 20 years through the following four enabling factors:

- Regional early warnings and coordination for tsunami preparedness
- Rapid regional mobilization for tsunami response
- Regional capacity building for resilient recovery
- Regional finance mechanisms.

1. REGIONAL EARLY WARNINGS AND COORDINATION FOR TSUNAMI PREPAREDNESS

The 2004 Indian Ocean Tsunami brutally exposed the lack of regional tsunami preparedness. In particular, the absence of a coordinated tsunami EWS meant that many countries had little to no advance notice of the impending disaster, which significantly contributed to the high death toll and extensive damage caused by the tsunami. There were multiple reasons for this lack of preparedness. Indian Ocean countries had not experienced a major tsunami in recent memory, leading to a false sense of security and a lack of investment in tsunami-specific preparedness measures. There was also limited scientific understanding of the tsunami risk in the region, with many countries lacking the technical capacities to assess and monitor such risks. Critically, there was an absence of regional mechanisms to coordinate preparedness efforts and share critical information.

Since 2004, substantial progress has been made in regional preparedness efforts in ASEAN. A key milestone was the establishment of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS) in 2005, along with its Regional Tsunami Service for the Indian Ocean in 2011, with the Tsunami Service Providers (TSPs) established by Australia, India and Indonesia assuming responsibility for the provision of tsunami advisory services for the Indian Ocean.[236] This system connects national tsunami warning centres across Indian Ocean countries, facilitating the rapid dissemination of tsunami warnings. Similarly, the formation in 2011 of the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES), a regional EWS within a multi-hazard framework, established in order to build capacities for preparedness and response to transboundary hazards, including tsunamis, has also significantly enhanced the ASEAN region's capacity to detect potential tsunamis and issue timely warnings, addressing one of the major gaps exposed by the 2004 disaster (see Lesson 1 for more on EWS).[237]

ASEAN and the AHA Centre have also played crucial roles in enhancing regional preparedness. For example, the Disaster Monitoring and Response System (DMRS) provides real-time information on hazards and disasters in the region, as well as hydrometeorological data, such as wind direction and speed, clouds, and sea temperature.[238] By streamlining information flow and providing a comprehensive overview of disaster scenarios, the DMRS significantly bolsters the region's preparedness and resilience against disasters by facilitating rapid decision-making and coordinated action. Another significant initiative is the ASEAN Regional Disaster Emergency Response Simulation Exercise (ARDEX), which is conducted on a regular basis, generally every two years, to test regional disaster processes and capabilities.[239] These exercises provide a platform for ASEAN Member States to practise coordinated response procedures, identify gaps in their preparedness and develop solutions collaboratively. For example, the 2018 ARDEX held in Indonesia focused on testing the region's readiness for a major earthquake and tsunami scenario through simulating a scenario of an 8.7 magnitude earthquake and tsunami (similar in magnitude to the 2004 tsunami), inflicting damages on a major industrial hub (in this exercise, Cilegon, and the southern coastal areas of Sumatra and West Java).[240] This exercise helped identify areas for improvement in regional tsunami preparedness, such as the need for faster information sharing and more efficient resource mobilization.

Moving forward, there are several opportunities to further enhance regional tsunami preparedness. For example, tsunami risk assessment methodologies could be further harmonized across the region. While individual countries have made progress in assessing their tsunami risks, there is a need for a standardized, region-wide approach. This would enable better comparison and aggregation of risk data, leading to more comprehensive regional preparedness strategies. Regionally standardized public education programmes on tsunami preparedness could be developed and put into effect. While some countries, like Indonesia and Thailand, have made significant strides in tsunami education following the 2004 tsunami, others lag behind. A regionally standardized education programme that provides up-to-date information on tsunamis and tsunami evacuations, and examples that can be applied in different contexts, could ensure that all people in tsunami-prone areas in the ASEAN region have the critical knowledge about tsunami risks and appropriate responses to be able to take action to protect themselves during a tsunami event.

Regionally standardized digital tools for schools to assess

236 UNESCO-IOC. Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWMS). https://tsunami.ioc.unesco.org/en/indian-ocean/icg-iotwms

237 RIMES. Overview: Regional Integrated Multi-Hazard Early Warning System (RIMES) for Africa and Asia. https://rimes.int/aboutus/overview

238 AHA Centre. Disaster Monitoring & Response System. https://ahacentre.org/disaster-monitoring/disaster-monitoring-response-system/

239 AHA Centre (2015). *ARDEX Handbook: A Handbook for Exercise Organisers.* https://ahacentre.org/wp-content/uploads/publications/ARDEX-Handbook-2015-09-16-final.pdf

240 ASEAN (2018). "ASEAN begins disaster response exercise in Indonesia". 5 November. https://asean.org/asean-begins-disaster-response-exercise-in-indonesia/

their preparedness for tsunamis could also be used to complement the regionally standardized education programmes. For example, the STEP-A (School Tsunami and Earthquake Preparedness Assessment) application,[241] which has been used in schools in Indonesia (see Lesson 3), is being enhanced in two ways: to make the assessment process more engaging and fun, which will encourage schools to conduct assessments independently and more regularly; and to contextualize the assessment questions so that they can better capture local conditions. This enhancement of the application is being led by UNDP, with support from UNESCO, U-INSPIRE (a network of young professionals dedicated to disaster risk reduction), BRIN (Indonesia's national research and innovation agency) and other partners.

Moreover, a regional programme could be developed specifically for tsunami exercises. While ASEAN conducts regular disaster response exercises through ARDEX, there is an opportunity to develop a specific programme focused on tsunami preparedness and response. This could involve regular simulations of regional early warning processes, evacuation procedures and coordinated response mechanisms, based on best practices. ASEAN could learn from ICG/IOTWMS's experiences conducting regular Indian Ocean-wide tsunami simulation exercises to test and enhance the readiness and operational capabilities of the end-to-end IOTWMS (see Lesson 1 for more).[242]

By leveraging these opportunities, the ASEAN region can build on its significant progress since 2004 and further strengthen its collective preparedness for future tsunami events. This would not only reduce the potential impacts of tsunamis but also build overall resilience to various types of disasters, contributing to the region's achievement of the SDGs.

241 STEP-A. About STEP-A. https://inarisk2.bnpb.go.id/step-a/about

242 UNESCO-IOC. IOWave Tsunami Exercises. https://tsunami.ioc.unesco.org/en/iowave.

Box 4.1: How RIMES supports cross-country regional collaboration

In 2016, the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) and the Seychelles Meteorological Authority (SMA), with support from the Earth System Science Organization–India National Centre for Ocean Information Services (ESSO–INCOIS), successfully deployed a wave rider buoy 27 nautical miles off the fishing harbour at Frigate Island, Seychelles, in order to track and predict the high swells originating from the Southern Ocean. As a result, real-time data from Seychelles are now incorporated in INCOIS's model, which allows INCOIS to refine and enhance the accuracy of its forecasts.

The forecasts now provide at least two days of lead time for India to provide early warnings to coastal areas and at-risk communities to anticipate and take actions to reduce the potential impacts, enhancing their preparedness. For example, the INCOIS forecast for the April 2018 coastal flood event, with data from Seychelles, saved lives and helped coastal management authorities minimize damage to assets. The financial benefits from the delivery of an accurate and timely forecast of this coastal flood event to Kerala, Karnataka and Goa in India has been estimated to be USD 29 million. While these kinds of severe hazard events are more life threatening, the more accurate forecasts for the common but less severe coastal flood events that occur every year bring substantial financial savings annually.

RIMES, as an intergovernmental and regional organization, has been instrumental in facilitating this cross-country collaboration between India and Seychelles. RIMES was able to articulate clearly to Seychelles the benefits of the marine buoy for their local forecasting, while optimizing early detection capacities to be able to forewarn coastal communities in India and other Indian Ocean countries. RIMES also facilitates non-GTS (Global Telecommunication System) data sharing between both distant and neighbouring countries through the Regional Data Exchange platform.[243] More regional cooperation should be encouraged, as it promotes mutually beneficial incentive-based data-sharing arrangements that can increase preparedness and resilience against disasters.

Source: Expert inputs from RIMES (2024).

243 RIMES. Developing Mechanisms for Data Sharing. https://rimes.int/node/1001

2. RAPID REGIONAL MOBILIZATION FOR TSUNAMI RESPONSE

The 2004 Indian Ocean Tsunami exposed critical weaknesses in the region's capacity for a coordinated disaster response. In the absence of robust regional response mechanisms, the initial reaction to the disaster was largely ad hoc and uncoordinated. This led to significant inefficiencies, including duplication of efforts in some areas and glaring gaps in others. The lack of coordination resulted in delayed aid delivery, misallocation of resources and, in some cases, the provision of inappropriate or unnecessary assistance. The incoherent response to the disaster can be attributed to several factors. The absence of a regional coordination centre left the affected countries without a centralized entity to orchestrate cross-

border response efforts. This was compounded by a lack of standardized protocols for requesting and receiving international assistance. The limited pre-positioning of relief supplies in strategic locations also significantly hindered rapid response capabilities. Furthermore, the absence of an efficient system for sharing real-time information about the disaster's impact and evolving needs across countries impeded effective decision-making and resource allocation. These combined shortcomings highlighted the need for improved regional cooperation and advanced planning in disaster response mechanisms.

In the aftermath of the Indian Ocean Tsunami, ASEAN countries recognized the importance of unified regional efforts for responding to future disasters. Since 2004, significant improvements have been made in regional response capabilities, particularly within the ASEAN framework, which collectively address previous gaps in information sharing, coordination and standardization. A major milestone was the establishment of the AHA Centre in 2011, alongside its Emergency Operations Centre (EOC), which serves as the central operational coordination hub for monitoring disasters and coordinating ASEAN's collective response to disasters, addressing the critical need for a centralized coordination entity.[244] The effectiveness of these improved processes was demonstrated during the response to Typhoon Mangkhut in 2018, which affected the Philippines. The AHA Centre activated its EOC within hours of the typhoon's landfall, facilitating coordinated information sharing and resource mobilization among ASEAN Member States.[245]

The ASEAN Joint Disaster Response Plan (AJDRP) is a strategic framework designed to enhance the speed, scale and solidarity of ASEAN's disaster response efforts.[246] Developed under the AADMER, the AJDRP facilitates coordinated action among ASEAN Member States and partners during large-scale disasters. By identifying and earmarking assets and capacities across the region, the plan ensures the rapid mobilization of resources, including humanitarian assistance and logistical support, to affected areas. Its comprehensive approach integrates contributions from governments, civil society, the private sector and international organizations, aligning them under the "One ASEAN, One Response" vision. This framework not only strengthens regional preparedness and response mechanisms but also fosters a sense of unity, amplifying the collective impact of disaster management efforts within ASEAN. The Mentawai Megathrust Tsunami in Indonesia was one of three disaster scenarios selected as reference points in the development of the AJDRP, due to its high probability of occurrence and possibility of severely impacting the population, underlining the continuing dangers of tsunamis in the ASEAN region.[247]

The AHA Centre has significantly bolstered the region's coordinated disaster response capabilities through the implementation of several key mechanisms. The ASEAN Emergency Response and Assessment Team (ASEAN-ERAT) provides a rapidly deployable team of trained professionals from Member States, designed to support the National Disaster Management Organization (NDMO) of the affected country during the -initial phase of a disaster emergency at a very short notice.[248] Whenever a disaster occurs in the ASEAN region, ERAT personnel are ready to be deployed within eight hours after the emergency alert is activated or in response to a request from the affected country's NDMO. Complementing this, the Disaster Emergency Logistics System for ASEAN (DELSA) has established regional emergency disaster relief stockpiles, enabling swift provision of essential supplies to ASEAN countries facing post-disaster emergency situations.[249] The effectiveness of these improvements in regional disaster response capacities was demonstrated during the response to the 2018 Sulawesi earthquake and tsunami in Indonesia. Within hours of the disaster, the AHA Centre activated the ASEAN-ERAT and mobilized relief supplies from the DELSA warehouse in Malaysia. This rapid response helped address the immediate needs in the affected areas and supported the Indonesian government's relief efforts.

Despite these advancements, there remain opportunities for further enhancing regional response capabilities. Firstly, the interoperability of response teams and equipment across countries could be further enhanced. While ASEAN-ERAT has improved coordination, there is still a need for greater standardization of equipment, procedures, and training standards across national response teams, which would facilitate smoother joint operations during large-scale disasters.[250] Secondly, customs and immigration procedures for emergency responders and relief goods should be streamlined. Despite existing agreements, the movement of responders and relief supplies across borders can still be delayed due to bureaucratic processes. ASEAN should work towards a more comprehensive regional agreement that provides blanket pre-clearance for certified responders and relief goods during declared emergencies.[251] Thailand's efficient customs clearance procedures for humanitarian assistance during the 2011 flooding event could serve as a model for such protocols.

It would also be valuable to develop a regional database of response assets and expertise. While the AHA Centre maintains some information on regional capacities,[252] a more comprehensive and regularly updated database could improve resource allocation during emergencies. This database could include specialized equipment, expert

244 AHA Centre (2021). *The AHA Centre Annual Report 2020: Transformation Through Adversity.* https://ahacentre.org/wp-content/uploads/publications/AHA-Centre-Annual-Report-2020.pdf.
245 AHA Centre (2019). *The AHA Centre Annual Report 2018: Breaking New Ground.* https://ahacentre.org/wp-content/uploads/2019/05/AHA-Centre-Annual-Report-2018-Digital.pdf.
246 AHA Centre (2017). *AJDRP 2017: ASEAN Joint Disaster Response Plan.* September. https://ahacentre.org/files/AJDRP.pdf.
247 Ibid.
248 AHA Centre (2018). ASEAN-ERAT: ASEAN-Emergency Response and Assessment Team. Factsheet. https://ahacentre.org/wp-content/uploads/2018/01/DIGITAL-Version-FACTSHEETS-ASEAN-ERAT.pdf.
249 AHA Centre (2018). Disaster Emergency Logistics System for ASEAN (DELSA). Factsheet. https://ahacentre.org/wp-content/uploads/2018/01/DIGITAL-Version-FACTSHEETS-DELSA.pdf.
250 ASEAN (2015). SASOP: Standard Operating Procedure for Regional Standby Arrangements and Coordination of Joint Disaster Relief and Emergency Response Operations. https://asean.org/wp-content/uploads/2021/09/27.-September-2015-SASOP-5th-Reprint.pdf.
251 ASEAN (2020). ASEAN Agreement on Customs. https://asean.org/wp-content/uploads/2020/12/ASEAN-Agreement-on-Customs-3.pdf.
252 AHA Centre. ASEAN Disaster Information Network (ADINet). https://adinet.ahacentre.org/

personnel and the unique capabilities of each ASEAN Member State. For example, Singapore's urban search and rescue capabilities[253] or Viet Nam's expertise in flood response[254] could be catalogued for rapid mobilization when needed. Moreover, private sector engagement in disaster response could be better supported. The private sector often has significant resources and capabilities that can complement government efforts in disaster response, and ASEAN could develop a framework for more systematic engagement of private sector partners in regional response efforts.[255] The Philippines' experience with private sector partnerships during the response to Typhoon Bopha in 2013 could provide valuable lessons for such a regional framework.[256]

By exploring these opportunities, ASEAN can build on its progress since 2004 and further strengthen its collective capacity for rapid and effective response to tsunamis and other disasters. These enhanced response capabilities will not only save lives and reduce suffering in the immediate aftermath of a disaster, but also contribute to faster recoveries and the increased long-term resilience of affected communities.

253 Civil Aviation Authority of Singapore (CAAS). "Search and Rescue Services". https://www.caas.gov.sg/who-we-are/areas-of-responsibility/contingency-planning-crisis-management/search-rescue
254 Oxfam (2012). Flood Preparedness in Viet Nam. Programme Insights. October. https://oxfamilibrary.openrepository.com/bitstream/handle/10546/247211/cs-flood-preparedness-vietnam-081012-en.pdf?sequence=1&isAllowed=y
255 ADPC (2018). Engaging the Private Sector in Preparedness for Response: Experiences from the Asian Preparedness Partnership. https://reliefweb.int/report/philippines/engaging-private-sector-preparedness-response-experiences-asian-preparedness
256 Humanitarian Futures Programme (2014). Best Practice Case Studies on Private Sector Engagement in DRR. https://www.humanitarianfutures.org/wp-content/uploads/2014/06/Best-Practice-Case-Studies-Private-Sector-DRR-Engagement.pdf

PHOTO: UNDP SRI LANKA

3. REGIONAL CAPACITY BUILDING FOR RESILIENT RECOVERY

The recovery process following the 2004 Indian Ocean Tsunami revealed significant disparities in capacities and approaches among affected countries, highlighting the need for stronger regional cooperation in post-disaster recovery efforts, particularly around capacity building. Several factors contributed to the challenges in recovery. The lack of standardized recovery frameworks led to inconsistencies in assessing recovery needs and recovery planning efforts across the region. Limited mechanisms for knowledge sharing countries' ability to exchange experiences, best practices and lessons learned in disaster recovery. Disparities in financial and technical capacities resulted in uneven recovery trajectories, with economically stronger countries like Thailand recovering more quickly, while others, such as Indonesia, faced prolonged challenges, particularly in severely affected areas like Aceh Province. Moreover, inadequate coordination of international assistance sometimes led to duplication of efforts or misalignment with local needs and priorities, despite the crucial role of such aid. These factors collectively highlighted the importance of developing more robust, standardized and coordinated regional approaches to post-disaster recovery and long-term resilience building.

Since 2004, significant strides have been made in enhancing regional cooperation for recovery, particularly through knowledge sharing and capacity-building initiatives. A key development has been the creation of the ASEAN Disaster Recovery Reference Guide, developed in collaboration with UNDP.[257] The guide provides a comprehensive framework for post-disaster recovery planning and implementation, addressing the previous lack of consistent approaches across the region. It offers guidance on key principles of disaster recovery, institutional arrangements, financing and implementation strategies. By providing a common reference point, the guide facilitates better alignment of recovery efforts both within and between countries.

While primarily focused on disaster response, the AHA Centre also plays a crucial role in supporting recovery efforts by facilitating knowledge sharing and capacity building among ASEAN Member States. The AHA Centre regularly organizes workshops, training sessions and exchange programmes focused on various aspects of disaster recovery, including Build Back Better principles and community-based recovery approaches. For example, the AHA Centre Executive: Leadership in Emergency and Disaster Management Programme (ACE-LEDMP), funded by the Japan-ASEAN Integration Fund (JAIF), has been providing in-person trainings on recovery, with support from UNDP, to strengthen the capacities of government officials working in ASEAN Member States.[258]

257 ASEAN and UNDP (2016). *ASEAN Disaster Recovery Reference Guide.* April. https://www.undp.org/sites/g/files/zskgke326/files/migration/asia_pacific_rbap/RBAP-RSD-2016-ASEAN-Disaster-Recovery-Reference-Guide.pdf
258 AHA Centre (2024). AHA Centre Executive (ACE): Leadership in Emergency and Disaster Management Programme (ACE-LEDMP). Project Brief. https://jaif.asean.org/project-brief/aha-centre-executive-ace-leadership-in-emergency-and-disaster-management-programme-ace-ledmp/

Opportunities exist for further enhancing regional cooperation in recovery. Firstly, a regional recovery fund could be established. While ASEAN has mechanisms for emergency response, there is currently no dedicated regional fund for long-term recovery efforts. Establishing such a fund could provide crucial support to countries with limited resources, ensuring a more equitable recovery process across the region. Secondly, mechanisms for sharing skilled labour and expertise during the recovery phase after a tsunami could be developed. The recovery process often requires specialized skills that may be in short supply in affected countries. A regional mechanism for rapidly deploying experts and skilled workers from other ASEAN countries could significantly enhance recovery capacities. For instance, Singapore's Building and Construction Authority could provide technical expertise in rebuilding critical infrastructure, while Viet Nam's experience in mangrove restoration could be valuable for enhancing coastal resilience in other countries.

A regional platform for sharing lessons learned and best practices in disaster recovery could also be established. While ad hoc knowledge sharing between ASEAN countries does occur, a more structured platform could enhance learning across the region. This could take the form of a digital repository of case studies, best practices and lessons learned, that is regularly updated with experiences from recent recovery efforts. This platform could also provide specialized guidance and training programmes focused on Building Back Better and enhancing long-term resilience through Resilient Recovery. This could include region-specific strategies for climate-adaptive reconstruction, culturally sensitive resettlement practices and innovative financing mechanisms for resilient infrastructure. Private sector engagement in recovery efforts could also be enhanced. The private sector can play a crucial role in driving economic recovery and livelihood creation post-disaster. ASEAN could develop guidelines and incentives for private sector participation in recovery efforts, drawing on successful examples such as Malaysia's collaboration with the private sector in rebuilding small businesses after the 2024 floods.[259]

By addressing these opportunities, ASEAN can further strengthen its collective capacity for effective and resilient recovery from tsunamis and other disasters. Enhanced regional cooperation in recovery not only accelerates the restoration of affected communities but also contributes to building long-term resilience across the region. This approach aligns with the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030 and supports the achievement of the Sustainable Development Goals, particularly in reducing vulnerability and building resilient communities.

4. REGIONAL FINANCE MECHANISMS

The 2004 Indian Ocean Tsunami highlighted critical gaps in disaster risk financing at both the national and regional levels. The catastrophic event exposed the financial vulnerability of many countries in the region and underscored the need for sustainable financing mechanisms for disaster risk reduction and recovery. Dedicated funds for disaster preparedness and response were insufficient; this left many countries ill-equipped to handle large-scale disasters, with specific budget allocations for DRR activities notably absent. An overreliance on post-disaster international aid, stemming from a lack of pre-arranged financing mechanisms, led to delayed assistance and duplication. The limited availability of risk transfer mechanisms, such as insurance instruments, hindered countries' ability to manage the financial impacts of the disaster effectively. Furthermore, while bilateral aid arrangements existed, there was an absence of a comprehensive regional mechanism for financial support during and after disasters. These challenges collectively highlighted the urgent need for more robust, proactive and coordinated financial strategies to enhance tsunami resilience across the ASEAN region.

External financing has played a significant role in improving tsunami resilience across the region since 2004. International financial institutions such as the ADB and World Bank have provided grants, loans and technical assistance to support the construction of early warning systems, resilient infrastructure and recovery projects. These external funding sources have been critical in strengthening the financial capacity of ASEAN Member States, many of which lacked the resources to invest in long-term disaster resilience measures. However, this dependence on external donors has also highlighted the importance of developing sustainable, regionally driven financial solutions.

Fortunately, there has been some progress in addressing these financial challenges. A milestone was the establishment of the ASEAN Disaster Management and Emergency Relief Fund (ADMER Fund) in 2011. This fund serves two primary purposes: it supports the implementation of the AADMER Work Programme, funding various regional DRR initiatives, and provides immediate financial support to affected ASEAN Member States in times of disaster, enabling a more rapid and regionally driven response. The ADMER Fund demonstrates the commitment of ASEAN Member States to collectively address disaster risks and provides a mechanism for pooling resources for both preparedness and response activities. However, the Fund is totally dependent on voluntary contributions from Member States, which is not necessarily a sustainable or predictable source of long-term financing. The Fund's effectiveness is closely tied to the availability of resources, underscoring the importance of sustained and diversified funding to enhance ASEAN's disaster management capabilities. Recognizing these limitations, ASEAN has undertaken reforms to enhance the fund's capacity: in 2023, the ASEAN Ministerial Meeting on Disaster Management (AMMDM) adopted revised financial rules for the ADMER Fund, enabling contributions from public and private sources, which aims to diversify funding streams.[260]

259 ABM (2024). "Banks in Malaysia Committed to Aid Flood-Hit Customers". 3 December. https://www.abm.org.my/press-releases/banks-in-malaysia-committed-to-aid-flood-hit-customers/

260 ASEAN (2023). Chairman's Statement of the Eleventh Ministerial Meeting on Disaster Management (AMMDM) and Twelfth Meeting of the Conference of the Parties (COP) to the Asean Agreement on Disaster Management and Emergency Response (AADMER). 12 October. https://asean.org/wp-content/uploads/2023/10/Chairman-Statement-of-11th-AMMDM-and-12th-COP-to-AADMER_adopted.pdf.

The ESCAP Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness (Box 4.2) is another regional fund that has contributed to important disaster preparedness initiatives since the Indian Ocean Tsunami, most notably supporting the establishment of RIMES. However, like the ADMER Fund, the ESCAP Trust Fund is also entirely dependent on mobilizing resources from external donors to carry out its work.

Box 4.2: ESCAP Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness

The ESCAP Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness was established in response to the devastating 2004 Indian Ocean Tsunami; it serves as a crucial example of regional cooperation which enhances tsunami resilience in the Asia-Pacific region. The Trust Fund, launched in 2005 with an initial contribution from the Government of Thailand, was aimed at building the capacities for tsunami early warning in Indian Ocean and Southeast Asian countries. The Trust Fund's support was key in the establishment of the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) in 2009, which demonstrated the value of pooling resources for regional cooperation, with a focus on high-risk, low-capacity countries.[261] However, challenges remain in securing continuous funding and extending early warning coverage to all vulnerable communities, particularly in areas prone to near-field tsunamis.[262]

A critical enabling factor behind the Trust Fund's success has been its focus on regional and transboundary cooperation. Early warning systems, particularly for low-frequency, high-impact hazards like tsunamis, require a collective approach to be economically viable. The Trust Fund also facilitates South–South cooperation, and supports the development of region-wide Standard Operating Procedures (SOPs) for EWS, which are essential for ensuring coordinated responses during disasters.[263] This model of regional cooperation and collaboration has demonstrated how pooling resources and knowledge can strengthen disaster resilience across multiple countries simultaneously.

Despite these advancements, gaps persist. The Trust Fund has identified areas where EWS still fall short, particularly in addressing multi-hazard risks and ensuring timely and accurate dissemination of warnings. Ensuring that these systems reach the 'last mile' remains a priority, as many at-risk communities are located in remote, difficult-to-access areas. Moreover, rapid urbanization and climate change are amplifying and creating new risks, requiring EWS to be responsive to new situations.

261 ESCAP (2022).The ESCAP Trust Fund for Tsunami, Disaster and Climate Preparedness. Brochure. https://repository.unescap.org/bitstream/handle/20.500.12870/5039/ESCAP-2022-RP-Brochure-ESCAP-Trust-Fund-Tsunami-Disaster-Climate-Preparedness.pdf?sequence=3&isAllowed=y.
262 ESCAP (2020). ESCAP Multi-Donor Trust Fund for Tsunami, Disaster and Climate Preparedness: Strategic Note 2021–2024. https://repository.unescap.org/bitstream/handle/20.500.12870/4661/ESCAP-2020-RP-ESCAP-Strategic-Note-2021-2024.pdf?sequence=1&isAllowed=y.
263 Ibid.

Some innovative financial mechanisms have been explored at the regional level in ASEAN with promising early results, including parametric insurance such as through the Southeast Asia Disaster Risk Insurance Facility (SEADRIF) (see Lesson 2), catastrophe bonds (see Lesson 2) and public–private partnerships (PPPs) (see Lesson 1). However, despite these efforts, the amount of finance available for ASEAN countries is insufficient in the face of the region's disaster risks, which will increase due to the impacts of climate change: in South-East Asia, the total average annual loss (AAL) from disasters is estimated at USD 91 billion in the current climate conditions.[264] This estimate increases to USD 108 billion under the moderate climate change scenario (RCP 4.5), and to USD 127 billion under the worst-case climate change scenario (RCP 8.5).

By addressing these financing gaps, ASEAN can significantly enhance its collective financial resilience to disasters like tsunamis. Improved disaster risk financing not only enables more effective response and recovery but also incentivizes investments in preparedness and risk reduction. This approach aligns with the emphasis of the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030 on investing in disaster risk reduction for resilience and supports the achievement of the SDGs by reducing the economic impacts of disasters on vulnerable communities.

264 ESCAP (2022). *Asia-Pacific Disaster Report 2022 for ESCAP Subregions: Pathways to Adaptation and Resilience in South-East Asia.* https://www.unescap.org/sites/default/d8files/knowledge-products/Asia-Pacific%20Disaster%20Report%202022%20for%20ESCAP%20Subregions%20-%20Pathways%20to%20Adaptation%20and%20Resilience%20in%20South%20East%20Asia_report-v2-6-E.pdf.

Conclusion

Regional cooperation has proven to be a critical factor in enhancing tsunami resilience in the ASEAN region in the aftermath of the 2004 Indian Ocean Tsunami, with ASEAN countries making significant strides in strengthening their collective capacities for tsunami risk reduction, response, recovery, and financing.

The establishment of regional early warning systems and disaster management institutions and mechanisms, including ICG/IOTWMS, RIMES, AADMER, and the AHA Centre, coupled with enhanced standardization of processes and protocols across the region, have significantly strengthened ASEAN's collective capacity to prepare for, respond to, and recover from disasters, including potential future tsunamis. This regional progress should be celebrated, and these efforts have gone a long way to ensuring that the impacts of future tsunamis would likely be significantly reduced.

Despite this notable progress, significant opportunities remain to further strengthen regional cooperation across all aspects of disaster management in the ASEAN region. These include further harmonization of risk assessment methodologies and EWS to ensure consistent and effective approaches throughout the region, and the development of more robust regional mechanisms for long-term recovery support. Exploring innovative disaster risk financing instruments could provide additional resources and flexibility in disaster response and recovery. Greater integration of climate change adaptation strategies into regional DRR frameworks is also essential to address the evolving nature of disaster risks in the face of climate change. Addressing these areas will contribute to a more resilient and prepared ASEAN region in the face of natural disasters and climate-related challenges.

It is crucial to continue building on existing regional mechanisms, addressing identified gaps, and exploring innovative approaches to further enhance tsunami resilience. This will require sustained political commitment, significantly greater resource allocation, and the active engagement of all stakeholders, including governments, international organizations, civil society, and the private sector. By leveraging the collective strengths and resources of the region, ASEAN countries can build a more resilient future, better prepared to face the challenges posed by tsunamis and other disasters.

PHOTO: UNDP THAILAND

SECTION 3

RECOMMENDATIONS

PHOTO: UNDP INDONESIA

Recommendations

In the 20 years since the 2004 Indian Ocean Tsunami, ASEAN countries have made remarkable strides in strengthening their resilience to tsunamis, with a collective commitment to reducing vulnerabilities and protecting communities from the devastating impacts of future tsunamis. Building upon these achievements, these recommendations aim to address the remaining gaps and emerging challenges, while reinforcing the foundation of resilience and preparedness across the ASEAN region.

EARLY WARNING SYSTEMS

1. Strengthen and harmonize regional early warning system components to build an effective and resilient ASEAN end-to-end early warning system.
2. Improve near-field tsunami detection capabilities to address gaps in warning systems for tsunamis triggered by non-seismic events, such as landslides or volcanic eruptions.
3. Expand national and regional capacities for probabilistic tsunami hazard analysis (PTHA) to provide more accurate long-term risk perspectives and inform disaster planning.
4. Conduct regular evaluations and upgrades of existing early warning systems to ensure they remain reliable and effective in response to evolving risks.
5. Support localized tsunami hazard mapping to identify vulnerable zones and guide urban planning, evacuation routes and risk reduction strategies.
6. Develop and standardize communication protocols for tsunami warnings, with a focus on clear, actionable messages, and ensure warnings reach the last mile through establishing multiple and inclusive communication channels.
7. Establish sustainable financing mechanisms for the maintenance and enhancement of early warning systems, integrating them into national budgets and exploring public–private partnerships (PPPs).

RESILIENT RECOVERY

8. Incorporate Build Back Better principles into disaster recovery plans to ensure infrastructure is rebuilt to higher resilience standards and considers future risks.
9. Embed anti-corruption mechanisms within recovery agencies to enhance transparency, accountability and public trust during post-disaster reconstruction.
10. Promote proactive recovery financing by allocating a portion of national budgets to disaster recovery and leveraging regional risk pooling.
11. Strengthen local government capacities to lead recovery efforts by providing resources, training and decision-making authority to address community-specific needs.
12. Designate pre-identified recovery leaders and agencies with clear jurisdictional mandates to avoid delays and inefficiencies in post-disaster coordination.
13. Prioritize community-driven recovery approaches that involve local populations in planning, decision-making and implementation to ensure culturally appropriate outcomes.
14. Institutionalize knowledge-sharing mechanisms, such as disaster recovery platforms, to document lessons learned and improve future recovery efforts.

COMMUNITY PREPAREDNESS

15. Foster a culture of preparedness by expanding public education campaigns to raise awareness about tsunami risks, natural warning signs and appropriate response actions.
16. Embed tsunami preparedness and drills into national school curricula, to ensure that every child that lives in exposed coastal areas is taught about tsunamis and is given first-hand experience of what to do through participating in a tsunami drill each school year.
17. Strengthen partnerships with local leaders and organizations to design community-specific response plans that reflect local contexts and priorities, and conduct annual community-wide tsunami evacuation drills to test and refine these plans and build public trust in early warning systems.
18. Establish inclusive disaster preparedness programmes that address the needs of vulnerable populations, including women, children, the elderly and persons with disabilities.
19. Provide technical and financial support to local governments to improve evacuation routes, build safe shelters and stock emergency supplies.
20. Develop mobile applications and digital platforms that provide real-time tsunami alerts and guidance in multiple languages to reach diverse populations.
21. Increase access to public alert systems, such as sirens and loudspeakers, in remote or underserved areas to enhance last-mile communication, with particular efforts made to ensure that early warnings reach and can be understood by vulnerable populations, including children, the elderly and persons with disabilities.

REGIONAL COOPERATION

22. Recognize and celebrate the substantial progress made by ASEAN countries since the 2004 Indian Ocean Tsunami, and leverage the lessons learned since the disaster to foster a shared commitment to continuous improvement in regional disaster risk reduction and resilience.
23. Further strengthen regional mechanisms for tsunami early warning, such as the ICG/IOTWMS and RIMES, to enhance data sharing, capacity building and collaboration.
24. Harmonize early warning protocols across ASEAN countries to improve cross-border communication and

coordination during transboundary tsunami events.

25. Conduct regional tsunami simulation exercises to test the interoperability of national systems and identify areas for improvement in joint responses.
26. Establish a regional knowledge-sharing platform to document and disseminate best practices and lessons learned from tsunami preparedness and recovery efforts.
27. Create a regional mechanism for rapidly deploying experts and skilled workers during the recovery phase after a tsunami to enhance affected countries' recovery capacities.
28. Explore innovative financial mechanisms for tsunami risk reduction and recovery at the regional level, including parametric insurance and catastrophe bonds.

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