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The United Nations Office for Disaster Risk Reduction works towards the substantial reduction of disaster risk and losses to ensure a sustainable future. UNDRR supports the implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030, which sets out a people-centred approach towards achieving a substantial reduction in disaster losses from man-made and natural hazards and a shift in emphasis from disaster management to disaster risk management.

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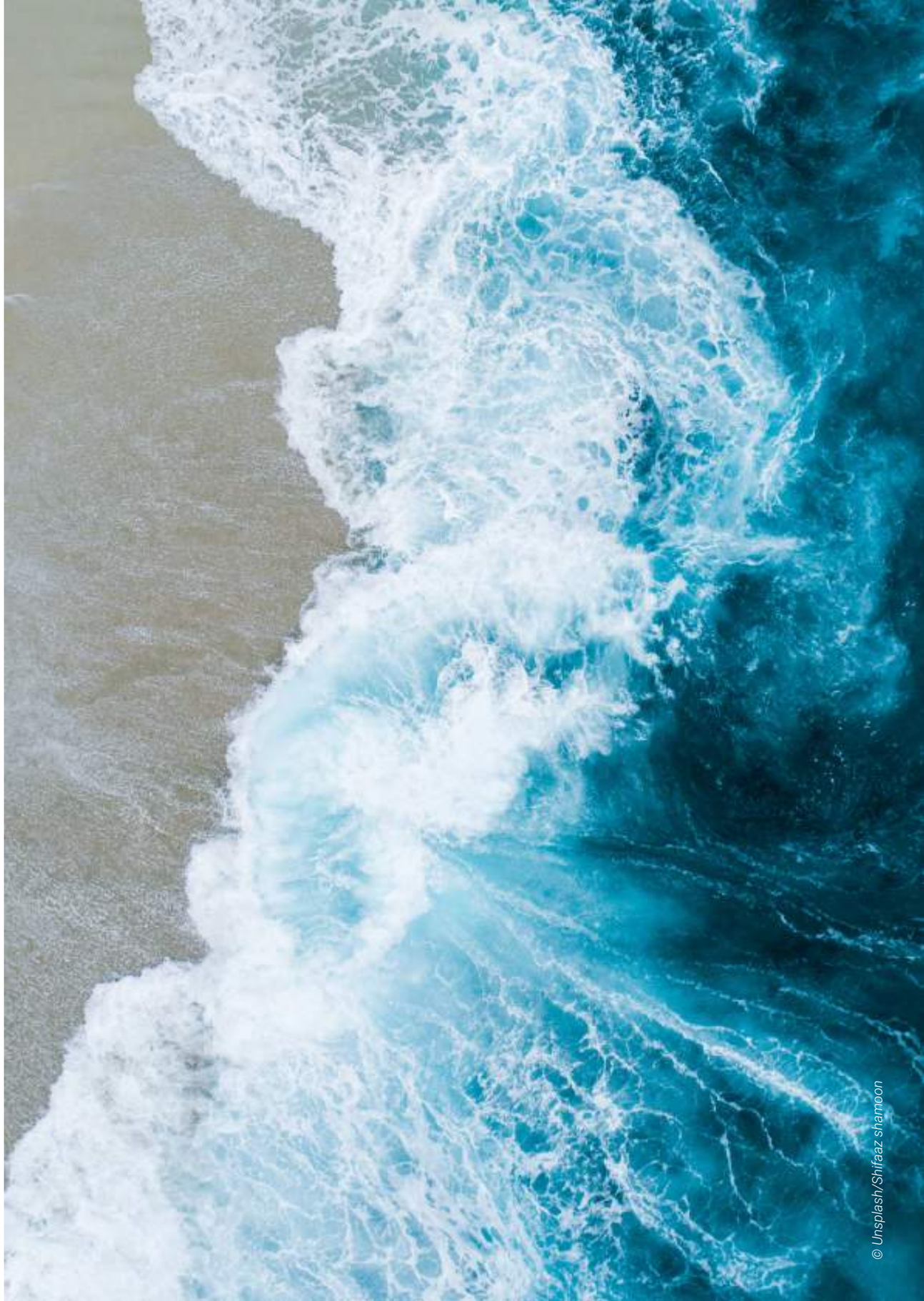

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Mission 2021: international cooperation

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In this edition of Tsunami News, we explore examples of how governments and organizations around the world are increasing their levels of cooperation.

The Sendai Framework for Disaster Reduction identifies seven targets to be achieved by 2030, and UNDRR selected Target F as the focus for 2021.

Target F is to "substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030."

World Tsunami Awareness Day messages

On World Tsunami Awareness Day on 5 November, the Secretary-General of the United Nations and Mami Mizutori, the Secretary-General's Special Representative for Disaster Risk Reduction, both delivered messages about the importance of international cooperation.

Message from António Guterres, UN Secretary-General

On World Tsunami Awareness Day, we call on countries, international bodies and civil society to increase understanding about the threat and share innovative approaches to reduce risks.

We can build on progress achieved – ranging from better outreach to tsunami-exposed communities around the world, to the inclusion of a Tsunami Programme in the United Nations Decade of Ocean Science for Sustainable Development.

However, the risks remain immense.

Rising sea levels caused by the climate emergency will further exacerbate the destructive power of tsunamis. We must limit warming to 1.5 degrees over pre-industrial averages and invest at scale in the resilience of coastal communities.

Science and international cooperation — as well as preparedness and early action — must be at the heart of our efforts to save lives from tsunamis and other hazards.

Boosting support to developing countries and improving detection and early warning is critical.

In the face of increasing complex global crises, we need to be better prepared.

Let us work to reduce tsunami risk, deliver on the Sendai Framework, and together build resilience against all disasters.

Message from Mami Mizutori, UN Secretary-General's Special Representative for Disaster Risk Reduction

This year's World Tsunami Awareness Day on 5 November is an occasion to celebrate a once-in-a-lifetime opportunity to reduce tsunami risk around the world.

However rare they might be, tsunamis are the single most deadly of all sudden-onset natural hazards. Millions of people live and work in tsunami-exposed communities across the world's oceans.

After five years of marking this day in many unique ways, this year we can announce a major new development.

The UN Decade of Ocean Science for Sustainable Development has the potential to fill capability gaps to speed up the detection and warning for tsunamis, even from the near instant that they form.

This can only further enhance the preparedness of coastal communities for tsunamis through the TsunamiReady Programme of the Intergovernmental Oceanographic Commission of UNESCO or UNESCO-IOC.

The UNESCO-IOC Assembly of UN Member States has approved the establishment of the Ocean Decade Tsunami Programme and a Scientific Committee to draft a 10-year research, development and implementation plan for this programme. This will be fully supported by the UN Office for Disaster Risk Reduction, United Nations agencies, civil protection agencies and others.

In a major boost to international cooperation to developing countries and small island developing states, the Tsunami Programme will contribute to the Safe Ocean outcome of the Ocean Decade by making all communities at risk of tsunamis, prepared and resilient by 2030.

Scaling up of the TsunamiReady programme is testament to what focused international cooperation can deliver and will make a significant contribution to reducing risk and saving lives in future events.

Only together can we achieve this ambition.

TsunamiReady achievements

As of August 2021, there are 173 sites recognized as TsunamiReady.

In 2021 these communities achieved UNESCO/IOC TsunamiReady recognition:

Caribbean and adjacent regions

- St. John's City, Antigua and Barbuda
- Shermans, St. Lucy to Mullins, St. Peter, Barbados
- Union Island, St. Vincent and the Grenadines
- Carenage, Trinidad and Tobago.

Pacific Ocean

- Samara Costa Rica
- Tamarindo, Costa Rica.

Indian Ocean

- Venkatraipur, Odisha province, India
- Noliasahi, Odisha province, India.

Ocean Decade – becoming 100 per cent tsunami-ready by 2030

WORLD TSUNAMI AWARENESS DAY
5 NOVEMBER

In a major win for communities vulnerable to tsunamis worldwide, the IOC has approved the establishment of the Ocean Decade Tsunami Programme.

In June this year, the Thirty-first Session of the Intergovernmental Oceanographic Commission (of UNESCO) Assembly approved the establishment of the **Ocean Decade Tsunami Programme**.

The programme will form part of the UN Decade of Ocean Science for Sustainable Development (the Ocean Decade), which was launched on 1 January 2021 and will run through to 2030.

A safe ocean

The programme is intended to support the Ocean Decade's societal outcome of a **Safe Ocean**, and calls for:

- a scientific committee to prepare a draft 10-year research, development and implementation plan based on the concept paper: 'Protecting communities from the world's most dangerous waves: a framework for action under the UN Decade of Ocean Science for Sustainable Development'.
- A *TsunamiReady* coalition to support this plan.

The IOC described the establishment of a dedicated Ocean Decade Tsunami Programme as *"a once-in-a-generation opportunity to address and fill critical gaps in global tsunami detection, measurement, forecasting and preparedness."*

Focus areas

The 10-year plan aims to make transformational advances in tsunami detection, measurement and forecasting, including tsunamis generated by non-seismic sources, and dramatically improve the preparedness and resilience of at-risk coastal communities.

The plan has a set of focus areas relating to tsunami warning and mitigation capabilities:

1. Become tsunami-ready

- Adopt and implement the UNESCO-IOC *TsunamiReady* Guidelines and Indicators as the international standard for evidence-based community preparedness for tsunamis.
- Accredit all at-risk communities worldwide as TsunamiReady by 2030.
- Enable rapid restoration of socio-economic activities and critical infrastructure services after tsunami impacts.

2. Expand and improve detection systems

- Expand existing seismometers, coastal tide gauges, and deep-ocean tsunameters (DARTs) to fill identified gaps.
- Plug the gaps in existing systems, including implementing scientific instrumentation on SMART subsea cables, plus a programme for sustainable development of this technology.

3. Improve data access

- Provide wider real-time and near-real-time sea-level, seismic and GNSS-derived land motion data at an appropriate sampling rate, plus relevant tools to forecast tsunamis from all sources.
- Increase access to coastal topographic and bathymetric data and provide regular updates in collaboration with the Nippon Foundation-GEBCO Seabed 2030 project.
- Develop high-performance computational capabilities to enable more timely, accurate and comprehensive tsunami and other coastal hazard forecasts and warnings.

4. Upgrade warning centres

- Ensure that all national tsunami-warning centres have access to data, tools, communication platforms, protocols and training, so they can provide timely and effective warnings to coastal and maritime communities threatened by tsunamis and other coastal hazards.
- Integrate all these warning centres into a multi-hazard framework to minimize tsunami disaster impacts.

A major step forward

"It's hard to overstate the importance of the IOC's resolution to make the Tsunami Programme part of the UN Ocean Decade," said Vladimir Ryabinin, Executive Secretary of the Intergovernmental Oceanographic Commission of UNESCO, "This resolution ensures that our capabilities to detect tsunamis and the ability of affected communities to respond quickly to warnings, will improve globally."

"The 100 per cent TsunamiReady target in particular will have direct effect on the wellbeing of the hundreds of millions of people who live in at-risk coastal regions all over the world. It's an ambitious target, but with the support of the IOC, I believe we can achieve it."

About the Ocean Decade

Proclaimed in 2017 by the United Nations General Assembly, the UN Decade of Ocean Science for Sustainable Development (2021-2030) ('the Ocean Decade') seeks to stimulate ocean science and knowledge generation to reverse the decline of the state of the ocean system and catalyse new opportunities for sustainable development of this massive marine ecosystem.

The vision of the Ocean Decade is 'the science we need for the ocean we want'.

The Ocean Decade provides a convening framework for scientists and stakeholders from diverse sectors to develop the scientific knowledge and the partnerships needed to accelerate and harness advances in ocean science to achieve a better understanding of the ocean system, and deliver science-based solutions to achieve the 2030 Agenda.

The UN General Assembly mandated UNESCO's Intergovernmental Oceanographic Commission (IOC) to coordinate the preparations and implementation of the Decade.

Leveraging the power of science and technology - New York hosts World Tsunami Awareness Day

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"650 million people live within ten metres of the coastline, so if we are going to have 100 per cent of our communities tsunami-ready by 2030, we've got to work together."

This quote from Vladimir Ryabinin, Executive Secretary of the Intergovernmental Oceanographic Commission of UNESCO summarized the message of the World Tsunami Awareness Day event in New York on 5 November 2021.

With the theme *Leveraging the power of science and technology to reduce tsunami risk*, speakers from around the world discussed the progress they had made, and the work yet to be done, to improve the preparedness and resilience of communities exposed to tsunami risk.

Reaching everyone at risk

The technologies and capabilities to detect and warn of tsunamis exist, but as **Dr Abdulla Shahid**, President of the 76th session of the UN General Assembly noted, "more needs to be done to reach all those at risk. Investment in disaster risk reduction and technology transfer needs to be directed where it matters most to ensure that at risk countries, such as small island states and the least-developed countries are better supported."

Dr Shahid commended the Permanent Mission of Japan in keeping the issue of tsunami risk on the international radar, saying that "as we proceed through the United Nations Decade of Ocean Science for Sustainable Development, there is no better time to invest in risk reduction, prevention and preparedness."

Looking at the achievements of recent years, **Mami Mizutori**, Head of the UN Office for Disaster Risk Reduction, noted that "signs of progress are everywhere, including the tsunami ready certification for the new airport in Jakarta, Indonesia. Most heartening of all is the work being done with the youth of climate vulnerable small island developing states in the Caribbean and across the Pacific."

Mami Mizutori also applauded UNDP's School Tsunami Preparedness Project, "which has trained so many students over so many years, supported by the Government of Japan."

Recalling the catastrophic effects of the 2004 tsunami, **Huda Shareef**, member from the Maldives said "in a few hours, two thirds of our capital was flooded, submerging homes, causing buildings to collapse, electrocutions and explosions. In total, the tsunami cost the Maldives almost 62 per cent of our country's GDP.

"Natural disasters have dramatic consequences, forcing massive threats to assets and investments in sustainable development. Through enhanced international cooperation, we can support the transfer and development of innovative technology, such as early-warning systems and resilient infrastructure. Disaster risk reduction is an issue that can be tackled together."

Getting the most out of technology

Ambassador Kimihiro Ishikane, Permanent Representative of Japan, said "We cannot stress enough the importance of science and technology in policy and decision making. For example, we are seeing emerging new technologies that will allow us to predict tsunamis in advance more accurately than ever."

On the theme of advances in technology, **Miyake Shingo** from the Ministry of Foreign Affairs of Japan, said: "It is essential that we strengthen policy making based on scientific knowledge. For example, analysis of past disasters and the

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mechanism that generates tsunamis will enable us to estimate the wave height and area to be impacted by tsunamis that may be caused by large scale earthquakes in the future."

Echoing the President of the General Assembly's call for increased investments in science and technology, **Dr Fiona Webster**, Deputy Permanent Representative of Australia to the United Nations, said "We need to build resilience and reduce risk in the least developed countries and small island developing states. In the Pacific, 90 per cent of Pacific Islanders outside of Papua New Guinea live less than five kilometres from the ocean, and close to half live at low elevations, making them highly vulnerable to tsunamis and to storm surge."

Dr Webster said "We are in a new era of disaster-risk management and need to broaden our focus from managing emergencies to managing disaster risks, and from thinking about individual hazards to thinking about interdependent systems."

Fiji, too, has made significant strides in early-warning systems with the support of development partners.. **Vasiti Soko**, the Director of Fiji's National Disaster Management Office said "We currently have 13 tsunami sirens installed along the Suva Peninsula thanks to the support of the University of the South Pacific, the New Zealand Government, the European Union, and the Secretariat of the Pacific Community, with a further 26 sirens to be installed with funding from the Government of Japan.

"Fiji has been conducting awareness training for communities and the private sector, together with tsunami drills in collaboration with our national counterparts."

Partnership and collaboration at the scientific and technical level is a priority for **Sergio Castellari**, Senior Scientist, National Institute of Geophysics and Volcanology (INGV).

"Last September, Italy launched a new tsunami forecasting model and a map of all the tsunami events in the Mediterranean basin from 365 A.D. to the present." said Sergio Castellari, "Through our National Tsunami Alert Center, which is part of the network coordinated by UNESCO, we are able to warn many countries in the Mediterranean area based on the best available science."

Sergio Castellari noted that their research shows the importance of natural risk reduction. "For example, coastal forests like mangroves have proven to be beneficial to climate-change resilience and also to mitigation and ecosystem conservation and restoration. So, this ecosystem based approach for tsunami can be also integrated with technology to produce a hybrid solution."

The importance of engaging youth

The conference heard the voices of young people from around the world (see *Youth raise their voices in the Big Apple*).

In his opening address, **Dr Shahid** noted that "I'm pleased to see this year's emphasis on youth in raising tsunami awareness. I have made youth a priority of the 76th session, the Presidency of Hope, and I have already announced a youth fellowship programme in line with this."

Miyake Shingo, added that "It is vital to raise awareness of tsunami among younger generations. Japan has assisted school education on tsunami risk-reduction and evacuation drills in the Asia Pacific in cooperation with UNDP. More than 100,000 teachers and children have joined the programme since 2017."

Ricardo Toro, Director of Chile's Office of National Emergencies, explained that "To be more resilient, we need to integrate the system and the community. In Chile, we carry out preparedness and response activities for youth, including programmes for young volunteers and training for massive drill and simulation exercises on the coastline. I would like to reiterate the important of the population knowing the risk so they can make a timely decision, supported by an adequate early-warning system."

Among six key messages, **Nur Safitri Lasibani**, Executive Director of the Sikola Mombine Foundation, spoke of the importance of local wisdom and knowledge, passed through the generations, in particular understanding the natural signs of a tsunami and knowing how to self evacuate.

"A crucial role in tsunami reduction is the leadership of a local champion, either elder people, women, or young people. Women and young people can be the engine of the process, and youth can breach intergenerational gaps, from research to practice, and also to policy, technology and innovation."

Ambassador Kimihiro Ishikane said "Today we have heard the powerful voices of young people. Passing down the memories of the past tsunamis and the lessons learned from generation to generation is key to preventing future disasters and creating a more resilient society. We should continue to listen to the youth, as well as to the elders, and think about how we can further work together, taking advantage of World Tsunami Awareness Day."

Intertwining technology with society

Technology by itself can only do so much, it takes human awareness and preparedness to make the most of the warnings that technology can provide.

Dr Vladimir Ryabinin, Executive Secretary of the Intergovernmental Oceanographic Commission of UNESCO acknowledged that, after decades of effort "We have tsunami warning systems in the four parts of the world that are prone to tsunamis generated by earthquakes, but we are still poorly-protected from non-seismic tsunamis, or earthquakes that happen close to shore.

"If there is a tremor, there is no time to think, we have to run to high ground, to safety. That's the rule that everyone needs to know, and that takes education and practice."

Dr Ryabinin acknowledged the critical importance of the human element, saying "What we learned from the tsunami in Japan in 2001 is that the courage of people, the responsibility of people, the responsibility of officials, and also the noble character of people may really help in mitigating the disaster."

Dr Ryabinin talked of expanding the 11 tsunami service providers and the four tsunami information centres already in the four regions that are prone to seismic tsunamis.

"We have the technology and the procedures, and a decade of ocean empathy to expand people's awareness. This is a system that is highly technical, but really intertwined with massive societal fabric. Our scientists are leading the way, but the most important element that makes the system work is the societal reaction to this."

Dr Ryabinin concluded with a quote from the movie called The Wave: "It has happened before. It will happen again."

Building on these observations, **Ronald Jackson**, Head of the Disaster Risk Reduction, Recovery for Building Resilience Team at the UNDP, described three key elements to building tsunami resilience.

"Firstly, taking early-warning action can make the difference between life and death. We must continue to invest in improving and maintaining our systems so that warnings are received at the earliest possible time to allow for early action.

"Second, the science and technology have to be adapted to local needs and be user friendly and people oriented. Local governments must be able to interpret and act upon warnings, communicate them, and give clear instructions for evacuation. For this, last-mile connectivity is equally important."

"Lastly, in our digitalized world today, we must use technology to prioritize the needs of the poorest, the most vulnerable, and the marginalized, so that no one is left behind. It is the poorest and the most vulnerable who continue to inhabit hazard prone areas or engage in precarious livelihoods."

Spreading the word through cooperation

Chile is a good example of how international partnership and cooperation can change the way we tackle tsunami awareness.

Ricardo Toro explained how, after Chile joined the Pacific Tsunami Warning Center Conference in 2012, the tsunami protocols they introduced had an effect on other countries.

"The concept was unprecedented at the time and has since been considered for implementation in countries such as Peru, Ecuador, Colombia, and Costa Rica."

Chile has found two that kinds of engagement have worked particularly well: dialogue between specialists and authorities, in which both parties learn directly from their counterpart, and executing simulations of risk at all levels, from local population, national authorities and international partnerships.

When it comes to making early-warning technology and education available, smaller nations have to rely on the cooperation of others. As evidence of this, **Gina Bonne**, Chargee de Mission for Gender and Risk Reduction, the Indian Ocean Commission, said that "Before the 2004 tsunami, the word tsunami was not known to our generation, to our population. It was not in the language of the common people."

That changed overnight in 2004, but since then the region has become more vulnerable due to the impact of climate change and activities of mankind.

"All the natural barriers that acted as wave breakers, such as mangrove forests, coral reefs and sand dunes, are slowly disappearing," said Bonne, "and this is due to sea-level rise and over-exploitation of natural resources."

"As island nations, we need to invest more and think collectively, but we cannot do it alone. We need to improve our early-warning systems, and put education and awareness in the schools, because our schools are mostly on the coast. This is where regional cooperation and international collaboration is very much required."

As the host of the tsunami warning system for the Northeast Atlantic, Portugal is setting the standard for international cooperation. **Eduardo Ramos**, Portugal's Deputy Permanent Representative, explained that "Portugal and the UNDRR will host the forum for Disaster Risk Reduction with the European Commission and the council of Europe in November. This will bring together 55 member states, stakeholders and partners from Europe and Central Asia."

Portugal is also co hosting with Kenya the second United Nations Ocean Conference in June 2022.

The representative of the **Republic of Korea Mission** added "We believe that regional cooperation for disasters is very important, as it is possible to provide prompt and effective assistance because of similar disaster experiences and geographical proximity. The Republic of Korea has been making various efforts to strengthen disaster cooperation with Northeast Asia and ASEAN countries and will actively contribute to Disaster Risk Reduction in the region and beyond."

Ambassador Kimihiro Ishikane of Japan concluded the day by reiterating Japan's commitment to mainstream Disaster Risk Reduction, and issued a call to action to private enterprise to play its part.

"Japan hosted the past three United Nations conferences on disaster risk reduction," said Ambassador Ishikane, "and has been actively promoting the implementation of the Sendai Framework. How we can bring the private sector in to play in this challenge is something we need to really work on."

Trouble with thieves

The people of the Solomon Islands are no strangers to the perils of tsunamis. In 2007, a tsunami generated by an earthquake measuring 8.1 on the Richter scale hit the island of Gizo, killing 52 people and wiping out 13 villages in the western provinces of Makira and Jematu.

In 2018, the World Bank supported the construction of sea-level monitoring stations and five seismic stations to provide early warning. Often positioned in remote locations, these stations are powered by solar panels.

David Hiba, Director, Solomon Islands Meteorological Service, says "The time it takes to receive the warning data depends on how many stations you have. Our problem is that thieves are stealing the solar panels and batteries that power these stations."

Even the loss of a single station can have significant consequences.

"With one station down we are losing time in terms of information coming in. The five seismic stations were installed mainly in the southern parts, so we need to expand that to the western province and Georgia where it's also a hot spot."

The Solomon Islands are a perfect example of the need for international cooperation, as the government does not have the means to install more warning systems itself.

"The government's plan is to continue working with donors to get more data, more-accurate information and faster dissemination."

Finding ways to secure the stations against theft will no doubt be a high priority.

An exemplar of international cooperation

The global tsunami warning system is a testament to the effectiveness of international cooperation that transcends geopolitics.

Since its humble beginnings in 1965 with just a single outpost in the Pacific Ocean, the global tsunami early-warning system (TEWS) has grown to cover close to 1.5 million kilometres of coastline in 150 countries.

Bernardo Aliaga, Programme Specialist Tsunami Unit IOC/TSU, says that the expansion of TEWS over the last five decades has been possible only because so many countries were able to work together.

Working together really works

"The tsunamis of 2004, 2010 and 2011 in the Indian and Pacific oceans in particular showed everyone that we needed to work together to be prepared for these catastrophic events," says Aliaga, "the extent of international cooperation we've seen on TEWS is quite possibly unprecedented."

The system is made up of four regional intergovernmental systems covering the Pacific, Indian, and north-eastern Atlantic Ocean basins, as well as the Mediterranean Sea, Caribbean Sea and adjacent regions. Eleven IOC member states now serve as either basin-wide or regional Tsunami Service Providers (TSPs).

"This is an impressive achievement," says Aliaga, "TSPs can now provide accurate measurements of the depth and location of an earthquake with tolerances of just five to 10km, and transmit this data worldwide within 10 minutes of an earthquake."

Even within the components of TEWS, cooperation is key, with government departments working together to manage the system.

"In Australia, for example, the system is run cooperatively by the Bureau of Meteorology and Geoscience Australia," says Aliaga, "and it's a similar picture of inter-agency cooperation in Japan, China, the USA and Europe."

More than warnings

Aliaga is quick to point out that the TSPs are a rich source of data used to inform tsunami research worldwide.

"The TSPs deliver a technical information product containing data such as predicted arrival times, wave heights, energy levels, inundation maps and more. This is a solid system that covers most of the world and gives us many insights into seismic tsunamis."

The significance of the Ocean Decade

In June this year, the IOC Assembly endorsed the Tsunami Programme as a component of the Safe Ocean outcome for the UN's Ocean Decade.

"This is hugely significant for the development of tsunami preparedness," says Aliaga, "in particular the commitment to make 100 per cent of at-risk communities worldwide *TsunamiReady* by 2030."

The *TsunamiReady* component of the programme aims to provide education, training and exercises among coastal communities to increase awareness of tsunamis and ensure that people recognize the signs and know what to do.

"This is an enormous undertaking," says Aliaga. "It's huge, out of scale, but it provides a target for us to work towards and it's a novel approach to an ancient problem."

Delegation as well as cooperation

One consequence Aliaga sees of this target will be a de-centralisation of the programme to regional areas.

"We have 30 accredited *TsunamiReady* communities now. By 2030 we'll need hundreds, too many to list them all," says Aliaga, "which is why we're focusing on helping our colleagues in each country manage this themselves using a delegated model."

2022 will see the formation of the *TsunamiReady* Coalition, a group of NGOs, emergency-management agencies, prefectures and municipalities all working together channelling funds from disaster-management funds and foundations.

"This is where we'll see the next great example of international cooperation," says Aliaga, "our objective for this year was to implement part F of the Sendai Framework, which is to improve international cooperation to developing countries. It's the small island states and developing nations that need the *TsunamiReady* programme, countries like New Zealand and Japan are much ahead."

The three aims of the 10-year plan

The first objective of the Ocean Decade Tsunami Programme is to produce a draft 10-year plan to see us through to 2030. Aliaga expects this to be published in March 2022 and predicts that it will cover three main areas.

"The first is **hazard assessment**, in particular looking at non-seismic tsunami triggers such as landslides or volcano collapses. These are harder to predict, so we need to identify the at-risk areas, as well as the parts of the world that TEWS doesn't cover."

The second component of the plan will focus on **increasing data exchange**, says Aliaga.

"Today we share sea-level data among 1,000 stations operated by 164 institutes (station operators) worldwide, but there are gaps, especially in North Africa. For the whole North Africa coast, we have only one station in Morocco and one in Egypt, for example. We need to work with countries in that region to connect many more stations to the network and help keep them operating."

"We are also aiming to install sensors on the undersea telecommunication cables that run all over the seabed around the world," says Aliaga, "we're working with the telecommunications industry so that whenever they install or repair a cable they put sensors in. This is particularly important in the subduction zones 200-500 kilometres offshore."

The third component, and one that Aliaga believes is potentially the most important, is **community preparedness**.

"A warning is important, but knowing what to do when you get it, or if you don't get it at all, is more important. We're all about saving lives, we're not in the business of repairing the damage after the event, we want to minimise the loss of life. International cooperation through the *TsunamiReady* programme is the key to this."

Positive unintended consequences

One unintended consequence of the three major tsunamis of the last decade has been a boom in the number of people specializing in tsunami research.

"In 2004, there were perhaps a few dozen tsunami experts in the world," says Aliaga, "now there are hundreds of scientists contributing to tsunami science. The increase in knowledge and in the capabilities of the observing systems we've built to provide information to these experts is quite incredible.

"We now have scientists working in the social and natural sciences providing input to the ways we forecast and respond to tsunamis. They are all over the world, constituting a scientific community that transcends national boundaries and politics. They are true exemplars of international cooperation."

© Densho Road 3.11: Journey to Experience the Lessons from the Disaster | Tohoku, Japan

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The importance of memory

Remembering the tsunamis of the past is critical to reducing the impact of the tsunamis of the future. Japan's 3.11 Densho Road project shows how best to do this.

Professor Fumihiko Imamura, Professor of Tsunami Engineering at Tohoku University, says that learning the lessons of the past is the best defence for the future.

"It's ten years since the Great East Japan earthquake of March 2011. The tsunami from that earthquake caused huge damage, both social and economic over a wide area," says the professor, "many people died, and it was a very hard time for the people of the region."

Despite the extent of the devastation, in particular the long-lasting effects of the meltdown at the Fukushima nuclear plant, Professor Imamura says these experiences are rapidly forgotten.

"Humans tend to forget easily, and even though we hold memorial events every year, our challenge is to remind people of the lessons learnt. When it comes to reducing the impact of tsunamis, preparedness is everything and to be prepared you first need to be aware."

Iwate Tsunami Memorial Museum (© Professor Imamura)

3.11 Densho Road

In an effort to keep the memory of the earthquake and the tsunami alive, the 3.11 Densho Road Promotion Organization has created a network of disaster memorial facilities along the coast in the Tohoku region.

Running 500km along the length of the four prefectures of Aomori, Iwate, Miyagi and Fukushima that were devastated by the tsunami, the network consists of 280 facilities of different kinds.

"There are three categories of facility," says Professor Imamura, "ranging from simple stone monuments, to larger, more accessible memorial sites, and museums such as the Great East Japan Earthquake and Tsunami Memorial Museum in Iwate."

© Kaisho Monument

The facilities are designed to provide facts and lessons from the disaster, contribute to disaster prevention and preparedness, and convey the horror of disasters and the fearsomeness of nature.

The network also provides disaster-preparedness seminars to spread knowledge and public awareness, and gain the understanding not only of people in disaster-stricken areas, but of everyone throughout Japan.

"The 3.11 Densho Road memorials are a powerful reminder of this catastrophic event," says Professor Imamura, "all of Japan needs to be aware of the risks."

Telling the story

Other features of the network include destroyed schools and hotels, deliberately left in their unrepaired condition.

"We've kept these ruined buildings to show the power of the forces of nature," says Professor Imamura. "By doing this we're aiming to enhance the awareness and education of what happened. We know it will happen again, whether it's from an earthquake or a human-induced disaster, so it's important that people remember it and know what to do the next time it happens."

Storytellers provide another aspect of recalling these events, visiting schools to recount the experiences of the disaster to schoolchildren.

"We have many storytellers here in Japan, some of whom were only babies when the tsunami came," says Professor Imamura, "but they have learnt the story and are passing it on to future generations. This is an important element of memory."

The power of partnership

Ten years after the event, restoration work is still going on in the region, and the effects of the nuclear disaster in Fukushima are strongly felt. Professor Imamura emphasises just how important preparedness is in reducing the impact of a tsunami and helping with the recovery.

"Before the 2011 earthquake, we ran partnership exercises between the cities of the region, as well as with companies in the area. When the earthquake and tsunami struck, the organizations in the damaged areas knew they could contact governments and companies in other areas for assistance. This kind of cooperation makes a big difference."

While governments are often seen as the main body responsible for tsunami preparedness and response, Professor Imamura says that the private sector has a critical role to play.

"Involving the private sector is very important, especially in areas such as insurance, infrastructure, power and water. In 2011, many companies sent volunteers and gave financial support to help rebuild the region. Many of them are still giving this support even now, and this has had a great impact, even bigger than that of the government."

Lessons save lives

The 3.11 Densho Road's motto is 'Lessons save lives', and the main aim is to pass on to succeeding generations the memory of the self-sacrificing actions taken immediately after the Great East Japan Earthquake and in the ten years of recovery since.

"The aim of 3.11 Densho Road is to improve awareness of disaster prevention and promote communication with many people across regions and national borders," says Professor Imamura, "We know this type of catastrophe will happen again, so we have to make the effort to create a disaster-resistant society."

Cannes seminar to the tourism sector

On 5 November 2021, a seminar was held in the city of Cannes in southern France to increase the awareness of the actors of the tourism sector.

Pascal Roudil of the French National Tsunami Warning Centre (CENALT) presented the alert chain to the town in the presence of the Mayor, and gave an update on progress towards *TsunamiReady* recognition for Cannes.

Pascal Roudil also presented the latest version of the evacuation plan, and proposed that a tsunami charter be presented to hotel owners to sign.

Matthieu Péroche, Maître de conférences en Géographie of the Université Paul-Valéry Montpellier, helped the city implement standardized evacuation plans according to a methodology already tested in the French West Indies (https://exploit.univ-montp3.fr/).

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"With this method we can optimize the choice of refuge sites according to several criteria such as accessibility, hosting capacity, security and availability," said Matthieu Péroche. "The map

has been integrated into the city's operational documents, and a dynamic version will be available online soon."

"Through the framework of TASOMA research project (financed by the CNRS), we also worked closely together to implement evacuation itinerary signage, improve the top-down alert chain (actors, vectors, message contents), and take maritime issues into account," said Matthieu Péroche.

The tsunami exercise in Cannes took place within the framework of the World Tsunami Awareness Day on 5 November, organized under the auspices of UNESCO. This date was chosen at the national level (DGSCGC/CENALT) and by the city of Cannes.

"The scenario we tested is an earthquake of magnitude 7 at sea along the Algerian coast which, generates a tsunami whose arrival time of the first effects at the coast in France are about one hour," said Matthieu Péroche.

"During this exercise, we mobilized our university students and the Communal Reserve of Civil Security to distribute a survey questionnaire to the population on the how well they understood the warning messages broadcast in the loudspeakers of the city."

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Raising tsunami awareness in the Pacific

World Tsunami Awareness Day was marked by events all over the world. In Suva, the message about the importance of international collaboration was at the forefront.

The countries of the Pacific are experiencing rising sea levels and cascading disasters due to climate change. To make these communities more resilient to disasters, including the deadliest of them all— tsunamis — international collaboration needs to be made stronger.

This was the main message from both government and international organizations at the World Tsunami Awareness Day event in Suva, Fiji.

Increased UNDRR support for the Pacific

Mami Mizutori, the UN Secretary-General's Special Representative for Disaster Risk Reduction, opened the event by announcing the establishment of the Ocean Decade Tsunami Programme under the UN Decade of Ocean Science for Sustainable Development.

Marco Toscano-Rivalta, Chief of the UNDRR Regional Office for Asia-Pacific, followed this with a further announcement that UNDRR was increasing its support to the Pacific, especially on early warning and action.

Together with the World Meteorological Organization (WMO) and the World Bank, UNDRR has launched a four-year project to enhance national and regional early-warning systems, and to integrate the needs of women and persons with disabilities.

"This year's World Tsunami Awareness Day aims to amplify this message by calling for increased international cooperation, in line with Target F of the Sendai Framework for Disaster Risk Reduction," said Marco Toscano-Rivalta.

A history of cooperation

Speaking about the necessity of international cooperation, **Ofa Fa'anunu**, Vice chair of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS), explained that PTWS was a great example of cooperation in action.

"The 1960 Southern Chile Earthquake generated a Pacific-wide tsunami that caused substantial damage and loss of life, especially on the Pacific coast of Chile, in Hawaii, Japan and the Philippines," said Ofa Fa'anunu. "The creation of PTWS in 1965 is a testament to the benefits of international cooperation in strengthening local, national, regional and global tsunami warning and mitigation systems."

Arona Ngari, Director of the Cook Islands Meteorological Services, also recalled the 1960 Chilean tsunami and the 2006 Tonga earthquake, which generated a tsunami that reached the islands in only 19 minutes. The country has since been collaborating with WMO, building staff capacity and improving information communication.

Japan's continued commitment

Recalling the experiences of Japan in dealing with tsunamis, **Fumihiro Kawakami**, Ambassador of Japan to Fiji, said that "Japan's experiences and lessons learnt have driven us to work hard in developing ways to enhance tsunami disaster risk reduction as well as to build back better."

He highlighted different ways Japan was contributing to tsunami resilience in the Pacific, including:

- development assistance to help countries acquire advanced technology and improve critical hardware
- funding for regional projects such the Partnerships for Strengthening School Preparedness for Tsunamis in the Asia Pacific Region
- providing technical assistance through the Japan International Cooperation Agency
- hosting the High School Students Tsunami Summit.

The Ambassador confirmed Japan's commitment to continuing its collaboration with countries and international organizations for enhancing disaster risk reduction in the Pacific region.

Warning systems a priority for Vanuatu

The Director General of Vanuatu's Ministry of Climate Change Adaptation, Meteorology, Geo-Hazards, Environment, Energy and Disaster Management, **Esline Garaebiti**, said that "Maintaining a tsunami warning system is one of the main priorities of the government of Vanuatu." It is one of the key pillars of Vanuatu's National Strategic Development Plan 2030.

Esline Garaebiti noted that international support has been critical to helping Vanuatu increase its tsunami preparedness, including:

- support from Japan for a tsunami warning system, development of evacuation plans and capacity building
- the tsunami detection system supported by the governments of France, Japan and New Zealand
- support from UNESCO's International Tsunami Information Center (ITIC) providing awareness-raising tools enabling Vanuatu to distribute its own material to schools, communities and the general public.

Becoming tsunami-ready

"Nearly 70 per cent of tsunamis happen in the Pacific, and 99 per cent of deaths by tsunamis in the Pacific are from local and regional tsunamis that can hit in minutes or a few hours," said Dr **Laura Kong**, Director of the ITIC in Hawaii.

Dr Kong gave an overview of the UNESCO IOC TsunamiReady programme, which aims to make all communities at risk of tsunami prepared and resilient by 2030. The programme, she explained, has twelve indicators, standard guidelines, and is facilitated by ITIC. Currently, a number of Pacific Island Countries and Territories are working to become certified as Pacific Tsunami Ready.

Preparing the Mediterranean for the hidden menace

Recent tsunamis have hit Mediterranean locations like Bodrum, Kos, Izmir and Samos, and while it may not seem obvious, countries such as Morocco and Egypt are also at risk.

To improve their readiness, the European Union is running a €1.2m project in North Africa and the Mediterranean.

Denis Chang Seng, Programme Specialist Global Ocean Observing System, said "The case of the Samos 2020 tsunami has really shown that the level of education and awareness on tsunami risk is generally low in the Mediterranean region.

"This new European Union project will support education and awareness of tsunami risk, but most of all it will support the establishment of TsunamiReady-recognized communities in the Mediterranean regThe EU project will build on lessons from countries like Greece and Turkey, says Mauricio Gonzalez, Instituto de Hidraulica Ambiental at the University of Cantabria, who is working with Chipiona city on the south-west coast of Spain, on the Atlantic coast near Cali city.

"This is a high-risk tsunami area, and the objective of these evacuation exercises is to define evacuation times for different groups of people. We are divided into different groups by gender, and ages between 10 and 80 years. The idea with these exercises is to obtain some time for every question, and different slopes and different difficulties in the roads, and the idea is to include these in the numerical evacuation model that we are developing. So the idea is to prepare Chipiona before tsunamis using the TsunamiReady programme."

"Countries such as Spain, France and Italy have started to pilot TsunamiReady initiatives in different places," says Chang Seng, "so this project will support different aspects of the early-warning system, including sirens, evacuation mapping, evacuation signs, and also support in terms of carrying out exercise and drills in the Mediterranean region."

"Our target is to have at least seven TsunamiReady-recognised community sites by the year 2023," says Chang Seng, "and this will contribute to the 100 per cent TsunamiReady by the year 2030".

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TSUNAMI NEWS

Translating global thinking into local action

"Success in building resilience among at-risk communities comes from holistic thinking and empowering local people."

So says Ronald Jackson, a man with a passion for maximising the value and impact of development work, who has been head of Head of Disaster Risk Reduction, Recovery for Building Resilience, UNDP since May 2020.

A common risk language

"Our biggest challenge at the moment is developing a common risk language, so we know we're all talking about the same things," says Jackson. "Well-intended investments can lead to fragmented outcomes unless we all understand what the terms mean."

Tsunamis are a good example of the kinds of challenges the UNDRR is dealing with, challenges that cut across national boundaries and have impacts that aren't limited to a single region.

"The relative capacities of different states and communities to prepare for disasters vary widely," says Jackson, "so we need to ask ourselves the question: how we can identify and advance the spaces of harmonization? For example, harmonization of investments linked to parts of the three large global frameworks (The Sendai Framework, Paris Agreement and the Sustainable Development Goals) where we can maximise the return on investment that can contribute to a reduction in disaster risks through harmonized investments. A global standard for risk knowledge and a common risk language would mean we can all be in harmony."

The holistic view

Ronald Jackson is acutely aware of the need to get the most out of the development investments that the UNDP makes.

"When we look at development investments to help communities facing coastal risks such as tsunamis, it's essential that we take a systemic, multi-hazard approach," says Jackson, "we can't think in silos and just put up a tsunami warning siren if a town is also at risk from other threats."

Infrastructure that's resilient to one threat might be vulnerable to another, so it's important not to plan for just one possibility.

"For example, it's no use building a roof that's hurricane-proof if there's an earthquake risk," says Jackson, "We need to ask ourselves: Can we make one investment that allows us to build resilience to multiple challenges based on our integrated understanding of the risks? My answer to this would be a resounding yes".

Assessing the risks that a coastal village faces, for instance, involves considering a range of factors including sea level, set-back requirements, ecosystems as buffers and seismic risk, then making the appropriate contingency plans that consider these challenges. Authorities then have to consider how best to co-ordinate all of this within a regional or national context.

"If we agree that an area is vulnerable to tsunamis, we have to ask 'And what else?'" says Jackson, "what's the social construction of the risk there, what trade-offs do we have to make? A multi-hazard approach will most certainly present a better return on investment."

The theatre of operations is local

With a distinguished career at the Caribbean Disaster Emergency Management Agency and the Office of Disaster Preparedness and Emergency Management in his country of origin, Jamaica, Jackson has witnessed first hand the critical importance of cooperation down to local level.

"The UNDP has a network that goes at least to national level, but at some point we have to funnel the global agenda down to local level. The institutional mandate of the United Nations sometimes makes it difficult to nurture local operations, but where is the theatre of operations after all? It's not in the global theatre of discourse, it's at local level.

"Resilience must be viewed in the context of what is good and right and how local and national plans can become the instrument for integrating international frameworks. They have to come together in a structured and systematic way to be effective."

Since joining the UNDP, Jackson acknowledges that he is now looking at the same scene from the top down.

"As we move further away from the theatre of operations, the more difficult it becomes," says Jackson. "Empowering local leadership and getting everyone around the same table using the same terminology is the best way to ensure that an investment can have a macro effect."

Carry that weight

He adds that working within United Nations frameworks can be a challenge for some small States and local communities alike.

"All the actors have to be able to handle the weight of United Nations infrastructure that can at times be very heavy," says Jackson. "It's not easy for local administrators to coordinate national strategies, and the United Nations brings its own sets of expectations, bureaucracy and systems of accountability that take some getting used to."

Having worked in the Caribbean with Caricom, Jackson is mindful of the varying capacities of member states, and stresses that unless the relationship is genuinely cooperative, local actors can feel imposed upon rather than a sense of partnership or collaboration.

"Co-creation is critical," he says, "we don't pretend to have all the answers, but we can co-create solutions with stakeholders and beneficiaries that address the local needs and aren't general approaches superimposed from a distance. What worked in one place may not necessarily work in another, so getting to know the community and giving its leaders the tools to act is fundamental."

Including inclusivity

On the question of getting to know the community, Jackson notes that this includes identifying the needs of members who are disadvantaged.

"If we know that women and people with disabilities are disproportionally affected in disasters, why haven't we fixed this?" he asks. "We need to ask who is vulnerable and why? Equality, access, equity—it all links back to how we are analysing the people in these communities and working with them to develop solutions that address their needs."

Jackson points out that poverty is often a major contributor to these issues, and a significant driver of risk.

"This is a systemic problem which impacts the capabilities and capacities of local communities. Many of them simply don't have the resources or the governance arrangements needed to manage local risk properly, especially when the risk is systemic. This will require levels of sophistication in our analysis, planning in order to better identify, plan for and support persons with disabilities."

The importance of negotiation

When it comes to the political side of things, Jackson acknowledges that there are numerous challenges, and that bringing negotiating skills to the table is key.

“Managing the political machinations is something we’re all grappling with,” he says with a laugh, “finding the best pathway for collective action is not easy, and we gain nothing if we alienate one stakeholder.”

“Governments recognise that there is a value proposition here,” he says, “and if they believe there’s value, we can negotiate on shared elements and find common ground, but it requires good negotiation skills, no question.”

“Nothing done in the name of development is easy,” says Jackson, “but if we devote our efforts to translating global thinking into local action we will go a long way to achieving our goal of ensuring no-one is left behind.”

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Java – the most at-risk part of the world

Indonesia has more people threatened by tsunamis than any other place on Earth. Java, its most populated island is broadside on to the southern Indian ocean, and as we know from the disaster in 2004, is acutely vulnerable to tsunamis.

Conscious of the threat, local communities in Java have been working together to increase tsunami awareness and preparedness.

Abah Lal, of the DRR TsunamiReady Community in Lebak, says ”Since 2017, we have independently initiated community-based risk-reduction efforts with assistance from the Bandung Institute of technology and U-Inspire Indonesia.”

U-Inspire is an alliance of youth, young scientists, and young professionals working in science, engineering, technology and innovation.

Aan Anugrah of the West Java Chapter says “We have helped the communities integrate the way they work with the local disaster-management office, warning centre and other stakeholders including universities, to help them with their assessments.”

Abah Lal explains that they adopted TsunamiReady because “the programme gives us a clear direction to build tsunami preparedness in South Lebak comprehensively, and because the flexibility of the programme enables us to use local wisdom as the foundation for building preparedness.”

Indeed, the flexibility of the programme is fundamental says Abah Lal, because “a bridge of wisdom is needed to communicate modern science to people who are still traditionally agrarian and have low literacy skills.”

After suffering the deaths of over 200,000 people in the 2004 tsunami, the DRR community in Java is only too aware of the need to reach the goal of 100 per cent of communities TsunamiReady by 2030.

Acknowledging the benefits of cooperation

World Tsunami Awareness Day was marked in Bangkok by a symposium of international experts who outlined the many ways in which the region’s capacity to cope with tsunamis is improving.

The importance of international cooperation

Armida Salsiah Alisjahbana, Under-Secretary-General of the United Nations and Executive Secretary of ESCAP opened the event, noting that the theme for this year is target F of the Sendai framework for disaster risk reduction: to substantially enhance international cooperation to developing countries.

Marco Toscano-Rivalta, Humanitarian Affairs Officer, UN Office for the Coordination of Humanitarian Affairs, elaborated on this theme, acknowledging the support and backing of countries like Japan and Sweden.

“The efforts made to increase resilience in the Asia region wouldn’t have been possible without the support and backing of countries like Sweden and Japan, who generously contributed funding and expertise to help developing countries,” said Marco Toscano-Rivalta.

He added that increasing this type of support is a key target for the Sendai framework for Disaster Risk Reduction, saying “Without such international cooperation, the least developed countries will experience disasters that push them further into poverty and weaken their chances of graduating to middle-income status.”

Early warnings rely on preparedness

Since it was first established in 2014 by Japan and the USA, the tsunami alert system for the Indian Ocean has expanded to provide risk assessment and early warnings for 25 member states.

Rick Bailey, the head of the Indian Ocean Tsunami Warning and Mitigation System Secretariat under UNESCO explained that, despite this success, warnings by themselves aren’t enough, and that “Maintaining awareness and preparedness among communities is a continuing challenge that we are now meeting with the TsunamiReady programme.”

Rick Bailey cited a UNESCO project to strengthen tsunami early warning in the north-west Indian Ocean, involving India, Pakistan, Oman and the United Arab Emirates as an example of international cooperation.

“The whole idea is bringing these countries together, working together, combining their own expertise with international expertise. It’s all about regional cooperation, to make sure that at-risk communities are TsunamiReady and we continue to learn from each other. It’s a two way process, and it’s through this regional cooperation that we reach the successes.”

Engaging the youth

Jaco Cilliers, Manager, UNDP Bangkok Regional Hub, thanked the government and people of Japan for their continuing support of tsunami awareness, and shared several points that demonstrate the effectiveness of international cooperation.

He spoke of the importance of engaging youth, and how over 150,000 students, teachers and officials in over 350 schools in 23 countries had been participating in tsunami-preparedness exercises.

"This is a difficult task, especially in countries like Indonesia where over 3,500 schools are at risk of tsunamis," said Jaco Cilliers. "Through our partnerships with Tokyo University and IOC UNESCO we benefit from their decades of experience working with schools. This has helped us to adapt best practices to the local context and translate documents into local languages."

Jaco Cilliers announced the launch of a children's book Dury-sensei and Tsunami based on the life of a tsunami survivor in the Solomon Islands, the first of a series that is available as a digital book from the UNDP website at https://www.jp.undp.org/content/tokyo/ja/home/library/the_tsunami_teacher.html

The value of the trust fund

After the 2004 tsunami, the Economic and Social Commission for Asia and the Pacific (ESCAP) multi-donor trust fund was established. This fund is the only dedicated regional funding mechanism delivering coordinated support for tsunami early-warning systems in the Indian Ocean and Southeast Asian countries.

Tiziana Bonapace, Director ICT and Disaster Risk Reduction Division ESCAP, explained that "Since then, the trust fund has expanded its mandate and is now focusing on strengthening people-centred multi-hazard early-warning systems and social and economic resilience in the Asia Pacific region."

On behalf of ESCAP, Bonapace expressed her appreciation for the donors to the fund. Started in 2004 with a $10 million donation from Thailand, following years saw contributions from Sweden, Germany, India, Switzerland and, this year, Italy.

"Without your support the trust fund would not exist and if it didn't, we'd have to invent it, because it's not about whether a disaster will occur, but when a disaster will occur."

The Philippines, benefitting from international cooperation

With approximately 14 million people living in coastal areas of the Philippines that can be inundated by tsunamis, the archipelago nation is benefitting from cooperation with neighbouring countries.

Dr Renato Solidum, Junior Undersecretary of the Department of Science and Technology, Philippine Institute of Technology said "Our efforts were hastened by the 2004 Indian Ocean tsunami that devastated some of our neighbouring countries, and thanks to international collaboration we have made significant progress in tsunami awareness."

He particularly noted the support of the government of Japan in enhancing the earthquake monitoring system over three decades, which now has 19 sea-level stations country-wide and a database of 30,000 tsunami scenarios.

Dr Renato added that Japan's support has also been instrumental in youth education in the Philippines.

"As a result of a collaborative study with Japanese institutions on the impact of the 2011 East Japan earthquake, we are producing comics or manga on the stories of Filipino survivors of the event, and these are widely used in schools."

A gender-equal approach to disaster risk reduction saves lives

Jon Astrom Grondahl, Sweden's Ambassador to Thailand drew attention to the gender imbalance in the effects of disasters like tsunamis, and noted that social forces and patterns fundamentally influence the course of disasters.

"Some of these are surprisingly often overlooked by agencies, decision makers and leaders," he said, noting that in the case of the December 2004 tsunami, "Four times, I repeat, four times more women were killed, and this agenda disaster continued in the emergence of camps and resettlement sites where women experienced much increased rates of gender-based violence."

Other social factors to consider include access to economic resources, ethnic, religious and social identities, educational level and political representation, as well as physical ability and age.

"Some programmes may be gender or rights blind, and through the Sweden Development Corporation, we aim to do better than this by integrating disaster risk reduction with inclusive and human-rights-based approaches," he said.

Japan, bringing nations together

Yuchi Oba, Minister and Deputy Chief of the Japanese Embassy in Thailand, spoke of Japan's perspective on international cooperation.

"Since 2017, Japan has been implementing a programme to support preparedness in tsunami-prone schools in the East Asia Pacific through the UNDP," said Yuchi Oba. "Today, more than 150,000 students in 23 countries have participated in tsunami-awareness education.

"Under the terms of the Sendai Framework, the Government of Japan is currently working with UNDP to accelerate our digital transformation for disaster risk reduction and resilience-building in Sri Lanka, Nepal, the Philippines and Indonesia, and the Pacific region."

Yuchi Oba concluded the event with the statement that "Japan will continue to work with the United Nations and other stakeholders in the region to realize an era of economic and environmental growth and disaster resilience. We must do everything in our power to achieve the Sendai Framework goals so that no one will be left behind."

The DART II system

Launched by the New Zealand Government in 2019, the Deep Ocean Assessment and Reporting of Tsunamis (DART) is a system of buoys and sensors placed around the Pacific Ring of Fire to detect and measure tsunamis.

Bill Fry, research Seismologist GNS Science, said "The Ring of Fire is a place where we have the world's biggest earthquakes and the world's biggest tsunamis."

Sarah-Jayne McCurrach, Manager Risk Reduction and Resilience, New Zealand Earthquake Commission, adds that "The south-west Pacific countries are at huge risk of tsunamis. The Kermadec trench that goes up right and weaves around Tonga poses the most significant threat not just to New Zealand but all of the smaller south Pacific islands and territories."

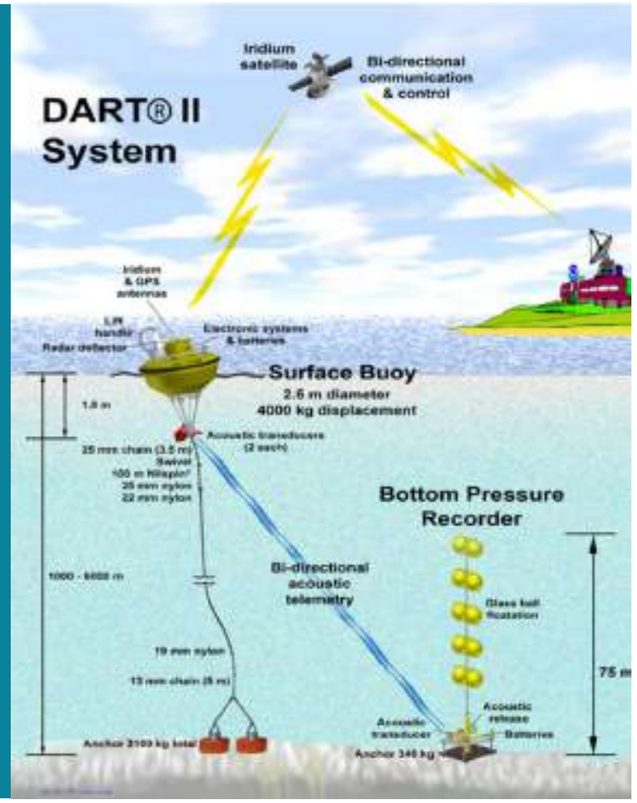
"DART buoy is a system" says Bill Fry, "the sensor on the sea floor that's tethered to a buoy measures pressure then communicates with a recorder telecommunications on the buoy. When a tsunami goes over that sensor it can measure how big it was."

"It was key for us to ensure that what we were developing would also be useful for other countries in the Pacific that will be using information from the DART buoys," said Sarah-Jayne, "the DART buoys will provide them with extra knowledge on where the waves are coming from and how long they've got."

DART is aligned with the Ocean Decade goal of Safer Oceans, and is a key component to achieving the goal of 100 per cent tsunami-resilient communities by 2030.

Bill adds that "We know that the best way to keep people safe from tsunamis is to keep them educated and prepared for tsunamis that will happen around the Pacific. TsunamiReady means that when that does happen that community is prepared for it and can take the appropriate action."

"Through the Pacific Tsunami Warning System, we have a strategy that outlines how we want to achieve certain goals within the next ten years," says Sarah-Jayne, "and what we've done in the Pacific is align our strategy with a UN Decade whose goal is to have safer oceans by 2030. So we're making sure that all of the work we do with regards to understanding tsunami risk, and then planning for that risk, is aligned with the outcomes of the decade, which is to have 100 per cent resilient communities at risk of tsunami by 2030."



TSUNAMI NEWS

A breakthrough in probabilistic tsunami forecasting

The Italian National Institute of Geophysics and Volcanology has revealed a new probabilistic method for predicting tsunamis that deliberately factors in uncertainty to provide more accurate warnings.

A key factor in minimizing the impact of a tsunami is knowing where and when it is likely to hit, and with how much force. With enough warning, a community that has a tsunami action plan, like that provided by the *TsunamiReady* programme, can get people to high ground before the wave hits.

A lack of certainty…

When predicting tsunamis, uncertainty is unavoidable, and in the past has led to many false alarms, as well as avoidable loss of life. The 2004 Indian Ocean tsunami in particular highlighted the cost of insisting on certainty, demonstrating the importance of clear communication between scientists and decision makers.

…and a lack of accuracy

At present there is no formal probabilistic method for determining the certainty of a tsunami. To define initial alert levels, early-warning systems worldwide typically rely on a range of forecasting methods that define alert levels deterministically. These methods also include safety factors that increase the number of false alarms

What's needed is a way for the scientific components of the process to provide a certainty rating for alert levels. The political components can then use these to make decisions about evacuating coastal areas.

The Italian National Institute of Geophysics and Volcanology (INGV) believe they have found the solution: the probabilistic tsunami forecasting (PTF) procedure.

A new way to estimate intensity and probability

Jacopo Selva of the INGV Tsunami Warning Center explains that "PTF quantifies the probability of a tsunami occurring with a given intensity within a few minutes of the shock capable of generating it."

The PTF method is the first to evaluate and quantify the unavoidable degree of uncertainty in real-time tsunami forecasts and provide appropriate alert-level definitions. Once it has estimates of the earthquake's location and magnitude, the PTF can predict the maximum run-up of a wave at multiple forecast points almost immediately.

"PTF offers the possibility of linking the definition of the alert levels for tsunami early warning to the forecast of the intensity of the possible tsunami and to the relative uncertainty, based on pre-established risk reduction criteria," said Jacopo Selva.

Tested on history

To test their theory, the INGV team used supercomputers to analyse data from all the earthquakes in the Mediterranean area that have activated the warning centre in recent years. They found the forecasting model to be statistically accurate over a wide range of magnitudes and types of seismic event, from relatively small crustal earthquakes to larger events generated in subduction areas.

These studies included the 8.8 magnitude earthquake that hit Maule, Chile, in 2010, the 2003 Zemmouri-Boumerdes tsunami in Algeria, generated by an earthquake of magnitude 6.8, and the recent tsunami generated almost a year ago by the earthquake of magnitude 7.0 near the Greek island of Samos.

"The forecasts are made by combining the earthquake parameters estimated in real time with those expected in the area and, finally, with millions of numerical simulations of tsunami propagation pre-calculated with modern supercomputers," said Stefano Lorito, co-author of the study.

Reducing uncertainty by factoring it in

Giving decision-makers the right information quickly is the first step in reducing both the risk of loss of life from a tsunami, and the socio-economic costs of false alarms.

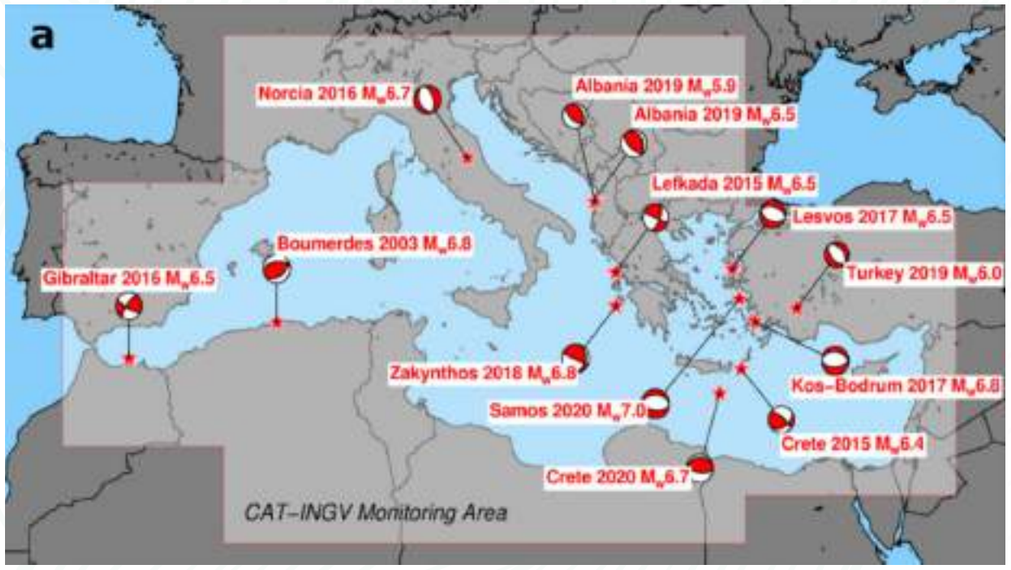
Reducing uncertainty at these time-critical decision points can make all the difference between a right decision and a wrong one. By intentionally building uncertainty into its calculations, the PTF approach provides a quantitative estimate of uncertainties, enabling more accurate forecasts of a tsunami's likelihood and its intensity.

And the future?

The INGV team also predicts that the PTF approach could be used to define new risk-management strategies and mitigation actions for specific issues based on real-time PTF data, such as activating procedures to safeguard industrial plants.

The Ocean Decade Tsunami Programme calls for the capability and tools to forecast tsunamis from all sources, as well as high-performance computational capabilities to enable more timely, accurate and comprehensive tsunami and other coastal hazard forecasts and warnings.

The PTF programme is a significant step in achieving both of these goals.



Odisha province - good governance in action

Being prepared is the key to surviving a tsunami, and preparedness comes from good governance. Nowhere is this better evidenced than in Odisha province in India, where the IOC has certified two villages as TsunamiReady.

In August 2021, the UNESCO Intergovernmental Oceanographic Commission (IOC) awarded a *TsunamiReady* Certificate of Recognition to Noliasahi in the Jagatsingpur district and Venkatraipur in the Ganjam district of Odisha province.

Noliasahi is located in the Erasama Block of Jagatsinghpur district on the Bay of Bengal, where nearly 7,000 people lost their lives in the 1999 super cyclone. In the Odisha region as whole, over 10,000 people lost their lives in this disaster, prompting the local authorities to take action. The IOC's *TsunamiReady* programme proved to be perfectly suited to the task.

"Being prepared for a tsunami hazard makes communities resilient to other coastal oceanographic hazards."

Regional government steps up

Dr Srinivasa Kumar Tummala, Director Indian National Centre for Ocean Information Services, said "The Odisha State Disaster Management Authority has taken several steps to implement this tsunami-relief programme in all the remaining 326 coastal communities."

The *TsunamiReady* programme provides a range of measures to improve community preparedness for any catastrophic weather event, not just for tsunamis.

"Key enabling factors that were helpful in making a lot of progress in the past year, despite COVID, were the realization of the communities themselves that being prepared for a tsunami hazard makes them resilient to other coastal oceanographic hazards," said Dr Tummala.

Meeting the twelve indicators

The IOC created the *TsunamiReady* programme to promote tsunami preparedness. It provides a structural and systematic approach to improve the preparedness of coastal communities for tsunami emergencies, and minimize the loss of life and property.

The programme has twelve best-practice indicators that define the benchmark for being *TsunamiReady*. The certification in Odisha came after the two villages met all of these indicators.

"With this recognition, India is the first country to implement *TsunamiReady* in the Indian Ocean Region and Odisha is the first state," announced the Indian National Centre for Ocean Information Centre.

Involving the community

TsunamiReady is a community performance-based programme, requiring the active collaboration of the public, community leaders, and national and local emergency management agencies. Odisha province demonstrated that collaboration at all levels is critical to the programme's success.

Shri Pradeep Kumar Jena, IAS, Managing Director Odisha state Disaster Management Authority said "We have trained more than 1,000 people in the villages and rural areas. Together we'll make it happen. Together we'll demonstrate that the political leaders and their regions in Odisha can create a disaster-resilient community."

Sharing the lessons

Where governments and communities work together to promote tsunami awareness, it's possible to create genuine resilience, and Odisha shows what real political will can achieve.

"It is important that this TsunamiReady programme is taken up amongst all the vulnerable communities," said Dr Tummala. "Because several countries have been implementing this initiative, the best practices and lessons learned can be shared across all of these stakeholders to ensure that our communities are safe from a tsunami threat."

Towards 100 per cent by 2030

With the inclusion of the tsunami programme in the UN Decade of Ocean Science, the target of making 100 per cent of at-risk communities *TsunamiReady* by 2030 has been set. Odisha province is a major step towards this target and sets a fine example for other communities to follow.

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The best-practice indicators for being TsunamiReady

Mitigate

- MIT-1 Have designated and mapped tsunami hazard zones.
- MIT-2 Include tsunami-hazard and community-vulnerability information in the community's FEMA-approved multi-hazard mitigation plan.
- MIT-3 Install signage, as needed, that (1) identifies, for example, tsunami danger area or hazard zone (entering and leaving signs), evacuation routes and assembly area; and (2) provides tsunami response education (go to high ground).

Prepare

- PREP-1 Produce easily understood tsunami evacuation maps as determined to be appropriate by local authorities.
- PREP-2 Support an ongoing sustained tsunami public-education effort. This effort should include the development and distribution of outreach materials.
- PREP-3 Support an ongoing sustained tsunami-education effort specific to public schools in coastal community pursuing TsunamiReady recognition.
- PREP-4 Hold at least one community-wide outreach or education activity annually.
- PREP-5 Conduct community exercises that reinforce the concepts contained in PREP-1 to PREP-4.
- PREP-6 Conduct evacuation drills for all public schools in the mapped tsunami evacuation zone to reinforce the concepts contained in PREP-1 to PREP-4.

Respond

- RESP-1 Address tsunami hazards in the community's emergency operations plan (EOP).
- RESP-2 Address tsunami hazards in the emergency operations plans (EOP) for all public schools in the tsunami hazard zone.
- RESP-3 Commit to supporting the emergency operations centre (EOC) during tsunami incidents if an EOC is opened and activated.
- RESP-4 Have reliable means for a 24-hour warning point (and EOC if activated) to receive official tsunami watch, advisory and warning alerts.
- RESP-5 Have reliable means for 24-hour warning point, or EOC to disseminate official tsunami watch, advisory and warning alerts to the public.
- RESP-6 Have public-alert-certified NOAA Weather Radio (NWR) receivers in critical facilities and public venues.
- RESP-7 Conduct emergency-operations-plan exercises that test at least one component of the community's EOP or one item from RESP-4 to RESP-6.

Youth raise their voices in the Big Apple

TSUNAMI NEWS

Young people involved in disaster risk reduction around the world lent their voices to World Tsunami Awareness Day.

The World Tsunami Awareness Day event in New York featured a video message that brought together young people engaged in disaster risk reduction from countries in at-risk areas all over the world.

The Pacific ocean

Speaking from Indonesia, **Dr Rina Oktari Suryani**, young scientist and faculty member of Syiah Kuala University Aceh, spoke of her experiences in 2004 and the value of being prepared.

"I was a student at university in Jakarta when the tsunami hit in the Indian Ocean in December 2004. The initial shock quickly turned into action as my lecturer set up an emergency medical team."

Katarina Rayawa, Seismology Section of the Mineral Resources Department, Ministry of Lands and Mineral Resources, spoke for the youth of Fiji.

"I am 25 years old and work for the seismology unit for the Mineral Resources Department under the Ministry of Lands and natural resources. We will continue to strive to better our services in ensuring the safety of lives in Fiji."

Anna Shinke a PhD student at Tohoku University in Japan recalled the suffering inflicted by the 2011 tsunami.

"I experienced the huge earthquake, the emergency shelter and the grade-three evacuation due to the nuclear power-plant accident. I was shocked to see my whole town destroyed by the tsunami. I strongly feel that such a painful experience should not be experienced by anyone again, and I want to reduce the number of people who die in disasters."

Representing the vulnerable island state of Tonga, Josephine Falemaka, Youth Volunteer for the Red Cross Society, spoke of the importance of youth involvement.

"Youths of Tonga make up about one third of Tonga's total population. As such, it is important to educate youth to know a tsunami's natural warning signs and also what to do and how they can contribute when the Government of Tonga issues a tsunami warning."

Another student from Japan, **Yu Watanabe**, Master Student, Tohoku University spoke of learning about tsunami risk.

"I started my research on tsunamis after listening to a storyteller in the area affected by the 2011 Great East Japan earthquake. In the future, I would like to contribute to empowering more citizens to learn the lessons of past tsunamis and to become involved in disaster risk reduction."

From the far side of the Pacific, **Alinne Melina Olvera Martinez**, BSc, Mexican School of Risk Management and Civil Protection Professionals (UNAM), spoke of the need for a multi-hazard approach.

"As multi-hazards will become more prominent due to climate change, contemporary conditions represent an urgent call for action for young professionals that, with their innovative perspectives, shall close the generational gap and engage in the multi-hazards matters. Cooperation is the only way to achieve resilience."

The Indian ocean

Nur Safitri Lasibani, Executive Director of the S Sikola Mombine Foundation in Indonesia, noted the importance of involving women in disaster risk reduction.

"I am 25 years old. As survivors of the 2018 earthquake, tsunami, and liquefaction in Central Sulawesi, as well as women's activists, we understand that the involvement of women and other vulnerable groups in disaster mitigation and disaster risk reduction is very important."

Representing the youth of Madagascar was. Aina Sylvania Andrianjakatina, member of Africa Youth Advisory Board on DRR, Researcher at the Centre of Economic Study and Research for Development, Antanarivo.

"I am recording this message to call for the increase in the awareness of tsunami risks, particularly for the youth, agents of change. Therefore I invite my fellow scientists, DRR leaders within NGOs or local, national and international organizations, to reinforce their efforts so that all the youth is informed about the risk they face."

The leader of U Inspire in the Maldives, **Mariyam Shizna**, Programme Coordinator of the Programmes Department of National Disaster Management Authority, spoke of youth as the foundation of the future.

"We firmly believe that youth are the building blocks and they can act as advocates for disaster risk reduction and they can be the building-blocks tool of other communities about disasters and risk reduction measures."

The Mediterranean Sea

Speaking from Italy, **Alexander Virgili**, Italian DRR advocate, civil protection volunteer co-ordinator called for young people everywhere to become advocates.

"Engaging youth in disaster-resilience strategies, informing them about the risks of the territory is important, and I would like to take the opportunity of the World Tsunami Awareness Day to reach out to the youth around the world and highlight the importance of prevention and DRR knowledge to become proactive citizens in our community."

Fifth World Landslide Forum

From 2-6 November 2021, after a year's delay due to Covid-19, the fifth World Landslide Forum took place in Kyoto, Japan.

Speakers at the forum marked that World Tsunami Awareness Day was taking place on 5 November, and acknowledged that, while 80 per cent of tsunami events are caused by earthquakes, landslides can contribute to tsunami occurrences, particularly in areas like Indonesia and the Caribbean.

TSUNAMI NEWS

The economics of sea levels

Understanding the likely economic impacts of a tsunami, and how rising sea levels affect them is an exciting new area of tsunami research.

Associate Professor Anawat Suppasri, Tohoku University, has been looking for ways to quantify just how much damage a tsunami will do in a given area. His research aims to give urban planners valuable insights into likely effects and mitigation measures.

"Planners have many things to consider, and tsunami risk is one that's often overlooked," says Professor Suppasri. "We've been doing modelling so we can show planners what the economic impact would be if a tsunami hit the area they're looking at, and what sort of measures they would need in place to limit the damage."

Check before you build

For organizations proposing an airport or an industrial zone near the coast, having this kind of information can help planners make informed decisions that take tsunami risk into account.

"If a government knows what the risk is they can work out where to build seawalls, and allocate resources to regions that are likely to be most affected," says Professor Suppasri. The project, scheduled to start in April 2022, will be sponsored by the Science and Technology Research Partnership for Sustainable Development (SATREPS, PI: Nobuhito Mori, Kyoto University) co-funded by JST and JICA.

"SATREPS is Japanese government programme that promotes international joint research," says the professor, "it will enable us to apply this research to Indonesian coastal zones, including lessons from Sulawesi Island and the Sunda Strait, areas that were both hit by tsunamis in 2018."

Combining mitigation methods

Professor Suppasri is proposing that the Indonesian government consider these methods when planning to move its capital from Jakarta to the island of Kalimantan.

"We're taking a risk-reduction approach for multiple hazards, considering a mix of green and grey infrastructure," says Professor Suppasri. "Green methods include natural features such as mangrove forests, while grey methods are seawalls and other built structures. We're trying to balance these and find the most effective combination."

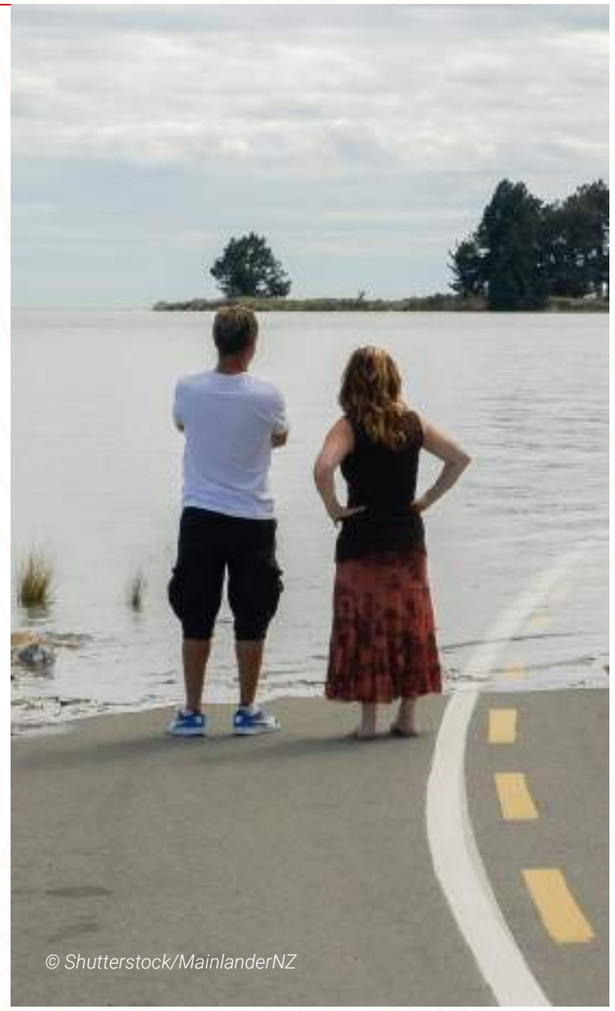
The effect of rising sea levels

With global warming now very much at the forefront of global politics, Professor Suppasri is also researching the effect of rising sea levels on tsunamis.

"It might seem self-evident that if the sea level is higher, tsunamis will be bigger, but surprisingly little research has been done on this. We want to quantify this scientifically so we can predict what the effect will be."

His team has found that relatively small sea level rises can have major effects.

"There are obviously many variables and factors involved," he says, "but a rise of say 75cm in sea level could result in a tsunami that is 1.5 metres higher. It's not a strictly linear relationship, but when you look at the maps of coastal areas, an extra 1.5 metres on a tsunami means a very significant increase in the inundation zone."



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Not just bigger, but more frequent

Looked at another way, the professor points out that a higher sea-level changes our understanding of tsunami frequency and size.

"For example, in the northeast of Macau Peninsula, we might expect a one-metre inundation once every 962 years. Raise the sea level 50cm and that becomes every 800 years. If the sea rose a whole metre, we could expect a one-metre inundation every 458 years," says Professor Suppasri."[1]

"The hazard maps and coastal-defence structures that the Japanese Ministry of Land, Infrastructure Transport and Tourism develops are based on current sea levels. With a higher sea level, these frequencies become shorter, so the likelihood of experiencing one of these disasters in our lifetime increases."

Decisions based on evidence

The aim of the professor's research is to provide an inclusive and evidence-based decision support platform.

"We're trying to create a consensus-building method by combining natural and social-science evidence and using numerical models to assess vulnerability," says Professor Suppasri.

"By considering the hazards of flood, beach erosion, landslide, earthquake and tsunami together, we're looking to help governments with the social implementation in coastal areas, in harmony with disaster risk reduction, environment and economy."

1 https://www.science.org/doi/10.1126/sciadv.aat1180

Regional success stories

Caribbean Sea

TsunamiReady certifications

These communities gained certification as TsunamiReady:

- St. John's City, Antigua and Barbuda
- Shermans, St. Lucy to Mullins, St. Peter, Barbados
- Union Island, St. Vincent and the Grenadines
- Carenage, Trinidad and Tobago

Exercises completed

CARIBE WAVE 20 and CARIBE WAVE 21 exercises were successfully completed with 98 per cent of Member States and Territories participating (nearly 400,000 people) despite the COVID-19 pandemic.

Exercises planned

CARIBE WAVE 22 is being prepared with three scenarios:

- A tsunamigenic earthquake along the Muertos Trough south of Dominican Republic.
- A flank collapse of the Cumbre Vieja Volcano (La Palma, Canary Island).
- An offshore event north of Panama along the Northern Panama Deformed Belt.

Mediterranean Sea and Atlantic Ocean

The Instituto Português do Mar e da Atmosfera (Portugal) gained accreditation as a fifth Tsunami Service Provider (TSP) in the NEAM region.

The NEAMWave21 exercise was carried out.

Pacific Ocean

TsunamiReady certifications

These sites in the Hawaiian Islands Rica gained TsunamiReady certification:

- South Maui
- Hanapepe-Eleele
- Wahiawa.

These sites in Costa Rica gained TsunamiReady certification:

- Samara
- Tamarindo.

These regions in the USA renewed their TsunamiReady certifications:

- Pender County, NC
- Hoquiam, WA
- Calabash, NC
- Guam
- Oceanside, CA
- Oxnard, CA
- Port Angeles, WA

Exercises completed

The PacWave20 exercise was completed.

Indian Ocean

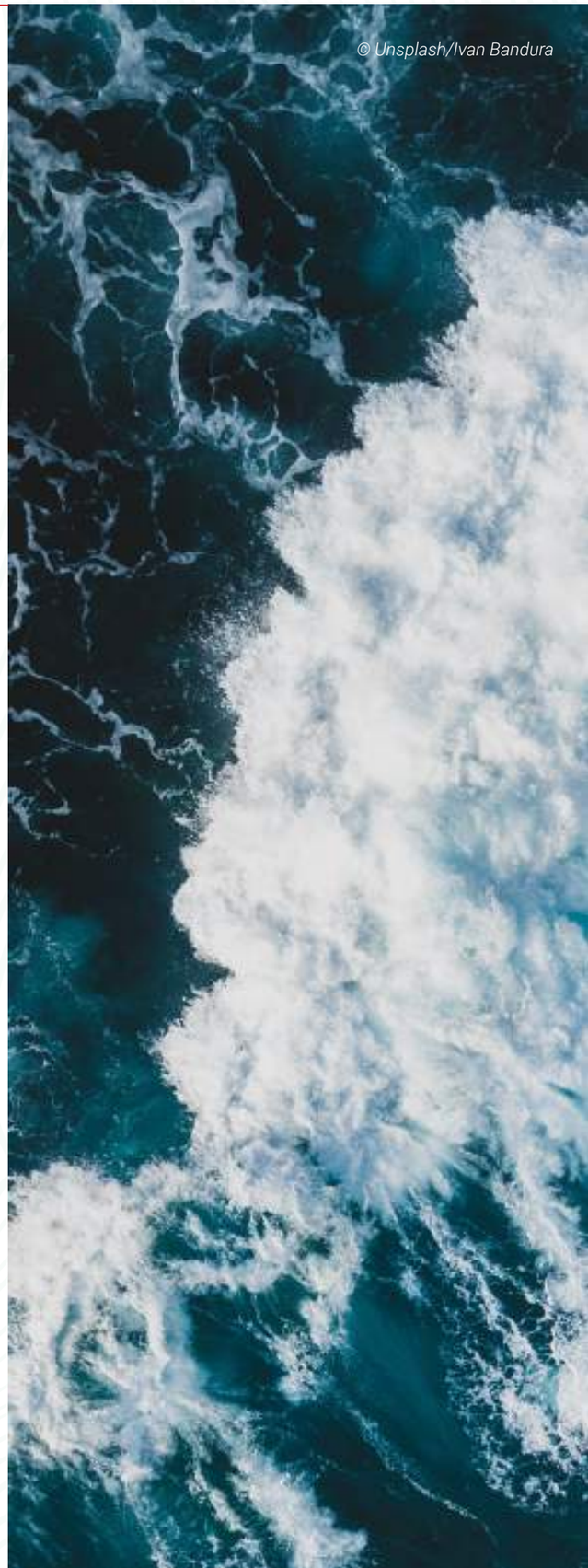
In India, the Noliasahi and Venkatraipur communities in Odisha province, India gained certification as TsunamiReady

Exercises completed

The IOWave20 exercise was completed.

Other progress

- ITIC and Indonesia BMKG were designated as Ocean Teacher Global Academy Specialized Training Centers (OTGA STC)
- Indonesia made progress in their application for ISO certification of a Community Based Early Warning System.



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