

2022 World Tsunami Day Focuses on Early Warning and Early Action

By Christa von Hillebrandt-Andrade, International Tsunami Information Center – Caribbean Office and Laura Kong and Carolina Hincapié-Cárdenes, International Tsunami Information Center

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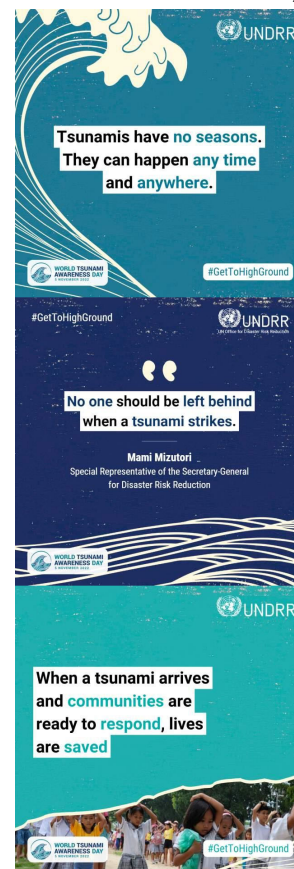
“In the face of devastation, early warning and early action remain the most effective ways of protecting people from tsunamis.” These were the words of Mami Mizutori, Special Representative of the Secretary General of the United Nations for Disaster Risk Reduction and Head of UNDRR, on occasion of the World Tsunami Awareness Day (WTAD). In December 2015, the United Nations General Assembly designated 5 November as World Tsunami Awareness Day, to promote a global culture of awareness of and preparedness against tsunamis.

Since the first WTAD held in 2016, a different target of the “Sendai Seven Campaign” has been selected. The theme for this year was Target (g) which calls for substantially increasing the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030. Additionally, in March 2022, the UN Secretary General, Antonio Guterres, announced a new action to ensure every person on Earth is protected by early warning systems by 2027.

The International Tsunami Information Center (ITIC) coordinated and participated in several actions before, during and after November 5. Actions included promoting WTAD 2022 through its [website](#) and social media, as well as attending and participating in several fora organized by the UNDRR and UNESCO and supporting the PacWAVE exercise. Videos highlighting this year’s theme were also produced.

As in previous years, the ITIC created a WTAD 2022 website. It includes an overview on World Tsunami Day, links to social media cards, events, videos and resources.

ITIC also participated in a social media campaign through the ITIC and the ITIC-Caribbean Office Facebook pages. The designated hashtags for WTAD were #TsunamiDay and #GetToHighGround. The three main messages that were highlighted on the [social media cards](#) were: “No one should be left behind when a tsunami strikes” (Mami Mizutori, UNDRR), “Tsunamis have no season, can happen anytime and anywhere” and “When a tsunami strikes and communities are ready to respond, lives are saved”.



TsuInfo Alert

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NATIONAL TSUNAMI HAZARD MITIGATION PROGRAM LIBRARY CATALOG:

<http://d92019.eos-intl.net/D92019/OPAC/Index.aspx>

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The main high-level event took place on November 4 by the UN General Assembly. On this occasion, Mami Mizutori gave her remarks on the significance of World Tsunami Awareness Day and the need of early warning systems for all. Several countries as well as the World Meteorological Organization, Red Cross Societies and Japanese students made interventions. The participants recalled the vulnerability of many communities, and the importance of considering the social dimension in developing early warning systems, including the integration of youth and the most vulnerable and the need to expand the tsunami warning system to cover those generated by volcanic activity given the lessons learned from the eruption of Hunga-Tonga Hunga-Ha'apai (HTHH). A similar high-level event took place in Bangkok, Thailand on November 4.

The Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System conducted its biannual Exercise Pacific Wave between September and November 2022 in order to support International Disaster Risk Reduction Day (13 October) and World Tsunami Awareness Day. In the framework of PacWave22, the Pacific Islands Countries and Territories Regional Exercise ([PacWave 22 PICT](#)) was held Nov. 9/10 (depending on the countries location). Eighteen Pacific Countries and Territories participated in the 2-hour live regional table top exercise to test new early warning procedures for a potential tsunami arising from volcanic activity in the HTHH volcano. The Exercise was the first-ever fully dedicated to Pacific Island Countries and Territories.

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TSUNAMI PREPAREDNESS

2022 World Tsunami Day Focuses on Early Warning and Early Action

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Short videos created by the UNDRR in collaboration with UNESCO IOC showcase progress in early warning systems and tsunami readiness from countries and partners around the world working together to save lives from tsunamis. The playlist with the following videos can be accessed [here](#):

- Tsunami in Tonga 2022
- Friendly community technology to support Indonesian tsunami early warning
- Preparing for tsunami risk in the Caribbean
- Tsunami risk in the Mediterranean
- Explained: How to detect the next tsunami

Christa von Hillebrandt-Andrade was a speaker at an event organized by UNDRR Americas to launch the documentary “Forget Me Not”. The documentary tells the story of an unexpected friendship across the ocean in Japan and Alaska after the 2011 tsunami that struck Japan and the Pacific region. In 2011 Miurasan lost everything she had, including her restaurant. One year later David and Yumi Baxter found her husband's buoy along the beach and offered to return it. Over the years, the Baxters and Miurasan visited with each other. The trailer can be viewed [here](#). The documentary, which will soon be released for public viewing, was produced by Pacifico, who also produced the animated film [The Girl and the Tsunami](#) and the documentary Tsunami Ladies ([trailer](#)). Christa highlighted that tsunamis know no borders and the importance of international cooperation and the human and social dimension of disasters.

It is the expectation that the WTAD 2022 activities and resources will have helped create a greater awareness about the threat of tsunamis and how to appropriately respond. As Audrey Azoulay, Director-General, UNESCO emphasized “We know that warning communities is not enough if they (people at risk) do not know how to react. Coastal populations must be prepared to face tsunamis at all levels - so lives can be saved, and futures preserved.” She further announced that UNESCO would extend its Tsunami Ready Recognition Programme to all at-risk communities by 2030, working with governments, schools, community institutions to build resilience to coastal hazard and risks - to get Tsunami Ready!



TSUNAMI PREPAREDNESS

Puerto Rico's Tsunami Program Launches an Inclusive Video for World Tsunami Awareness Day 2022

By Roy Ruiz-Vélez, UPRM Puerto Rico Seismic Network

The Puerto Rico Seismic Network (PRSN) Tsunami Program participated in the 2022 World Tsunami Awareness Day campaign to promote a global culture of education and preparedness against tsunami hazards. This year the Program's participation consisted of the creation of an inclusive short video for social media. The production team for this video included PRSN employees, volunteers, and students from the University of Puerto Rico at Mayagüez (UPRM) Geology Department.

The video opens with an aerial drone clip from Quebradillas's coast, an iconic tourist area on the Island, with Puerto Rican music in the background inviting the viewers to enjoy the video. Then the video makes a transition to slow tense music and the narrator using a news reporter voice style announces: "The threat of a tsunami in Puerto Rico is real". This statement is intended to catch the viewer's attention and invite them to think about this potential hazard.

In 2018 the Statistical Institute of Puerto Rico estimated that there are more than 218,400 officially deaf people on the Island, including people with a hearing disability¹. This community deserves to be educated and prepared in case of a tsunami.

During the pre-production process, the team took into consideration make the video in an inclusive way including sign language for the deaf community and English subtitles for the Anglophone community in Puerto Rico. The story of the video is centered around the 1918 earthquake that impacted the Island and caused a tsunami. A slideshow with historical photos and three short stories from 1918 earthquake survivors, supported by selected background music and effects, created an immersive experience while the narrator, in a simple way, releases the tsunami awareness message. The video has a duration of 2:55. As of December 1, 2022 the video has more than 15,100 views on Facebook.

The PRSN wants to thank volunteer student Yesenia Rivera from the UPRM Geology Department, a NOAA EPP/MSI USP Scholar, volunteer citizen Jackeline Cancel for the sign language interpretation, and other staff members that made possible this educational video. The PRSN's Tsunami Program recognizes that this is a small step and more initiatives like this one need to be done. To access the video visit:

<https://www.facebook.com/100064642873279/videos/1577813245982112>

¹ Instituto de Estadísticas de Puerto Rico, 2019: https://estadisticas.pr/files/Memoriales/RCS409_Comision_Gobierno-Instituto_Estadisticas_0.pdf



TSUNAMI RESEARCH

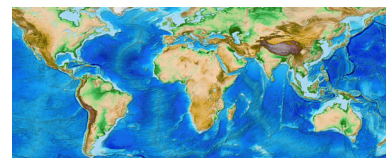
The World in Relief on ETOPO

By NOAA National Centers for Environmental Information

By combining land topography, ocean bathymetry, and shoreline data, Earth TOPOgraphy (ETOPO) shows the world in relief. An even more comprehensive version of the model, [ETOPO 2022](#), brings greater, more accurate details to the geophysical characteristics of Earth's surface.

ETOPO, derived from the words Earth and topography, uses high-resolution renderings to model the contours and features of the planet, both above and below sea level. With this visualization, the characteristics of our world become more than two dimensional. In science, researchers use ETOPO models for many purposes:

- Tsunami forecasting, modeling, and warning
- Understanding tectonic formation and activity
- Visualizing ocean circulation
- Exploring the effects of climate change



ETOPO comes in two versions: Ice Surface, which depicts the surface of the Antarctic and Greenland ice sheets; and Bedrock, which depicts the bedrock underneath the ice sheets.

ETOPO 2022

The release of ETOPO 2022 adds enhanced resolution that incorporates recent advances in data sources and processing techniques. ETOPO 2022 uses a combination of numerous airborne lidar, satellite-derived topography, and shipborne bathymetry datasets from U.S. and global sources. Its predecessor, ETOPO1, has been an important modeling tool for the tsunami community since its introduction more than a decade ago. ETOPO1 had a grid resolution of about 2 km. The new ETOPO 2022 resolution will be an enhanced 15 arc-second resolution, about 0.5 km, which is four times higher than ETOPO1.

The NCEI scientific team behind the update notes, “We built and deployed state-of-the-art computational methods to measure the accuracy of our input data as well as the final ETOPO 2022 product with more than 800 billion laser-ranging measurements from NASA’s ICESat-2 satellite spanning nearly the entire globe over the calendar year 2021.”

The update is the latest since ETOPO’s previous release in 2010. Dr. Christopher Amante, an NCEI geospatial research scientist with the [Cooperative Institute for Research in Environmental Sciences](#) (CIRES), originally developed ETOPO1 when he was a [NOAA Hollings Scholar](#). His work with the project continues, and he participated on the team producing ETOPO 2022.

Cascadia CoPes Hub Tsunami Research

By Alessandra Burgos, Daniel Cox, Carrie Garrison-Laney, and Randy LeVeque

The National Science Foundation-supported Cascadia Coastline and Peoples Hazards Research Hub, or [Cascadia CoPes Hub](#), is an interdisciplinary team of researchers focused on understanding natural hazards and climate change risks along the Cascadia coastline. Researchers at Oregon State University, University of Washington, Cal Poly Humboldt, University of Oregon, Arizona State University, the USGS, the NOAA Center for Tsunami Research, the WA and OR Sea Grant programs, tribal nations, and coastal communities are working together to advance coastal hazard research, increase the diversity of future coastal hazard researchers and practitioners, and improve community resilience.

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TSUNAMI RESEARCH

Cascadia CoPes Hub Tsunami Research

By Alessandra Burgos, Daniel Cox, Carrie Garrison-Laney, and Randy LeVeque

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Cascadia CoPes Hub researchers are developing a probabilistic suite of models that couple earthquake shaking and tsunami generation. These coupled models will be used to identify potential cascading hazards from earthquake shaking, tsunami inundation, landslides, liquefaction, and their combined impact on infrastructure and coastal communities. These models will help communities understand the likelihood of different impacts and inform their plans and projects. This work is initially focused on potential Cascadia subduction zone events but will also be extended to the study of tsunamigenic crustal faults, particularly those crossing the Salish Sea.

Coastal communities will be faced with significant debris after a tsunami. Hub modelers are predicting where tsunami debris is likely to accumulate (Figure 1). The mapping and forecast of the spatial distribution of debris will improve hazard mitigation planning for immediate life safety, assess possible effects on infrastructure, and support long term recovery by estimating the quantity and types of tsunami debris that will need to be removed and disposed of.

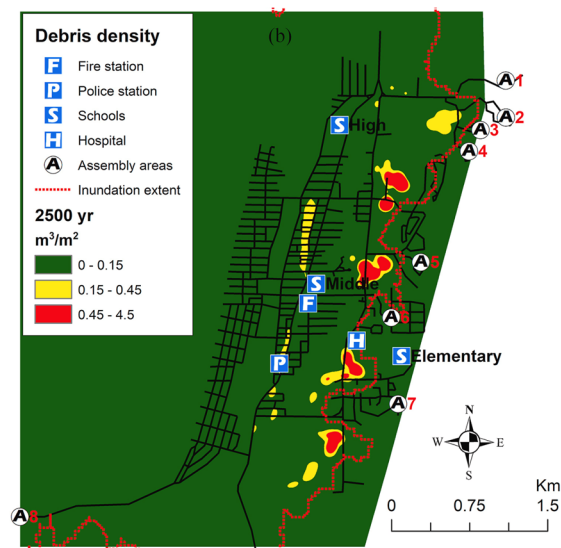


Figure 1. Model simulation of debris field of damaged buildings transported by a CSZ tsunami in Seaside, OR. Figure courtesy of Daniel Cox, OSU.



Figure 2. Garrison-Laney studying paleotsunami deposits at Discovery Bay, WA. Photo by Brian Atwater, USGS.

In addition to the modeling efforts, Cascadia CoPes Hub researchers are studying the geologic record of paleotsunami deposits to improve our knowledge of the recurrence and sources of past tsunamis. Updating the catalog of high-quality ages at Cascadia paleoseismic sites will improve recurrence estimates of Cascadia earthquakes and tsunamis and may lead to refinements of paleoearthquake deformation areas. At study locations in the Salish Sea, including Discovery Bay (Figure 2), improving radiocarbon ages and updating age models may not only narrow the ranges of past Cascadia tsunami events, but also constrain the timing of other potential Salish Sea tsunami sources, including crustal faults and landslides.

The Hub is dedicated to co-producing this research with communities, tribes, and other agencies. To continue expanding engagement and collaboration, the Hub hosted a [virtual workshop](#) on November 7, 2022 with state and federal agency partners to discuss plans for new geohazards research planned by the Hub and agency partners. Tsunami generation and inundation was a focus during the second session of the day. Bringing in over 90 people to hear pop-up talks and discussion allowed for participants to establish connections and areas to collaborate.

TSUNAMI ASSESSMENTS AND WARNINGS

Making Decisions with Incomplete Information: Difficulties of Real-time Assessment of Tsunami Hazard

By Dr. Ben Heath, Kara Sterling, Dave Snider, Impact-based Decision Support Services team at NTWC

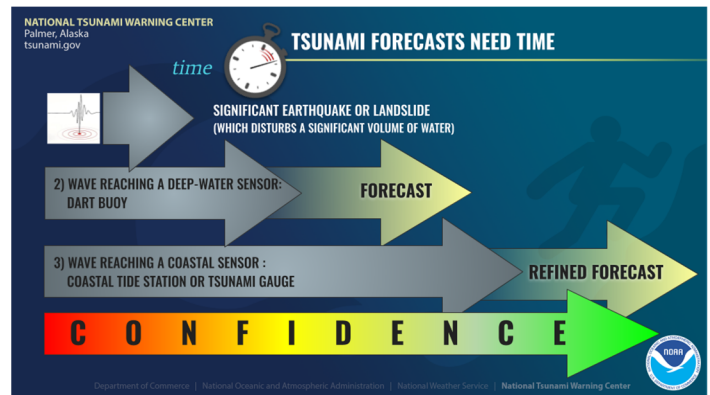
It takes time to evacuate coastal areas, therefore tsunami warning centers issue initial messages as quickly as possible. However, it also takes time to understand a tsunamigenic event. Due to the limited event information available during the initial response, we often have low confidence in the accuracy of preliminary forecasts, with confidence improving as we get additional observations which better illuminate event tsunamigenesis. Here we briefly outline the build-up of a tsunami warning center response, discussing how to navigate the time delay between an event occurring and an accurate, well-constrained forecast.

Approximately 9 out of every 10 tsunamis are generated by earthquakes. Within minutes of a seismic event, one can recover the earthquake depth, location, and approximate magnitude. Within 20-30 minutes, the focal mechanism/moment tensor is known. These event parameters can be used to approximate seafloor displacement and tsunamigenesis. We calculate the range or broad “ballpark” of plausible tsunami outcomes by running preliminary models with worst case assumptions using the known event

parameters. This, plus historical data relating impacts to distance from the event, helps us create a low-confidence forecast. To create a high-confidence forecast requires direct observations of the tsunami, which can be used to solve for a more accurate description of seafloor displacement. Additionally, these tsunami wave measurements can be used to validate and adjust tsunami model output, but with a cost of time: the tsunami wave takes tens of minutes to hours to arrive at and pass by water-level stations to fully describe the event.

How do warning centers improve tsunami response, knowing that there is this window of time where we need to wait for water-level measurements? A successful tsunami response relies on both accurate, timely forecasts and effective communication. As quantitative scientists, we often focus disproportionately on the former. This could mean, for example, improving initial source characterization (decreasing the reliance on water-level stations), or improving the capacity to go from event observation to potential impact. However, a spot-on, perfect forecast does not yield a successful tsunami response unless the information is communicated effectively. Socializing that the forecast confidence will be low until we get water-level measurements, sharing estimates of when these measurements will occur, communicating best estimates of time to impact, and simply providing a routine for when partners will hear from the warning center next enables decision makers to do what you do best: make the best possible decisions in spite of limited information. Decision makers need to be confident they have the most up-to-date information, which could be “there is no new information”. Informing our decision makers of our next decision point and limitations, and the current best-case, worst-case and most-likely forecasts with each update cycle informs the process, rather than waiting for a perfect forecast with full confidence that may never be realized.

How can you help? How can operational tsunami scientists quickly narrow down and/or better describe our “ballpark” range of scenarios? Help us go from observation to potential impact faster. Quantitative models, while not the full story for warning centers, are still crucially important and there is a lot of room for improvement. For emergency managers and other partners, what do you need from us to make your decisions? What are your thresholds for response and action? How do we help clarify the “ballpark” range of scenarios to help you best make your decisions in a timely manner? Contact Dave Snider at NTWC to provide feedback: david.snider@noaa.gov.

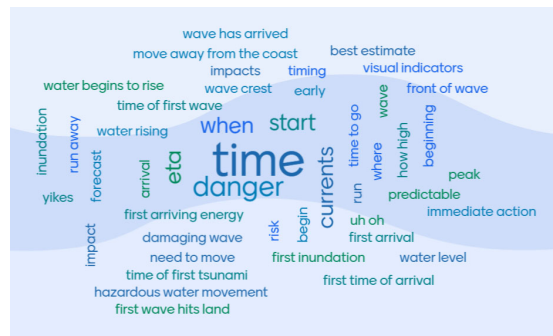


TSUNAMI PREPAREDNESS

Tsunami Wave Arrival Workshop

By Alex Dolcimascolo, Washington Geological Survey

It has come to the NTHMP's attention that 'tsunami arrival time' is a complex term that lacks consistent interpretation among different groups and agencies. In an effort to address the ambiguity surrounding tsunami wave arrival, the NTHMP held a kickoff workshop on this specific topic. This workshop introduced some of the challenges associated with defining and communicating tsunami wave arrival, in addition to how arrival times are used in assessing and planning for risk, product development, and public outreach for different states and territories. This workshop also took a deep dive into the methods, limitations, and uncertainties associated with real-time wave arrival forecasts from the Tsunami Warning Centers and how forecasted times are used in decision making. The NTHMP has identified a need to define 'tsunami arrival time' in simple, non-technical terms that are relevant and easily understood by the public and other key stakeholders. One of the difficulties around this objective will be how to accommodate the diverse interest groups that the NTHMP works closely with; the many nuances associated with the tsunami wave have different relevancies to various stakeholders. Overall, this workshop got conversations on tsunami wave arrival rolling and there is momentum to continue these conversations at the subcommittee level during the upcoming NTHMP Winter Meeting. Potential discussion topics include outlining the capabilities of the Tsunami Warning Centers along with the aspirations of the NTHMP, developing guidance for using tsunami arrival times in product development, and tying everything together with the current education and outreach efforts. If you missed December's workshop and would like to receive the video recording, please contact the Washington Geological Survey.



Word cloud listing some of the first words and phrases that come to mind when thinking about tsunami wave arrival. Word cloud generated using Mentimeter.

18 Pacific Island Countries and Territories Test New Early Warning Procedures for Volcanic Eruption-induced Tsunamis

By UNESCO Intergovernmental Oceanographic Commission

18 Pacific Countries and Territories conducted a 2-hour live regional table top exercise ([PacWave22-PICT](#)) to test new early warning procedures for a potential tsunami arising from volcanic activity in the Hunga-Tonga Hunga-Ha'apai (HTHH) Volcano. The Exercise was the first-ever fully dedicated to Pacific Island Countries and Territories.

The tsunami procedures and products, which are carried out by the Pacific Tsunami Warning Centre (PTWC) for the Pacific Tsunami Warning and Mitigation System, were immediately developed after the catastrophic eruption of the Hunga-Tonga Hunga-Ha'apai volcano on 15 January 2022 and ensuing tsunami to respond to the possibility of future tsunamis generated by HTHH volcanic activity.

On the afternoon of 15 January 2022, the Hunga Tonga – Hunga Ha'apai (HTHH) Volcano, located about 70km northeast of Tongatapu, Tonga, violently erupted. The massive explosion generated a damaging tsunami that impacted locally, regionally, and across the Pacific. International satellites captured the gigantic explosion, and countries in the region heard the loud blasts. The eruption severed the fiber communication cable from Tonga to the outside world, and pushed the island nation into a communication blackout for six weeks.

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TSUNAMI PREPAREDNESS

18 Pacific Island Countries and Territories Test New Early Warning Procedures for Volcanic Eruption-induced Tsunamis

By UNESCO Intergovernmental Oceanographic Commission

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“The Hunga Tonga – Hunga Ha’apai volcanic eruption and tsunami was unprecedented. When the fiber optic cable broke, all tsunami- and volcano-monitoring observations from Tonga stopped, leaving every PTWS National Tsunami Warning Center ‘data blind’ and having to make tsunami warning decisions without knowing the severity of Tonga’s tsunami,” explains Dr Laura Kong, Director of the International Tsunami Information Center (ITIC), a partnership between UNESCO and the U.S. National Oceanic and Atmospheric Administration.

PacWave22-PICT replayed the 15 January 2022 HTHH volcanic eruption and tsunami using specially-developed message products to enable countries to test their volcano tsunami response Standard Operating Procedures (SOPs), and also test regional communication systems for sharing warning and response information amongst national tsunami warning centres, national disaster management offices, and geological hazard observatories.



“More than ever, this stresses the crucial importance of regional cooperation and information sharing. If one nearby country is able to share its tsunami observations and assessment with others, it’s going to help those countries make better warning decisions that will save lives,” highlighted Vladimir Ryabinin, Executive Secretary of the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), the United Nations body responsible for global and regional coordination of tsunami early warning systems and preparedness activities.

IOC-UNESCO coordinates the larger Pacific Wave 2022 Exercise, which includes the PacWave22-PICT table top simulation of the HTHH volcano eruption as well as various other regional simulations taking place between 1 September and 30 November 2022. The Pacific Wave Exercises take place every two years to test the Pacific Tsunami Warning and Mitigation System, the response of national tsunami warning centres, as well as country preparedness arrangements and operational procedures to respond and recover from a destructive tsunami.

Learning from the HTHH event, where much of the information immediately available was through social media, the Pacific Wave 22 Exercise demonstrated that real-time sharing of official information within and across countries in the region was valuable for national tsunami alert decision-making. Information sharing methods included a dedicated E-mail listserv (hosted by ITIC), a WhatsApp group (hosted by UNESCO and the French Polynesia’s Centre Polynésien de Prévention des Tsunamis), and high-frequency radio in various countries.

“This PacWave22-PICT regional exercise, dedicated to Pacific Island Countries and Territories, was the 1st of its kind and it was a good opportunity for us to build regional cooperation and direct links between countries,” said Anthony Jamelot, Geophysicist, Centre Polynésien de Prévention des Tsunamis.

Link to original article:

<https://ioc.unesco.org/news/18-pacific-island-countries-and-territories-test-new-early-warning-procedures-volcanic>

TSUNAMI PREPAREDNESS

Updates from the Virgin Islands Territorial Emergency Management Agency

Ribbon Cutting Ceremony Celebrates the Completion of the Territories' Tsunami Warning System Restoration

The Virgin Islands Territorial Emergency Management Agency (VITEMA), on Tuesday, August 23rd, hosted Governor Albert Bryan Jr. and the leadership of federal and local agencies for a celebratory program and ribbon-cutting ceremony to recognize the erection of the 44th and final tsunami warning tower at the DC Canegata Recreation Center and sports grounds on St Croix.

VITEMA Director Daryl Jaschen led off the program by announcing to Governor Bryan and those in attendance that he was proud to declare that the construction phase of all towers territory-wide had been completed. "As of today, all the warning sirens that once dotted the territory's landscape prior to their destruction in the wake of two Category 5 hurricanes in 2017 have been replaced."

While the old system used wooden utility poles, the new sirens will sit atop galvanized steel poles that will better withstand natural disasters. The completed towers stand 60 feet high and are equipped with radio antennas that receive emergency signals to activate the sirens. The height and selected locations best position the sirens to warn persons of any tsunami threat along the over 1500 miles (about 2414.02 km) of territorial shoreline.

Additionally, the system is being modernized for compatibility with the Integrated Public Alert and Warning System (IPAWS), our nation's alert and warning infrastructure. This integration will boost the systems' capabilities to notify and alert the public of many other potentially catastrophic events, including hurricanes, earthquakes, and other weather-related occurrences.

There are nineteen towers on St Thomas, seventeen towers on St Croix, seven on St. John and one on Water Island. Director Jaschen stated that "testing of the sirens will take place between August and October with the goal to be completed in time for VITEMA's "Great Shake Out" earthquake awareness outreach week.

The dedication ceremony featured retired University of the Virgin Islands Professor Roy Watlington as its guest speaker. Watlington is a noted expert and author in the field of tsunamis. He currently serves as the USVI science representative to the National Tsunami Hazard Mitigation program and a member of its coordinating staff. In his remarks, he spoke of his gratitude to the agencies and persons responsible for making the resources possible to receive the funding for the preparedness assets that included the new tsunami sirens. Professor Watlington specifically praised the leadership and staff of VITEMA for their hard work and considerable effort in recruiting the necessary funding.

Prior to the official ribbon-cutting ceremony, the program was concluded with closing remarks by Governor Bryan. "We are moving forward on so many projects, we have to take the time to celebrate the win, and today is a big win." He also took the opportunity to praise VITEMA as one of the best emergency response departments in the country, referring to the planning and execution of the territory's response to COVID-19, the success of organizing the various public vaccination projects, and the follow-through in seeing the tsunami restoration project to its successful conclusion.



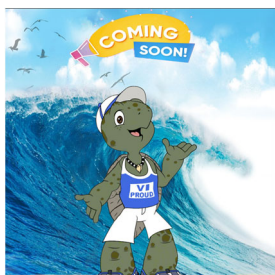
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TSUNAMI PREPAREDNESS

Updates from the Virgin Islands Territorial Emergency Management Agency

(Continued from page 10)

2022 U.S. Virgin Islands Seismic Workshop—VITEMA held a seminar titled the [2022 U.S. Virgin Islands Seismic Workshop](#) in anticipation of the Great Shakeout. The Territory was honored to have the following panelists: Professor Roy Watlington (USVI Science Representative to the NTHMP), Dr. Elizabeth Vanacore (University of Puerto Rico), Allison Shurway (USGS), Jason Penn (BVI Emergency Management Director), Christa Von-Hillerbrandt (ITIC), and Daryl Jaschen (Director VITEMA). The workshop was the first of many to come and was held to inform the community of all the research being done in Puerto Rico and the Caribbean, and to encourage collaboration with partners in the Territory. The next workshop will include time for the experts to answer questions from the public. Outreach events will continue throughout the year.



The Virgin Islands Territorial Emergency Management Agency (VITEMA) is proud to present the adventures of a leathery (leatherback) Turtle named Alfred. Born on the Island of St. John, he explores to learn more about how he can contribute to his community and his Lifelines.

Focused on educating the community about the warning signs of potential disasters and the preparations steps to ensure our safety, Alfred is a young but knowledgeable leathery turtle that enjoys sharing his passion for community awareness during his travels throughout the United States Virgin Islands. Join us as we welcome this friendly turtle as part of our 2022 Community Outreach Initiative!

Public Service Announcement premieres in December 2022

VITEMA Announces the Introduction of Alfred the Leathery (Leatherback) Turtle—VITEMA has created the character Alfred to help communities of young people in the U.S. Virgin Islands be prepared for potential disasters. Alfred will premiere December 2022. This will be shared by the Department of Education throughout schools in the Territory.

New Tsunami Maritime Response and Mitigation Strategy for Westport Marina

By the Washington Emergency Management Division

Among the most vulnerable facilities to tsunami impacts are ports, harbors, and marinas. The ability of maritime infrastructure to withstand a disaster and resume operations quickly plays a major factor in the recovery of the local community and economy in the short and long term. Thanks to funding from the NTHMP FY20 grant cycle, Washington Emergency Management Division (WA EMD) recently completed a [Tsunami Maritime Response and Mitigation Strategy](#) (TMRMS) for Westport Marina on Washington's outer coast (see figure 1) to help the Marina understand its tsunami risk and which mitigation and response options provide the best chance of reducing response and recovery time. The activities at the Port of Grays Harbor's Westport Marina and its uplands support nearly 2,300 jobs and more than \$227 million in business revenue every year in rural southwest Washington. Hundreds of commercial vessels use Westport Marina to harvest Dungeness crab, salmon, albacore tuna and more throughout the year. Both distant and local tsunamis pose a major threat to these operations.

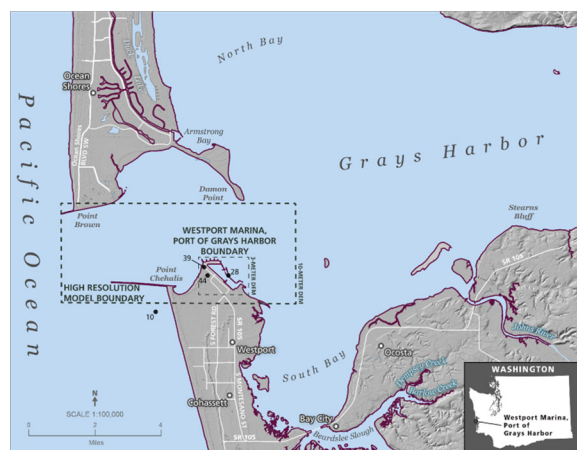


Figure 1: A map showing the location of Westport Marina and the boundary of the study area for the TMRMS modeling.

(Continues on page 12)

TSUNAMI PREPAREDNESS

New Tsunami Maritime Response and Mitigation Strategy for Westport Marina

By the Washington Emergency Management Division

(Continued from page 11)

The components of the Westport Marina TMRMS that set it apart from general maritime tsunami recommendations are threefold. First, the Westport Marina TMRMS features site-specific maps, figures, and other data provided by the Washington Geological Survey showing inundation, current velocity, and drawdown for a devastating 9.0 Cascadia subduction zone earthquake and tsunami in the Marina area. These same graphics are available for Washington’s maximum considered distant event, a 9.2 Alaska earthquake and tsunami based on the 1964 event. This is the first time such information is available for the Alaska scenario, making the TMRMS especially valuable for a location at which the waves would arrive in under 4 hours. Having such detailed mapping allows officials to understand how these scenarios may impact the Marina so they can plan accordingly.

Second, the Westport Marina TMRMS provides realistic mitigation and response recommendations based on the Marina’s specific risk and rated by feasibility (see figure 2). Examples of recommended mitigation methods include installing tsunami evacuation and hazard signage, increasing the size and stability of dock pilings, and other efforts which can facilitate evacuation and prevent vessels and docks from becoming dangerous debris. While a Cascadia subduction zone earthquake leaves little time to respond before the tsunami arrives, response actions taken to reduce potential damage could occur before an Alaskan tsunami arrives. For example, there is one port-owned chemical storage tank at the Marina that can be capped in the event a tsunami is on the way. Creating an emergency procedure to have Marina staff cap the storage tank prior to the first wave’s arrival could mitigate the potential spill of hundreds of gallons of used oil which could compound existing debris and spill clean-up.

Third, the Westport Marina TMRMS provides protective guidance recommendations for boaters based on Westport Marina’s location along Washington’s outer coast and the kind of tsunami dangers vessel operators might encounter. These recommendations include actionable steps people on every level can take to save lives and minimize the impacts of tsunamis on the Marina and its boaters. A separate brochure geared toward Washington’s maritime community was also created as part of this effort; WA EMD plans to distribute the guidance to charter boat captains, commercial fishermen, local U.S. Coast Guard, and others in the maritime community to promote tsunami preparedness.

WA EMD worked closely with officials from Westport Marina, the City of Westport, and other key subject matter experts to create this tailored strategy. “The Westport Marina Tsunami Maritime Response and Mitigation Strategy is an integral part of the overall resilience planning for the South Beach,” said Westport Public Works Director Kevin Goodrich. “The City of Westport and the Port of Grays Harbor provide services and infrastructure to a broad group of shared users, so having a cohesive Tsunami Mitigation Strategy is crucial. This includes building resilience into facilities and partnering on projects like the City’s proposed Tsunami Vertical Evacuation Structure in the Marina district.”

This is the second maritime strategy developed for the state of Washington. In 2021, the state developed a similar strategy for the Port of Bellingham thanks to funds from the NTHMP FY19 grant cycle. A new strategy is now being developed for the Guemes Channel/Anacortes area with funding from the NTHMP FY21 grant cycle. For more information about these and future strategies, please contact Danté.DiSabatino@mil.wa.gov.

Mitigation Actions	Feasibility for Westport Marina
Install Tsunami Signs	Yes
Increase Size and Stability of Dock Piles/Increase Height of Piles to Prevent Overtopping	Yes
Reduce Exposure of Petroleum/Chemical Facilities and Storage	Yes
Strengthen Cleats and Single Point Moorings	Needs Review
Improve Movement of Dock Along Dock/Pillings	Needs Review
Acquire Equipment/Assets to Assist in Response Activities	Needs Review
Improve Floatation Portions of Docks	Needs Review
Fortify and Armor Breakwaters	Not Feasible
Deepen or Dredge Channels Near High Hazard Zones	Not Feasible
Move Docks and Assets Away from High Hazard Zones	Not Feasible
Widen Size of Harbor Entrance to Prevent Jetting	Not Feasible
Construct Floodgates	Not Feasible
Construct Breakwaters Farther Away from the Marina	Not Feasible
Increase Flexibility of Interconnected Docks	Not Feasible
Debris Deflection Booms to Protect Docks	Not Feasible

Figure 2: A table showing potential tsunami mitigation actions for Westport Marina ranked by feasibility.

TSUNAMI PREPAREDNESS

Preparing the Public for Geologic Hazards Via Outreach Events

By Alex Dolcimascolo, Washington Geological Survey



Alex Dolcimascolo (Washington Geological Survey) sharing geologic hazard preparedness information outreach materials at the Grays Harbor Emergency Preparedness Expo in Aberdeen, Washington.

The Tsunami Teams at the Washington Geological Survey and Washington Emergency Management Division have been keeping busy with public outreach. Over the course of the last few months, they have reached several key regions of the state susceptible to tsunami risk by attending numerous public events. These include the Grays Harbor County Emergency Preparedness Expo in southwest Washington, the City of Edmonds Emergency Preparedness Expo in the Puget Lowland, the Ready Navy Event in Bangor on the Olympic Peninsula, and the Tsunami Maritime Preparedness event held at the Port of Bellingham. At each of these family-friendly events, attendees of all ages received vital information about tsunamis and other geologic hazards through various outreach materials such as handouts, pamphlets, activity books, and more. These materials outlined go-bag

preparations, the natural warning signs of a tsunami, and other survival strategies like knowing where and how to evacuate. During these events people were very receptive and showed great enthusiasm when learning about tsunamis no matter their prior knowledge level.

Since January 2022, the Tsunami Teams have:

- Reached over 13,000 people through presentations, in-person events, and other forms of outreach
- Reached over 1.5 million people through the ShakeOut Reddit AMA
- Reached over 1 million people during the 1/15 Tonga tsunami advisory
- Conducted over 82 outreach events, presentations, media interviews, workgroup meetings, and other forms of stakeholder support
- Presented at 16 notable annual meetings, conferences, workshops, and other major venues



Disaster preparedness outreach materials provided by Washington Emergency Management Division.

Both the Washington Geological Survey and Washington Emergency Management Division appreciate all the planning done at the local level to make these events successful and we are looking forward to continuing these efforts for years to come.

TSUNAMI PREPAREDNESS

Fleet Week San Diego

By Matt Palmer, California Office of Emergency Services,
and Mark Benthien, University of Southern California

The California Office of Emergency Services (Cal OES) Tsunami Program had the privilege of participating in the 2022 San Diego Fleet Week, November 3-6, 2022. The Cal OES Tsunami Program staffed an outreach booth to educate Fleet Week participants about the tsunami hazard and tsunami preparedness. This year's fleet week included an Innovation Zone. The Innovation Zone hosted "Student Stem Days," which allowed participating organizations to showcase interactive displays to local and regional students. Students could get an upfront view of new and emerging technologies and STEM education programs. Cal OES brought along our "Quake Cottage" to provide an educational experience of what it is like to go through a significant earthquake. The earthquake experience was used to initiate conversation regarding local source tsunamis and appropriate response for these tsunami events.



In partnership with Cal OES, the University of Southern California, Southern California Earthquake Center (SCEC) staffed an adjacent booth at Fleet Week San Diego and hosted an activity for World Tsunami Awareness Day (WTAD). A highlight for WTAD that we used to get patrons to engage with us was a recently updated map of the San



Diego County tsunami hazard areas printed on poster board. We provided pins so attendees could insert them on the map where they lived to learn whether they were "in the zone." As the areas are very thin along most of the coast, few attendees lived within inundation zones. Ironically our booth locations, at the end of Broadway Pier in San Diego Harbor, were well within the zone and about a 12-minute walk to reach high ground.

Messaging at the booths included discussion of understanding natural vs. official warnings and encouraging participation in California's Tsunami Preparedness Week scheduled for March 27-31,

2023. SCEC also provided some important earthquake safety information to stress the importance of securing items, so they cannot fall and cause damage or injury so that people can safely evacuate the area if a tsunami is expected.

TSUNAMI RESEARCH & EVENTS

RESEARCH

TITLE: CARIBE WAVE: A Decade of Exercises for Validating Tsunami Preparedness in the Caribbean and Adjacent Regions

CITATION: Soto, Stephanie; von Hillebrandt-Andrade, Christa; Vanacore, E. A.; Chacón-Barrantes, Silvia; Brome, Alison, 2022, CARIBE WAVE: A Decade of Exercises for Validating Tsunami Preparedness in the Caribbean and Adjacent Regions: Bulletin of the Seismological Society of America, <https://doi.org/10.1785/0120220095>.

ABSTRACT: The year 2021 marked a decade of CARIBE WAVE (CW) exercises organized by the United Nations Educational, Scientific and Cultural Organization Intergovernmental Oceanographic Commission Coordination Group for Tsunamis and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG CARIBE/EWS). This region has had a long history of devastating tsunamis, and over the years the risk to lives and livelihoods of coastal communities has continued to increase. The tsunami threat in the Caribbean provides a strong incentive for countries to prepare and participate in annual tsunami exercises. The CW exercise is carried out with the purpose of validating and advancing tsunami resilient communities in the region. As a result of these exercises, countries have been able to test and improve communications between the Tsunami Service Provider and their National Tsunami Warning Centers (NTWC) and Tsunami Warning Focal Points (TWFP), as well as practice their emergency response plans. Participation of the public (including mass media communications, social media engagements, tsunami walks, etc.) and regional government beyond TWFP and NTWC has played a critical role in developing tsunami awareness in the greater community. This study collates the history and background of exercises since 2011, resulting in enhancing tsunami preparedness and awareness. Ongoing CW exercises should continue and be strengthened so that the region is prepared as possible to respond and recover when the next tsunami strikes the shores of the Caribbean and Adjacent Regions.



UPCOMING NTHMP & RELATED EVENTS

- ◆ January 23-27, 2023—NTHMP Winter Meeting (Palm Springs, California)
<https://nws.weather.gov/nthmp/index.html>
- ◆ March 23, 2023—CARIBE WAVE 23 Tsunami Exercise
<https://www.weather.gov/itic-car/caribewave23>
- ◆ April 17-20, 2023—Seismological Society of America Meeting (San Juan, Puerto Rico)
<https://meetings.seismosoc.org/>
- ◆ July 11-20, 2023—IUGG General Assembly/Joint Tsunami Commission Meeting and Session (Berlin, Germany) <https://www.iugg2023berlin.org/>

