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CARIBE WAVE 20 Exercise

By Stephanie Soto and Christa von Hillebrandt-Andrade, NOAA CTWP and Elizabeth A. Vanacore, CARIBE WAVE Task Team Chair, PRSN

The annual tsunami exercise for the Caribbean and Adjacent Regions, CARIBE WAVE, has been improving and validating tsunami readiness since 2011. The 2020 exercise took place on March 19, 2020 under very different circumstances than previous years. After months of regional and national preparation and planning, given the COVID-19 pandemic, the UNESCO IOC Intergovernmental Coordination Group for Tsunami and Other Coastal Hazards for the Caribbean and Adjacent Regions (ICG/CARIBE EWS) agreed to only test the communication lines at a regional level. It was left up to the Member States and Territories to decide if any additional activity would be carried out and whether to use the simulated messages for one of two tsunami scenarios: Jamaica and Portugal.



Figure 1. The Barbados Department of Emergency Management participating in the CARIBE WAVE 20 exercise.

Despite the sudden change in scope of the exercise, CARIBE WAVE 20 was held successfully. The Regional Tsunami Service Provider, the Pacific Tsunami Warning Center, issued a “Dummy” message at 14h00 UTC to all officially designated Tsunami Warning Focal Points and National Tsunami Warning Centers. Many methods of communication were used to disseminate the message: the World Meteorological Organization Warning Information System (Global Telecommunication Systems), the Aeronautical Information Replacement System, NOAA Weather Wire, AWIPS, fax, email and social media. According to feedback as well as social media and web posts, the dummy message was successfully received, validating the communication platforms.



Figure 2. Staff of the Puerto Rico Seismic Network participating in the CARIBE WAVE 20 exercise.

Given the earthquake activity in Puerto Rico as well as the M 7.8 earthquake off Jamaica and Cuba in January 2020, the expectation was that CARIBE WAVE 20 would surpass the 800,000 participants from 2019. The Tsunami-zone.org web page, which provides resources for tsunami preparedness, is used also as the official registration site for the CARIBE WAVE exercises. Weeks leading up to the exercise,

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TsuInfo Alert

Prepared and published bimonthly by the Washington State Department of Natural Resources, Washington Geological Survey, on behalf of the National Tsunami Hazard Mitigation Program (NTHMP), a state/federal partnership led by the National Oceanic and Atmospheric Administration (NOAA).

This publication is free upon request and is available in print by mail and online at:

<http://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/tsunamis/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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CARIBE WAVE 20 Exercise

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and Elizabeth A. Vanacore, CARIBE WAVE Task Team Chair, PRSN

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over 100,000 had already registered. Nevertheless, due to the COVID-19 emergency, the number of actual participants was probably much less than the registered number.

The NOAA Caribbean Tsunami Warning Program (CTWP), which coordinated the exercise on behalf of CARIBE EWS, used virtual meeting tools to monitor CARIBE WAVE 20, including the availability of sea level data. If a tsunami had indeed occurred on this day, 33 of the 45 regional sea level stations that would have been expected to record the tsunami were operational. CTWP will be gathering and processing feedback from the participating Countries and territories, including Puerto Rico and the US Virgin Islands, through an online questionnaire. For more information on the exercise, the Jamaica and Portugal scenarios, and reports, please visit <https://caribewave.info>.

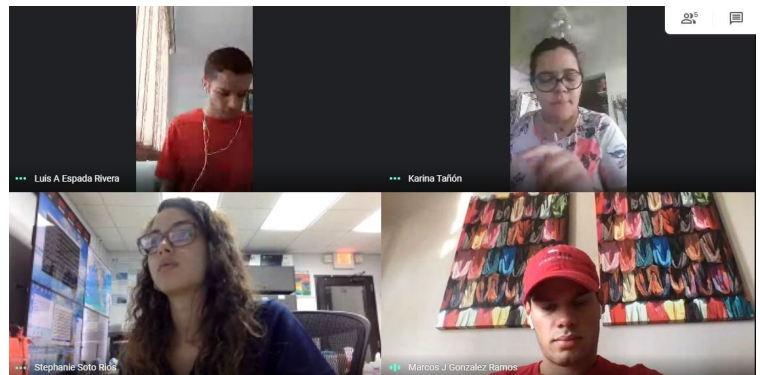



Figure 3. Screen shot of Virtual Meeting of the CTWP for CARIBE WAVE 20

TSUNAMI PREPAREDNESS

Washington Kicks Off First Virtual Tsunami Roadshow

By Elyssa Tappero, Washington Emergency Management Division

Officials from Washington Emergency Management Division (WA EMD), Washington Geological Survey (WGS), National Weather Service Seattle (NWS), and Washington Sea Grant, took to the web this month to provide a virtual Tsunami Roadshow. While the originally planned Inner Coast Tsunami Roadshow had to be cancelled due to the ongoing coronavirus pandemic, this provided a unique opportunity for the team to reach people across the entire state while still observing social distancing. With emergency preparedness at the forefront of everyone's minds, a webinar was also the perfect way to highlight the important work being done to mitigate and prepare for one of Washington's greatest hazards. Over 165 people took part in the webinar, many of whom expressed appreciation for the accessibility of the presentation and hope that similar ones will be held in future years.

The interdisciplinary Roadshow team included the following speakers 

The presentation covered tsunami history and science, local tsunami hazards, natural and official alerts (including efforts to fund and install WA's final All Hazards Alert Broadcast sirens), and personal preparedness. New for this year's Roadshow was an emphasis on the tsunami hazards faced by Washington's inner coast. The state's inner waterways, including the Strait of Juan de Fuca and the Puget Sound, have unique tsunami hazards that up until the last few years have not been well understood. New modeling and mapping, including tsunami wave and current velocity simulations by WGS, reveal tsunami threats from both the offshore Cascadia subduction zone and local crustal faults such as the Seattle and Tacoma Faults. With millions of residents in inner coastal communities and a thriving maritime economy, disseminating this information is vital to increasing Washington's tsunami mitigation, response, and resiliency.

The presentation closed with a reminder to register for the Great Washington ShakeOut, which is on 10/15/2020 and an announcement for the 2021 release of Washington's earthquake early warning app. Audience members then filled out a brief survey inquiring about additional preparedness activities they could complete after hearing from Roadshow experts including purchasing NOAA Weather radios, walking evacuation routes, sharing hazard information with loved ones, visiting online resources, and creating/adding items to preparedness kits. Participants also submitted over 40

Tsunami Roadshow Webinar

Carrie Garrison-Laney – Washington Sea Grant
Corina Allen – Washington Geological Survey
Maximilian Dixon – Washington Emergency Management Division
Samantha Borth – National Weather Service
Jacob Witcraft – Washington Emergency Management Division
Elyssa Tappero – Washington Emergency Management Division



You CAN survive IF you get prepared!

Resources

Washington State Emergency Management Division
mil.wa.gov/preparedness
mil.wa.gov/tsunami

Washington State Department of Natural Resources
Geologyportal.dnr.wa.gov
www.dnr.wa.gov/tsunami

National Oceanic and Atmospheric Administration
www.tsunami.gov
For SMS: Send text message to 40404 with
"Follow NWS_NTWC" as the message

United States Geological Survey
earthquake.usgs.gov/ens/register



questions to the chat box throughout the presentation which were answered at the end. These ranged from the general ("What should I put in a go-kit?") to the specific ("How are you calculating the chance of a Cascadia subduction zone event within the next 50 years?") and covered topics like tsunami alerting and sirens, local hazards, vertical evacuation structures, and what people can do to help in their own communities.

While virtual presentations have their unique challenges, the interest and active participation in this webinar shows they are a great avenue for connecting with stakeholders when in-person events aren't an option. This presentation will also be uploaded to WA EMD's YouTube page (@EMDPrepare) so it can continue to be a resource in the future.

TSUNAMI MODELING

Tsunami Inundation Forecast Models for Tacoma and Bellingham of Washington

By Vasily Titov, Christopher Moore and Diego Arcas, NOAA Pacific Marine Environmental Laboratory

The main tsunami hazard for Washington State coasts originates from a potential earthquake at the Cascadia subduction zone, which is stretched along the U.S. Pacific coasts offshore Washington, Oregon and Northern California. The main impact during such a tsunami would be the ocean-side communities on the open coast. Washington State's main population centers are located along coasts of Puget Sound, a long narrow inlet over 100 miles away from open coast and from potential Cascadia earthquake. Recent tsunami mapping and tsunami hazard modeling efforts of the National Tsunami Hazard Mitigation Program (NTHMP) demonstrated that the Cascadia tsunami impact could be significant even for the coasts deep inside Puget Sound. Considering high population and additional hazard from local faults with tsunamigenic potential (although uncertain probabilities of occurrence), the tsunami risk for Puget Sound coastal communities is realized to be relatively high. Consequently, a decision of the NWS Tsunami Research Advisory Council at the request of WA State Emergency Management Division was to develop real-time tsunami inundation forecast capabilities for high-risk coastal communities inside Puget Sound. Tacoma and Bellingham were chosen as priority communities (Figure 1) after considering analysis of Washington State research and NOAA Tsunami Warning Centers (TWCs) practices.



Figure 1. Locations of Bellingham and Tacoma forecast models. Inundation model computational domains are shown as red rectangles.

The National Oceanic and Atmospheric Administration (NOAA) Center for Tsunami Research (NCTR) at NOAA's Pacific Marine Environmental Laboratory (PMEL) has developed a tsunami forecasting system for operational use by NOAA's two Tsunami Warning Centers located in Hawaii and Alaska (Titov et al., 2005; Titov, 2009). The forecast system combines real-time deep-ocean tsunami measurements from Deep-ocean Assessment and Reporting of Tsunami (DART or tsunameter) stations (González et al., 2005; Meinig et al., 2005; Bernard et al., 2006) with the Method of Splitting Tsunami (MOST) model, a suite of finite-difference numerical codes based on the nonlinear shallow water wave equations (Titov and Synolakis, 1998; Titov and González, 1997; Titov et al., 2016) to produce real-time forecasts of tsunami arrival time, heights, period and inundation.

To achieve accurate and detailed forecast of tsunami impact for specific sites, high-resolution tsunami forecast models have been developed for United States coastal communities at risk (Tang et al., 2008, 2009, 2012; Wei et al., 2013; Bernard and Titov, 2015; Titov, 2016). The fidelity of these models has to be high enough to resolve the dynamics of a tsunami inside a particular harbor, including influences of major harbor structures such as breakwaters. These models have been integrated as crucial components into the NOAA's Short-term Inundation Forecast for Tsunami (SIFT) system. SIFT was integrated into TWCs operations in 2012, including 75 high-resolution inundation forecast models for most vulnerable U.S. coastal communities. The number of high-resolution models has been steadily increasing since 2012 to improve the accuracy of the tsunami forecast for more coastal locations.

NCTR is an integral part of the NOAA Tsunami Program and is involved in several tsunami hazard mitigation and risk reduction research programs. Besides the real-time forecast development for NOAA warning operations, NCTR also

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TSUNAMI MODELING

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participates in the tsunami risk assessment for State, Federal and NTHMP partners. These two efforts often provide opportunities for optimizing modeling developments. For example, the bathymetry and models developed for the tsunami hazard assessment mapping can be used for developing optimized forecast models, which substantially decrease forecast models' development time. This was the case for the Tacoma and Bellingham tsunami forecast development. NCTR, in collaboration with WA Department of Natural Resources (DNR) and WA Emergency Management Division (EMD), have previously developed tsunami inundation maps for Tacoma and Bellingham. The models and the bathymetry data used for that development provided the opportunity for faster development of the tsunami real-time forecast capabilities for these major population centers within the impact zone of potential Cascadia tsunami. While the tsunami wave amplitudes at Tacoma and Bellingham are expected to be lower in comparison with the outer coast communities during the Cascadia tsunami, the population density and potential local tsunamigenic faults within Puget Sound make these communities of high tsunami risk.

The forecast model for a coastal community is developed for implementation into SIFT component of the NOAA's TWCs forecast operations. The forecast models have to satisfy stringent operational requirement for accuracy, speed, robustness and compatibility with TWCs operations. NCTR has been developing inundation forecast models for SIFT as part of TWC's modernization efforts after 2004 Indian Ocean tsunami.

The development of the Tacoma and Bellingham models included extensive testing with available historical tsunami data for accuracy and robustness tests with a number of hypothetical large and small tsunamis to ensure stable model performance during real-time operations. Figure 2 shows results of robustness test for both models based on hypothetical tsunami scenario originated from the Cascadia subduction zone. Snapshots of amplitudes three hours after generation are shown for both locations. Tacoma amplitudes may reach above five meters for this scenario, while Bellingham shows above four meters of amplitudes.

Each model has been tested with data from more than 10 previous tsunamis recorded at tide gauges. Tacoma has the tide gauge at Pier 7 that recorded several tsunamis. Bellingham does not have operational tide gauge, however the gauge at Cherry Point, 22 km away from the port of Bellingham, has records of several tsunamis and was used to test

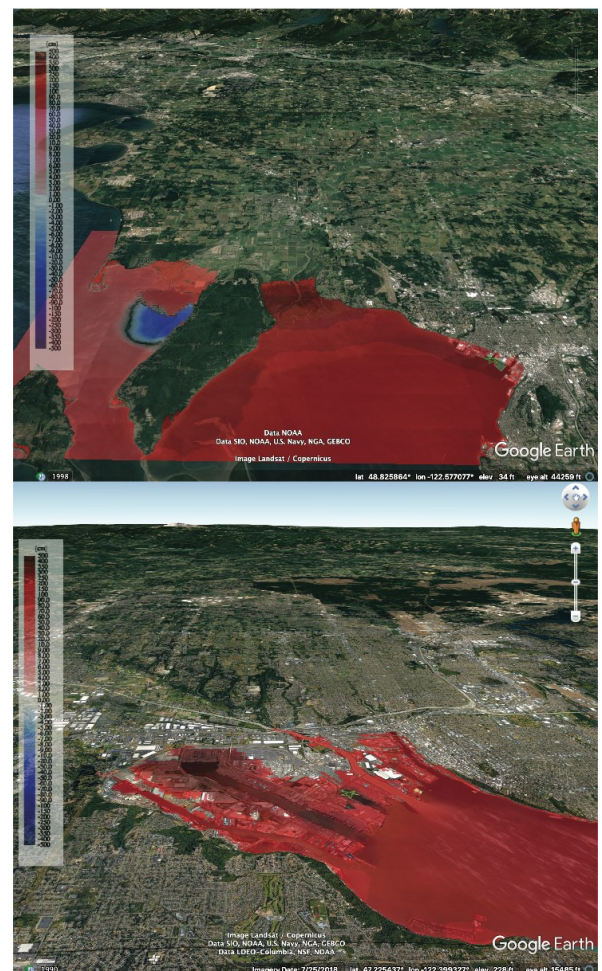


Figure 2. Tsunami test scenario for Bellingham (upper panel) and Tacoma (lower panel) forecast models. Tsunami amplitudes and inundation are shown for the same M9.0 scenario of the Cascadia tsunami 3 hours after tsunami generation.

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TSUNAMI MODELING

Tsunami Inundation Forecast Models for Tacoma and Bellingham of Washington

By Vasily Titov, Christopher Moore and Diego Arcas, NOAA Pacific Marine Environmental Laboratory

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accuracy of the Bellingham model. All tsunamis recorded at those gauges are small, nevertheless these records are the key to ensure the accuracy of the overall forecast capability for these locations. Instrumental recordings for even small tsunamis provide the necessary data to compare model performance with observations. Both models have been optimized to run in real time to provide results within seconds using TWCs computational capabilities.

Tacoma and Bellingham models have been developed, have gone through testing and are now being implemented into SIFT operations of the TWCs.

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TSUNAMI PREPAREDNESS

UNESCO Caribbean Tsunami Ready Youth Art Competition

By Sadie-Ann Sisnett, UNESCO-IOC Caribbean Tsunami Information Centre

Background: The competition was organized as a key output of the UNESCO-IOC project entitled “Strengthening Capacities of Early Warning and Response for Tsunamis and Other Coastal Hazards in the Caribbean” Project, sponsored by European Commission Humanitarian Aid department’s Disaster Preparedness Programme (DIPECHO). The contest targeted participants from the five Project Participating Countries; Antigua and Barbuda, Barbados, Dominican Republic, St. Vincent and the Grenadines, and Trinidad and Tobago.

Objective: The visual art competition encouraged students to explore and better understand their natural surroundings through artistic expression. It was geared towards creating and raising awareness of the tsunami hazard and promoting an improved understanding of geologic phenomena and emergency response systems in Antigua and Barbuda, Barbados, Dominican Republic, St. Vincent and the Grenadines, and Trinidad and Tobago and as an activity contributing to the recognition of World Tsunami Awareness Day 2019.

The competition targeted art students between 14 – 16 years of age in each of the project countries and the aim was to select the top three art pieces to receive prizes. The prizes were to be presented in each country, to the students at the joint ceremony for the recognition of the Tsunami Ready community and the art competition awards. However, due to travel and gathering restrictions in light of COVID-19, this ceremony has been postponed and will be virtual, when implemented.

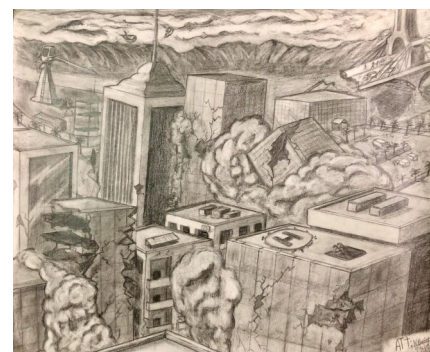
Results: It was found that the competition elicited a small to moderate response from students in the countries and the 1st place results are as follows:



Antigua and Barbuda – Miss Sapphire Percival of Sir Novelle Richards Academy



Barbados – Miss Kya Knight of Deighton Griffith Secondary School



Dominican Republic – Mr. Neury Henriquez of Rommel Cruz de León Polytechnic



St. Vincent and the Grenadines – Miss Jirahmae Kennedy of St. Vincent Girls' High School



Trinidad and Tobago – Miss Kirsten Skinner of Providence Girls' RC School

NTHMP EVENTS

10-Year Retrospective: Tsunami Preparedness in the Pacific

By Rocky Lopes, previous NTHMP Administrator

The Pacific NTHMP partners of Hawaii, Guam, and American Samoa served on a panel during a workshop at the 2020 PRiMO (Pacific Risk Management O'Hana) Conference in Honolulu on March 12, 2020.

The workshop was facilitated by Dr. Rocky Lopes who served from 2009 to 2019 in the National Weather Service Tsunami Program and had the national perspective, especially from Federal Tsunami grant deliverables, on how far the Pacific U.S. islands have progressed with regard to tsunami modeling, mapping, preparedness, education & outreach, and warning coordination.

Dr. Yoshiki Yamazaki of the University of Hawaii led off by describing tsunami modeling and mapping work done under the creative and professional supervision of Dr. Kwok Fai Cheung, Professor in the School of Ocean and Earth Science and Technology. Dr. Cheung's lab was funded by NOAA/NWS Tsunami Grants to run tsunami models that indicate the potential for tsunami inundation for coastlines of Hawaii, American Samoa,



PRiMO presenters left to right -- Rocky Lopes, Lisa Tuatoo, Yoshiki Yamazaki.

Commonwealth of Northern Mariana Islands (CNMI), and Guam. Using results from these models, Dr. Cheung, Dr. Yamazaki, and graduate students worked with state and territory partners to develop tsunami inundation maps, which are critical for public outreach and education, as well as to inform elected leaders on appropriate planning and tsunami mitigation efforts. Ongoing tsunami modeling work is being applied to estimate tsunami currents in major U.S. harbors, including Pearl Harbor, Pago Pago (American Samoa), Apra (Guam), and Saipan (CNMI).

Lisa Tuatoo, Deputy Director, American Samoa Dept. of Homeland Security, described how American Samoa has progressed since the devastating tsunami of September 29, 2009, that is reported to have caused 22 deaths on the island. American Samoa developed and installed a warning system, including numerous outdoor sirens. Maintaining these sirens has been challenging, but using results from a System Health Audit, funded by NOAA/NWS Tsunami Grants, helped pinpoint priorities for maintenance and replacement needs.

Further, American Samoa uses grant-funded inundation maps created by the University of Hawaii for ongoing outreach and education throughout the territory's islands. Additionally, American Samoa conducted table-top and functional exercises, and in cooperation with the Federal Emergency Management Agency, conducted a full-scale multi-agency exercise in September 2019. Results of that exercise are being applied for further improvements and response capacity-building.

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NTHMP EVENTS

10-Year Retrospective: Tsunami Preparedness in the Pacific

By Rocky Lopes, previous NTHMP Administrator

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Mr. Michael Taijeron, Hazard Mitigation Grants Coordinator for Guam, presented an overview of 10 years of tsunami capacity building on the island. During the past decade, Guam has printed tsunami evacuation maps and other tsunami outreach materials for use in public education efforts for residents, military, and visitors; conducted activities that increased preparedness and response capabilities of all Guam agencies, non-governmental organizations, federal partners, and other key players whose services may directly affect adequate response to a tsunami event. Further, Guam applied grant funding to expand and improve the tsunami warning notification and public information infrastructure, as well as installed and maintained tsunami evacuation route signage throughout the island.

Through collaborative efforts of NTHMP partners, applying over \$14M in grant funding from NOAA Tsunami Activities Grants*, led to significant and life-saving progress for tsunami modeling, mapping, and preparedness on all U.S. Pacific islands. We should all be proud of these collective accomplishments.

*Source: <https://nws.weather.gov/nthmp/grants/index.html> (as of October 8, 2019)

Washington Kicks Off First Maritime Response and Mitigation Strategy Project

By Elyssa Tappero, Washington Emergency Management Division

Like those in most coastal states, Washington's coasts are home to a wide variety of vital structures and entities including the Ports of Tacoma and Seattle (the 4th largest container gateway in the US), seven US Coast Guard stations, four Navy bases, the largest ferry system in the country, and over \$37 billion in economic income. These 3,000+ miles of coastline also face tsunami hazards which require unique and location-specific mitigation efforts. The state's inner waterways, including the Strait of Juan de Fuca, the Strait of Georgia, and the Puget Sound, have complex tsunami hazards that up until the last few years have not been well understood. New modeling and mapping, including tsunami wave and current velocity simulations by the Washington Geological Survey, NOAA's Pacific Marine Environmental Lab, and the University of Washington, reveal tsunami threats from both the offshore Cascadia subduction zone and local crustal faults such as the Seattle and Tacoma Faults. The bathymetry of the inner coast heightens secondary maritime hazards such as strong, unpredictable currents, sudden water-level fluctuations, eddies and whirlpools, bores, and amplified waves. With millions of residents in inner coastal communities and a thriving maritime economy, providing education about these hazards is vital to increasing Washington's efforts to improve tsunami mitigation, response, and resiliency.



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TSUNAMI PREPAREDNESS

Washington Kicks Off First Maritime Response and Mitigation Strategy Project

By Elyssa Tappero, Washington Emergency Management Division

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Thanks to a FY19 NOAA NWS grant, which funded an additional Tsunami Program Coordinator for the Washington Emergency Management Division (WA EMD), more time and effort can now be dedicated to addressing inner coast and maritime tsunami hazards in the state. This includes the creation of the first Tsunami Maritime Response and Mitigation Strategy (TMRMS), a two-part document which will provide both basic maritime guidance and more targeted information based on site-specific modeling. While the first part of the strategy will focus on general maritime tsunami hazard guidance applicable to most of those in the maritime community, the second half of the TMRMS is tailored to a



port's individual challenges and needs. For this pilot project the team has chosen the Port of Bellingham and all associated port properties located on the shores of Bellingham Bay (shipping terminals, two harbors, commercial and retail facilities, and the Fairhaven cruise terminal). Stakeholders for the project include Whatcom County, the Port of Bellingham and other port-area businesses, the US Coast Guard, the Alaska Marine Highway, PSE's Encogen Generating Station, BNSF Railway, local tourism entities, and commercial, private, and recreational boat owners. These stakeholders are joined at the table by subject matter experts from Washington Geological Survey, Washington Sea Grant, and Washington Department of Transportation.

Similar documents for general maritime guidance have been created by California, Alaska, and Oregon using standardized components from NTHMP. Washington's TMRMS expands on this important work by focusing down on port/harbor-scale decision making and guidance for water-based response and mitigation strategies. The new document will also include additional sections requested by local stakeholders such as visual representations of mitigation measures specific to the location (changes needed to pilings, strengthening of moorings, etc.); a section on tsunami alerting (how to receive alerts, what they mean, and how to respond); a Roles and Responsibilities section covering the state, county, city, port, US Coast Guard, and vessel owners; and Evacuation from Water maps showing water depth, locations of hotspots for strong currents, travel time to shore, and locations where vessels can gain access to land for evacuation. An appendix will provide additional port-specific information such as port data, response checklists, and inspection forms as appropriate.

WA EMD hopes continued funding in future years will allow other major Washington ports, ferry terminals, and marinas to receive the same focused treatment. The document will also provide guidance for jurisdictions who want to fund a project like this on their own. The cross-disciplinary collaboration the project has generated so far promises to deliver an end product that, when combined with interested and involved emergency management and port officials, will play a vital role in better preparing the maritime sector for the next tsunami.

NTHMP UPDATES

A Day in the Life of a Tsunami Forecaster

By Brian Nieuwenhuis, NOAA

It is 3 AM on a cool, mid-winter night in Medford, Oregon. Though most people are asleep, two sleepy National Weather Service forecasters are on duty, just finishing up the daily early morning forecast package. Suddenly, computer screens begin flashing and a shrill alarm pierces the early morning tranquility! The forecasters' drowsy eyes jerk wide open in sudden full awareness as crucial information streams into view on their glowing screens. The words appearing in near real-time tell them that a large earthquake has struck just offshore of Alaska, and even more importantly for their area of responsibility, a tsunami may be on the way! The forecasters, more awake now than if they had gulped down a full pot of coffee, immediately jump to action.

Within seconds of that first alarm, a voice comes over the National Warning System lines from the National Tsunami Warning Center (NTWC), confirming that a Tsunami Watch has been issued for the Oregon coast. With a knowing nod to each other, the forecasters push just a few keys, give a quick read-through of the resulting text, then transmit the Watch to the communities, the media, and all responding agencies along the coast. It has been less than a minute since the first alarm sounded on the computers, and less than two minutes since the earthquake occurred. It won't be long until the residents of the coast are awakened and alerted by alarms from sirens, cell phones, and radios.



The Tsunami Watch is out, but the job is far from done. The office phones begin ringing, and there is a conference call scheduled soon with the warning center, the states, and all of the affected NWS forecast offices. Data is still streaming into the system, and this information, including arrival times and possible wave heights, must be passed on to responders and others that lie in the path of the possible tsunami. The forecasters make a call to bring in additional staff, then set to work calling emergency managers and law enforcement, issuing relevant statements, updating the local website, and posting information to social media outlets.

Soon thereafter, the conference call begins, with discussion ranging from offshore tsunami buoys and coastal sea level measurements, to model runs and possible wave arrival times and heights. According to the data, it appears a small tsunami will sweep south along the Pacific coast, reaching Oregon roughly 4 hours after the initial earthquake. The NTWC upgrades the Watch to an Advisory, and the forecasters quickly step up their efforts, calling responders and communities along the coast with updates, and updating the previous products, websites, and social media posts; all in an effort to get the message out to as many affected people as possible before the wave arrives.

For the next several hours, the NWS forecast office will contact and support state, county, and city agencies and responders along the affected coastline, working to prevent loss of life and mitigate property and infrastructure damage until the waves recede, the currents calm, and the event is over.

This scenario is fictional, but something very like it could happen in any coastal National Weather Service office from Guam to Maine and Alaska to Puerto Rico. Forecasters and staff in these offices, manned 24/7, train and conduct simulations regularly so that they are prepared when the next tsunami strikes. They also routinely meet with the agencies and officials responsible for making the important decisions that save lives and mitigate damage. Doing so keeps the lines of communication open and builds the trust and partnership necessary to effectively and efficiently respond to the next tsunami. With these efforts and preparations, communities can be rest assured that their local weather service office has the knowledge and tools necessary to fully support them when the unthinkable happens.

NTHMP UPDATES

Tsunami Program Teleworking – Example from California

By Rick Wilson, California Geological Survey Tsunami Unit Manager

Like many State and Federal government agencies in the U.S. and organizations around the world, the California Geological Survey (CGS) Tsunami Unit has been teleworking since early March to not only help “flatten the curve” on the COVID-19 pandemic but also continue to “flatten the wave” on impacts from future tsunamis. Admittedly, the transition from the office to telework was not easy but our Unit has been able to stay in touch and keep a professional, yet jovial attitude as demonstrated by “screen captures” of staffs’ formal and informal dress code during internal online meetings.

The CGS Tsunami Unit has been able to maintain vital collaborations with partners as well as continue GIS and mapping work through online meetings and remote login to office work computers. The Unit has held online meetings with partners at the California Governor’s Office of Emergency Services, the University of Southern California, the California Coastal Commission, the California State Lands Commission, and the USGS Powell Center Work Group on tsunami source characterization. The following are some of the ongoing and new activities of the CGS Tsunami Unit being performed through telework:

- ◆ Implementing response protocols during the March 24, 2020 Kuril Island tsunami event. (Ironically, this was the day before California had planned to hold its annual tsunami response communications test that was cancelled because of the COVID-19 emergency.)
- ◆ Updating our 2009 tsunami inundation and evacuation maps for communities statewide.
- ◆ Continuing multi-hazard coastal analyses for mitigation reports to help protect harbor docks and infrastructure.
- ◆ Creating new guidance for tsunami debris and sediment analysis and recovery planning.
- ◆ Developing maps and guidance for the California Building Code and Seismic Hazard Mapping Act.

On a personal note, members of the CGS Tsunami Unit send out well wishes to all our colleagues and constituents during this trying time. We look forward to continuing meetings and collaborations “in person” at some point in the near future...when it is safer to meet.



CGS Tsunami Unit online Bluejeans meeting on March 25, 2020; note the surprise “formal” dress code.



CGS Tsunami Unit online Bluejeans meeting on April 8, 2020; note the surprise “informal” dress code.

Remembering Paula Kay Dunbar

By Kelly Stroker and Nic Arcos, NOAA National Centers for Environmental Information

On Thursday, April 23, 2020, the Tsunami community lost a true treasure in the passing of Paula Kay Dunbar. If you met Paula, you had the privilege to meet someone who was kind, generous and genuinely funny. Her professional legacy is certainly with her nearly 30 years at NOAA/NCEI as the lead on the global tsunami historical database. The passion, knowledge, and relentless pursuit of perfecting the database was only outmatched by her quick wit. Paula enjoyed experiencing the evolution of tsunami science, and often commented, with a grin on her face, how she'd have to change the database again (and again) to accommodate new datasets. Those that have used the database know that she took every piece of advice carefully and seriously.



Paula received a B.A. in Geography from the University of Colorado and a M.S. in Earth Sciences from Colorado State University. She carried out nearly 40 years U.S. Government service (including the NOAA/Space Weather Prediction Center and for the USGS/National Earthquake Information Center) with a few breaks in between. She even tried her hand in sales at one point, selling Mary Kay products (we all joked she just wanted that pink Cadillac), but that was obviously not what she was meant to do. Throughout her different career stages, Paula always loved being in Colorado and could often be found on a hiking trail or with a group on a snowshoe adventure. Although the last years of her life she wasn't able to explore the trails of Colorado as she once had, she often reminisced about her walks in the mountains.

The NCEI Database was the first tsunami database to become digital and when Paula joined in 1991, she undertook the enormous task of digitizing and verifying data from all available tsunami catalogs. If you ever wandered the halls of NCEI, you could find Paula in the room with all the books and if you didn't know where that was, you could just follow the laughter. Even in the digital age, Paula kept a remarkable number of books as references so that she could easily compare their data. She also had a way of stumping the NOAA librarian, often requesting books from the Interlibrary Loan that no one could find and they would work together to get just the right one.

Paula was part of the U.S. delegation for ICG/CARIBE EWS and ICG/PTWS and served as the IUGG Georisk Commission Secretary and Treasurer. She always remarked how lucky she was to explore the places she read about, though, she often lamented leaving her beloved dog. Her pioneering use of database and web technologies together with her comprehensive quality-control has made the database the most frequently cited source of historical tsunami information. Paula also authored numerous peer-reviewed articles as she recognized the need to make people aware of the data available to them through the database. NOAA recognized her efforts by awarding her the Department of Commerce Bronze Medal in 2007 and the Silver Medal in 2008 for her data work on the 2004 Indian Ocean tsunami. When she retired in 2017, she continued to provide expert advice on the database as University of Colorado staff, as she said there are things she wanted to finish.

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NTHMP NEWS & TSUNAMI PREPAREDNESS

Remembering Paula Kay Dunbar

By Kelly Stroker and Nic Arcos, NOAA National Centers for Environmental Information

(Continued from page 13)

Remarkably, Paula found time to develop educational products about natural hazards for adults and children. She even was a regular speaker in the local schools. Her willingness to serve her community went into her personal life too, as she was an extremely active member in her local church.

Paula's passing was a shock to all, but the impact that she made on the tsunami scientific community was no shock. Her great attention to detail, passion for the data, and commitment to ensuring all available information was public is unmatched. Those of us that met Paula were lucky, and those that did not have that good fortune owe her a debt of gratitude for making a wealth of data so readily accessible so that lives can be saved in the future.

The NCEI database will live on but there is no doubt she is smiling at us from above waiting to see what crazy ideas we will dream up next. Paula, you will be very missed.



Western Tropical Atlantic Meets in Preparation for UN Decade of Ocean Science for Sustainable Development

Christa G. von Hillebrandt-Andrade, NOAA Caribbean Tsunami Warning Program

The United Nations has declared 2021-2030 as the UN Decade of Ocean Science for Sustainable Development. As part of the Preparatory Process, a virtual meeting for the Western Tropical Atlantic was held on April 28-29, 2020. Over 300 scientists, policymakers, program managers, and government officials, representatives from tourism and maritime sectors, communicators, met to discuss the regional priorities and engage and identify regional priorities and engage and identify new and expanded stakeholders and partnerships.

The six outcomes of the UN Decade (CLEAN OCEAN, HEALTHY OCEAN, PRODUCTIVE OCEAN, PREDICTED OCEAN, SAFE OCEAN and TRANSPARENT OCEAN), as well as the cross cutting issues (Gender, Young Professional, Indigenous and Local Knowledge, Capacity Development and Ocean Literacy), were discussed. Tsunamis was a recurrent theme in most of the session, but most broadly in the Safe Ocean Outcome.



Figure 1. Word Cloud based on the responses to the Question: To achieve A safe ocean, what are the knowledge gaps/ scientific questions/ priority areas that should be addressed in the region through the Decade?

(Continues on page 15)

TSUNAMI PREPAREDNESS

Western Tropical Atlantic Meets in Preparation for UN Decade of Ocean Science for Sustainable Development

Christa G. von Hillebrandt-Andrade, NOAA Caribbean Tsunami Warning Program

(Continued from page 14)

Thru science and actions over the UN Decade, the goal is to achieve a safe ocean whereby life and livelihoods are protected from ocean hazards and where the safety of operations at sea and on the coast is ensured. As part of the preparatory phase, a questionnaire was made available online for stakeholders to submit their opinions. Thirty four people answered the questionnaire for Safe Ocean, 28 from the Tropical Western Atlantic. It was acknowledged that the region is threatened by many hazards of both natural and anthropogenic origin, including tsunamis (Figure 1).

During the 30 minute session on Safe Oceans, participants had the opportunity to participate in polls and provide comment and feedback thru the messaging application of the virtual meeting platform (Figure 2). In addition to the main presentation, four panelists representing different stakeholder sectors, were invited to offer their opinion on the interface of science and policy and decision making, COVID-19 and Coastal Resiliency, Capacity Building within the UNESCO Intergovernmental Oceanographic Commission, and Education, Outreach and Communications. From the rich discussion the following emerged as the Grand Challenges and Actions for a Safe Ocean.

GRAND CHALLENGE

The frequency and intensity of ocean related hazards and its cascading effects are escalating with a devastating and unsustainable impact on life and livelihoods.

GRAND ACTION

The development of a regional Multi Hazard Ocean Data and Forecast System linked to education, outreach and communication actions that empowers national and local policy and decision making and individual response for the protection of life and livelihoods.

The Grand Challenge and Action dovetails very well with the proposal of the global tsunami community for the decade: Tsunamis: Taking on the World's most Dangerous Waves.

Over the next months the Western Tropical Atlantic region will be coordinating future activities, which no doubt will include advancing tsunami forecasting and resilience.

For more information on the meeting, please visit <http://iocaribe.ioc-unesco.org/undecade>. The website for the UN Decade is <http://oceandecade.org>; the hashtag is #OCEANDECADE.



Figure 2. Collage that includes starting top left, Dr. Cesar Toro (meeting organizer) of UNESCO and the SAFE OCEAN Coordination Group & panelists; Christa von Hillebrandt-Andrade, Manager NOAA CTWP; Sharleen DaBreo-Lettsome, Dir. of the Dept. of Disaster Management & Permanent Secretary of BVI; Jorge Zavala, Professor UNAM & Dir. (Ag.), Mexico NWS; Alison Brome, Program Officer UNESCO/IOC - CTIC; Carlos Fuller, Caribbean Community Climate Change Center; Carolina Hincapie, PhD Student UPR at Mayaguez & Member of the Decade ECOP Network; Capt. (Retired) Frederico Antonio Saraiva Nogueira, Directorate of Hydrography and Navigation Brazil & UNESCO IOC Vice Chair for Group III; Dr. Garmalia Mentor, Mgr. of Coastal Hazards Project in Northern Haiti; Azra Blythe-Mallett, PhD Candidate Ministry of Industry, Commerce, Agriculture & Fisheries, Jamaica; Mrs. Ada Monzón, Chief Meteorologist Noticentro al Amanecer WAPA TV, WKAQ, Noticel and Founder and President, Board of Directors EcoExploratorio, Inc. and Museo de Ciencias de Puerto Rico.

TSUNAMI RESEARCH & NTHMP EVENTS

NEW TSUNAMI RESEARCH

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Sweeney, A.; Mungov, G.; Wright, L., 2020, NCEI Water Level Report - Tsunami Date:2020-02-10: CIRES and NCEI, 8 p., https://www.ngdc.noaa.gov/hazard/data/publications/Water-Level_Report-tsunami-508-compliant.pdf.



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UPCOMING NTHMP & RELATED EVENTS

- ♦ July 20-24, 2020—NTHMP Annual Meeting (Sacramento, California) **CANCELLED***
<https://nws.weather.gov/nthmp/>
- ♦ September 15-20, 2020—AEG Annual Meeting (Portland, Oregon)
<https://www.aegannualmeeting.org/>
- ♦ November 3-6, 2020—Washington State Outer Coast Tsunami Roadshow
<https://mil.wa.gov/tsunami>
- ♦ December 7-11, 2020—AGU Fall Meeting (San Francisco, California)
<https://www.agu.org/fall-meeting>



*In-person meetings cancelled. Check website for virtual meetings that may still occur.