TsuInfo Alert

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National Tsunami Hazard Mitigation Program
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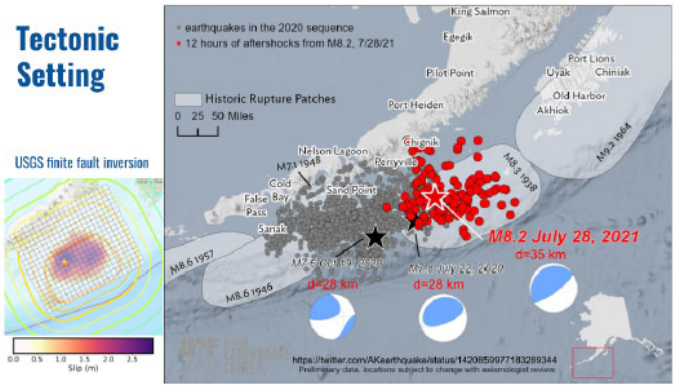
Service Improvement Themes From Our Tsunami Warning Partners

By Dave Snider, Tsunami Warning Coordinator,
National Tsunami Warning Center, Palmer, Alaska

IN THIS ISSUE:

For a newly vested Tsunami Warning Coordinator at the National Tsunami Warning Center (NTWC) in early 2020, I could not have predicted three significant events, thankfully all low-impact results, that would help me latch on to the work and conversations our tsunami warning partners desperately needed to have with NTWC. While I know the topics and concerns keeping us up at night have been on the docket well before my time, the NTWC's ability to elevate and amplify our mission shortfalls and needs hasn't been easy to come by. Along those lines, here are some themes you likely know well- but need to know that we know and are working on:

Over warning



In Alaska, political and alerting boundaries are not designed for the size and complexity of the 49th state. Over warning becomes a problem given widely diffuse population centers, complex terrain where mountains climb out of the ocean, and communication systems which aren't always on par with the lower 48. With each of the three alert-level events, the Kennedy Entrance breakpoint between Kodiak Island and the Kenai Peninsula was activated with a tsunami warning. In only one of the three events was the nearby city of Homer, Alaska (and others) intended to be alerted. Yet each of the three times, this community received and interpreted an alert and evacuated inundation zones. NTWC recognizes the tsunami alerting system is designed to warn the outer coasts of North America, and that contributes to the vulnerability of the inside waters and inlets.

While NWS Tsunami Warning areas are defined by zones that align with the actual Tsunami threat area, Wireless Emergency Alerts (WEA) can only geographically target the intersecting Federal Information Processing Standards (FIPS) codes that cover larger areas than the actual Tsunami threat area. This will be the case until NWS defines Tsunami Warning areas by polygon -- work on that transition is underway and expected to be completed before 2025. NWS currently defines many other alert types by polygon, such as Tornado, Flash Flood, and Severe Thunderstorm Warnings.

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Service Improvement Themes From Our Tsunami Warning Partners

By Dave Snider, Tsunami Warning Coordinator,
National Tsunami Warning Center, Palmer, Alaska
(Continued from page 1)

Our challenge is to fix this issue before an overwarned resident stops evacuating and second-guesses a tsunami alert message. NTWC recognizes there are other locations with a similar issue as we see with the Kennedy Entrance breakpoint.

Timely, useful event conference calls

The first event response I experienced was from my car, returning from scooping sockeye salmon from a river in July 2020. I was on the way home, with hours left in my journey when my phone lit up with alert texts and emails. I wasn't able to support the team onsite, but it gave me valuable insight into what you, our partners, experience when seconds count and information is limited. I experienced the event listening in on my phone like many of you did. Our goal is to move decision-support information to you in these conference calls with added context that supports your communities' needs. While we still hold these informational sessions over the phone, there will be a day when this becomes a video briefing with event information shared in a way that shows you what we're working with. When we speak to our broad national audience on the West, East or Gulf Coast, we must remember that information must remain usable at the community level- where you live. This level of support is fundamental to the National Weather Service Mission, prompting Dr. Louis Uccelini, Director of the National Weather Service, to propose a change to the National Weather Service mission statement which signifies the critical and fundamental service we aim to provide as "impact-based decision support services".

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Service Improvement Themes From Our Tsunami Warning Partners

By Dave Snider, Tsunami Warning Coordinator,
National Tsunami Warning Center, Palmer, Alaska

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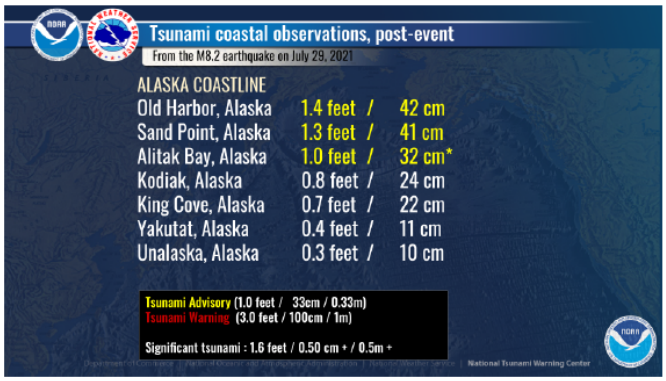
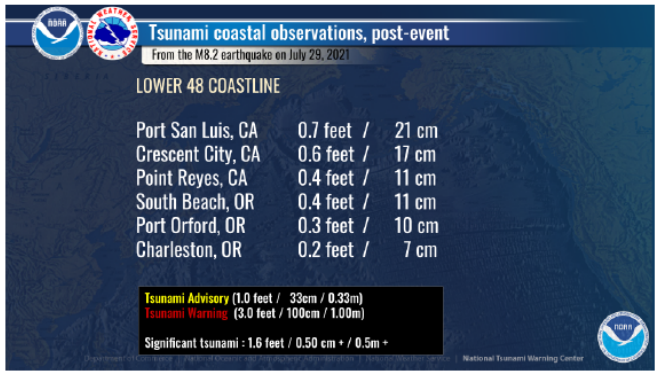
"Provide weather, water and climate data, forecasts, warnings, and impact-based decision support services for the protection of life and property and enhancement of the national economy."

- Proposed update to the National Weather Service Mission Statement, Oct 2021

"... the level of tsunami danger is being evaluated."

The above phrase is non-alert-level text in a tsunami message that puts your teams and communities on alert. This phrase was used during each of the last alert-level events. NTWC's intent with this phrase is to say "things look ok, but we're going to look one more time to make sure." For the July 29, 2021, the M8.2 Chignik, Alaska, event, a procedural error kept this evaluation phrase in alert messages past its intended useful point, which further compounded the concern and heightened awareness of our partners.





Meanwhile, the message our partners received could be similar to Lloyd Christmas's famous line, "so you're saying there's a chance?!" (Dumb and Dumber, 1994). If our intended message isn't meeting the mark, it's up to NTWC to both focus efforts on education toward an improved response and meet the customer where they (you) are. We have heard from our customers and partners that the phrase "danger is being evaluated" elicits "Tsunami Watch"-like responses even though a Watch is not needed. NTWC's goal is to only warn your communities when needed, and to end alerts as soon as possible. Another layer of confusion is added when this phrase is also used in some higher magnitude Tsunami Information Statements, an official message which is intended to be a "no threat" message. If we're alerting you in an unofficial capacity or adding confusion to the response, we must make appropriate changes.

NTWC can do better. And with a focus on improved communication in event support calls, improved official messaging, and a team dedicated to the high level impact-based decision support services from the National Tsunami Warning Center, I am confident we'll continue to learn and grow with and for you in measurable ways that bring the nation's tsunami service to the level you and your community's deserve.

It's an honor to serve you and to have your trust.

More Tsunami Marigrams Online

By Aaron Sweeney, Cooperative Institute for Research in Environmental Sciences (CIRES) and
UC Boulder/NOAA National Centers for Environmental Information (NCEI)

"The National Centers for Environmental Information (NCEI) stewards a collection of more than 3700 high-resolution, scanned images (TIFF) of paper tide gauge records, capturing worldwide observations of more than 390 tsunami events from 1854 to 1994. These marigrams are an important instrumental record of past tsunami events, useful for validating tsunami propagation and inundation modeling when digitized into time-series data. Until recently, only 7% (about 250) of these marigram images were available for direct download from NCEI's HazEL Marigram Search. We now have 71% (about 2650) of these marigrams online, covering 380 tsunami events. The columns circled in red on the accompanying figure of the HazEL Marigram Search Results provide links to low-resolution scan previews (JPEG) and high-resolution, full record scans (TIFF). We also improved the low-resolution, scan previews by merging multiple days of TIFF files for a given marigram into a composite sequence, rather than showing just a single image from one day. The second accompanying figure shows the scan preview from the December 20, 1946, tsunami event observed at Callao, Peru, formed from two TIFF images (also available directly at https://www.ngdc.noaa.gov/hazard/data/marigrams/1770/call_19461220.jpg). If you are interested in seeing specific images online, please contact us at haz.info@noaa.gov. We hope that with increased accessibility to these images, we'll see greater use by the tsunami research community and find support for completing the remaining 29%."

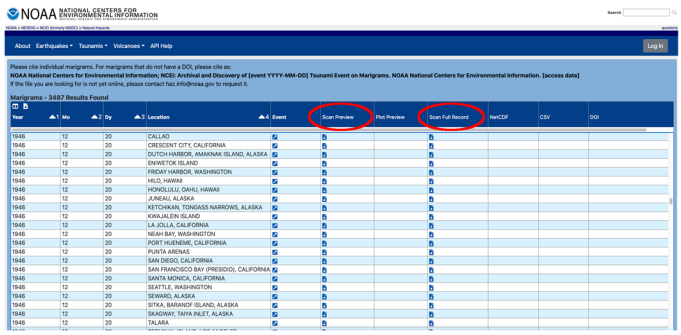


Figure 1: NCEI Marigram Search Results showing links to download low-resolution scan previews (JPEG) and high-resolution, full record scans (TIFF) of analog tide gauge records (marigrams).

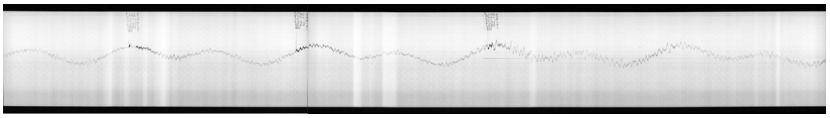


Figure 2: Scan preview from the December 20, 1946, tsunami event observed at Callao, Peru, formed form two TIFF images in sequence.

The Tsunami Education Portal is Ready to Hit

By Vanesa M. Muñiz Llorens, Roy Ruiz-Velez, and Elizabeth Vanacore,
TsunamiReady Program – Puerto Rico Seismic Network

In October 1918, Puerto Rico was impacted by a 7.3 magnitude earthquake and tsunami event that reached coastal communities from Aguadilla to Mayaguez. At the time, there was no plan for tsunami preparation and/or risk mitigation for public safety. Consequently, one of the goals of the Puerto Rico Seismic Network was to develop efficient evacuation and emergency response plans in preparation for future earthquakes and tsunamis. With that vision, the PRSN Tsunami Ready team put together a series of courses. Thanks in part to NOAA funding through the NTHMP FY19/FY20 Grant Cycle, this educational content is now available on the Puerto Rico Tsunami Education website: https://www.uprm.edu/prtsunamiedu/.

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The Tsunami Education Portal is Ready to Hit

By Vanesa M. Muñiz Llorens, Roy Ruiz-Velez, and Elizabeth Vanacore,
TsunamiReady Program – Puerto Rico Seismic Network

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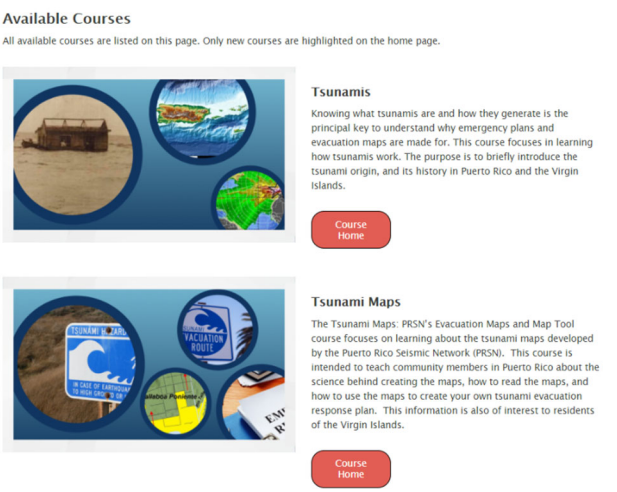
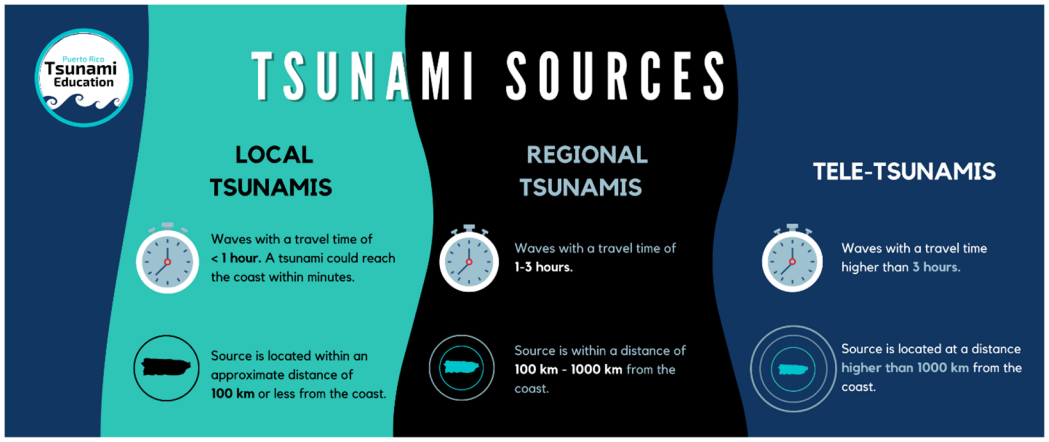
Puerto Rico Tsunami Education is a virtual alternative for learning about tsunamis, Puerto Rico historical tsunamis, and how to develop emergency plans. Because of COVID-19 and the growth of online education tools, an online resource seemed useful for the public to prepare for a tsunami from the accessibility and comfort of their homes. Perks about these online resources include: free scientifically reviewed content, visual engagement, subject matter expert approved quizzes, and direct links to the Puerto Rico Seismic Network and Puerto Rico Emergency Management resources.



Being visually engaging, simple, and informative is the main attraction for the page. The courses are aimed at community leaders and public with little to no general tsunami knowledge. The creative content includes videos, infographics, maps, and more. Each course is broken up into individual modules so a member of the public will be able to review the content of an individual module in 15 minutes or less; the time equivalent of a coffee break. The brevity of each module is designed such that an individual can review the content in bite-sized portions rather than a single long session which may be overwhelming. The knowledge will then be put in practice and tested with a series of activity suggestions and quizzes. The educational content is available in both English and Puerto Rican Spanish making it accessible to speakers of both the island's official languages.



The portal and its design permit the addition of future courses, further addition of audio/visual content, and simple content updates due to its modular design. The educational website is not intended to be static but rather to evolve as new pedagogical techniques for online learning are developed and as information on Puerto Rico tsunamis and warnings may change in the future. Most importantly, the website is meant as an outreach tool to Puerto Rican communities. Throughout a series of targeted communications focused on community leaders, the website intends to spread its message to the largest percentage of vulnerable people possible.

To learn more about Puerto Rico Tsunami Education please access: https://www.uprm.edu/prtsunamiedu/

Washington Emergency Management Hires New Tsunami Program Coordinator

By Elyssa Tappero, Washington State Emergency Management Division

The Washington State Emergency Management Division's (WA EMD) tsunami program has hired a new Tsunami Program Coordinator to replace Jake Witcraft, who recently took a position with the Washington State Department of Natural Resources.

Danté representing the WA EMD tsunami program at the recent Grays Harbor County Emergency Preparedness Expo.

Danté DiSabatino has been part of the WA EMD Geohazards and Outreach Program since December 2020 when he joined the team as Earthquake Early Warning (EEW) Outreach Coordinator, leading Washington's public outreach campaign for the launch of the ShakeAlert® EEW system in May 2021. Education, community engagement, and community empowerment have been cornerstones of his professional career. Prior to working at WA EMD, he was a hazard mitigation planning intern at the City of Seattle Office of Emergency Management, a community liaison for a non-profit, and a high school science teacher. He received a Bachelor's of Environmental Science with a minor in Meteorology from Florida State University and a Master's of Infrastructure Planning and Management from the University of Washington with a focus on hazard mitigation, community-driven resilience, and floodplain management.

As Tsunami Program Coordinator, Danté will be facilitating the development of Washington's second Tsunami Maritime Response and Mitigation Strategy for Westport Marina and will oversee Washington's Inner Coast Tsunami Workgroup. Living in coastal communities his entire life, Danté has fostered a deep appreciation for the natural environment and understanding of the risks associated with it. After seeing the devastating impacts of Hurricane Irma on his community while volunteering in a shelter, Danté decided to pursue a career in emergency management to help connect others to resources and mitigate the impacts from disasters. Danté is passionate about using his current position to empower communities along Washington's coastline to better prepare for, mitigate the effects of, and respond to tsunamis.

Mechanisms for Enhancing Tsunami Disaster Resilience

By Laura Bayona-Román, Caribbean Tsunami Warning Program Intern

The United Nations Office for Disaster Risk Reduction defines resilience as "the ability of a system or community exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of hazards in a timely and efficient manner" (Cumberbatch, 2020). The Cumberbatch (2020) article also states that social vulnerability is composed of social and place inequalities. These include social and physical traits (e.g. urbanization and income) that make a community more prone to harm. Social capital can offset social vulnerabilities and lead to resilience toward disasters like tsunamis, and is defined as "a collective asset in the form of shared norms, values, beliefs, trust, networks, social relations, and institutions that facilitate cooperation and collective action for mutual benefits" (Bhandari, 2009). Roque, Pijawka, and Wutich (2020) showed that social capital helped two Puerto Rican communities recover after Hurricane María.

Three maps were made, using QGIS, to demonstrate the relationship between social vulnerability and social capital in Puerto Rico (Figures 1, 2, 3). The Puerto Rico Social Vulnerability Index, created by Dr. Fernando Tormos-Aponte,

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Mechanisms for Enhancing Tsunami Disaster Resilience

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Dr. Mary Painter, Dr. Gustavo García-López, Giovanni Irizarry-Castro, and Brevin Franklin, is used to show the levels of social vulnerability per municipality (Figures 1 and 3). This index is an altered version of the Centers for Disease and Control and Prevention's/Agency for Toxic Substances and Disease Registry's Social Vulnerability Index (CDC, 2016; Figures 1 and 3). Social capital is represented by dividing the number of non-profit organizations in a municipality by the number of its inhabitants (Figure 2 and 3). The average social capital per municipality was subtracted from the average social vulnerability per municipality to calculate the gaps between them (Figure 3).

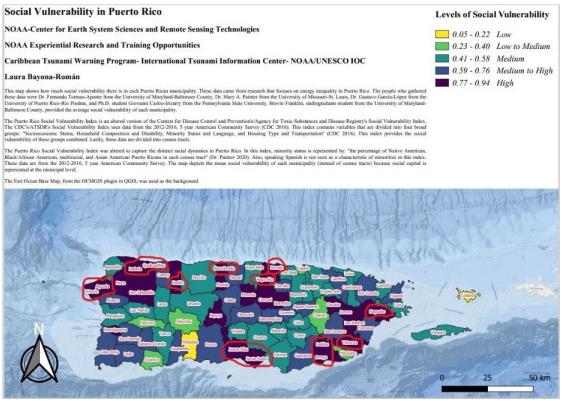

Figure 1. The coastal municipalities with the highest levels (represented by dark purple and circled in red) are: Aguada, Rincón, Quebradillas, Isabela, Juana Díaz, Santa Isabel, Vega Alta, Dorado, Arroyo, Patillas, Yabucoa, Hatillo, Barceloneta, and Naguabo.

Telephone and web interviews with disaster management personnel, community leaders, and non-profit workers from the coastal municipalities with the highest gaps between social capital and social vulnerability were conducted to see how social capital could be developed to improve tsunami disaster resilience. The themes that emerged include: Making Consistent Changes, Education, Creating Strong and Weak Ties, and Helping Disaster Management Personnel.

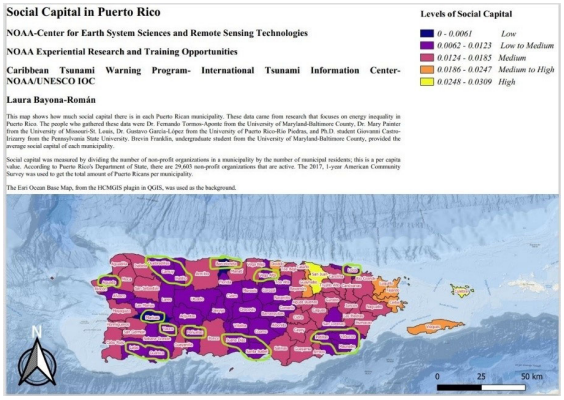

Figure 2. The coastal municipalities with the lowest levels (represented by dark blue and purple and circled in green) are: Barceloneta, Aguada, Lajas, Guánica, Yauco, Quebradillas, Camuy, Hatillo, Peñuelas, Juana Díaz, Santa Isabel, Patillas, Yabucoa, Maunabo, Loíza, and Vega Alta.

Some disaster management personnel said that changing plans can improve tsunami disaster resilience; one talked about cleaning sewers more to prevent flooding. Several respondents indicated that communities' demographic data must be updated constantly. This information helps determine which groups need more resources to face a tsunami.

Several participants discussed the importance of educating people about tsunami preparedness in order to improve tsunami disaster resilience. Others spoke about using closed schools for storing food in case of tsunamis. Some mentioned collaborations with the University of Puerto Rico to learn about tsunami preparedness and response.

Bhandari and Yasunobu (2009) state that strong ties are close and consistent relationships between people, like between family members. They state that weak ties are transient relationships, such as short friendships. Respondents indicated that fortifying these ties can improve tsunami disaster resilience. Some stated that frequent tsunami conferences strengthen strong ties within communities and weak ties between communities and disaster management personnel. Several remarked that fortifying these ties can be difficult when people underestimate the dangers of tsunamis.

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Mechanisms for Enhancing Tsunami Disaster Resilience

By Laura Bayona-Román, Caribbean Tsunami Warning Program Intern

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Most disaster management personnel said that their agencies lack staff and funds for things like equipment. It's highly probable that they need assistance from entities like the federal government to better support tsunami disaster resilience. One said that several personnel need care for their emotional health, to handle the emotional strain of responding to tsunamis. The majority mentioned that volunteers from programs like Community Emergency Response Team help them in tsunami preparedness and response.

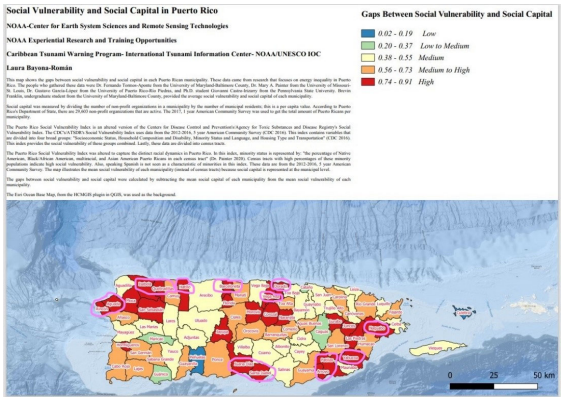

Figure 3. The coastal municipalities with the highest gaps (shown in red and circled in pink) are: Rincón, Aguada, Isabela, Quebradillas, Juana Díaz, Santa Isabel, Arroyo, Patillas, Yabucoa, Barceloneta, Hatillo, Vega Alta, Dorado, and Naguabo.

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Washington State Completes Vertical Evacuation Structure Assessment

By Elyssa Tappero, Washington State Emergency Management Division

Thanks to funding from the FY19 NTHMP grant cycle, the Washington State Emergency Management Division (WA EMD) has just completed an assessment of vertical evacuation structure (VES) needs for the state's three most vulnerable outer coast counties (Pacific, Grays Harbor, and Clallam). The assessment was conducted by Dr. Bob Freitag and Jeana C Gomez at the Institute for Hazards Mitigation Planning and Research, part of the University of Washington's (UW) Department of Urban Design and Planning, and built off the 2010 Project SafeHaven reports for the same areas.

The purpose of this assessment was to verify and analyze potential sites for vertical evacuation structures in each study area. For the assessment's scenario, the UW team chose a magnitude 9.0 Cascadia subduction zone earthquake with 5-6 minutes of ground-shaking and the first arrival of tsunami waves ~20 minutes after the start of the quake. The walk time

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Washington State Completes Vertical Evacuation Structure Assessment

By Elyssa Tappero, Washington State Emergency Management Division

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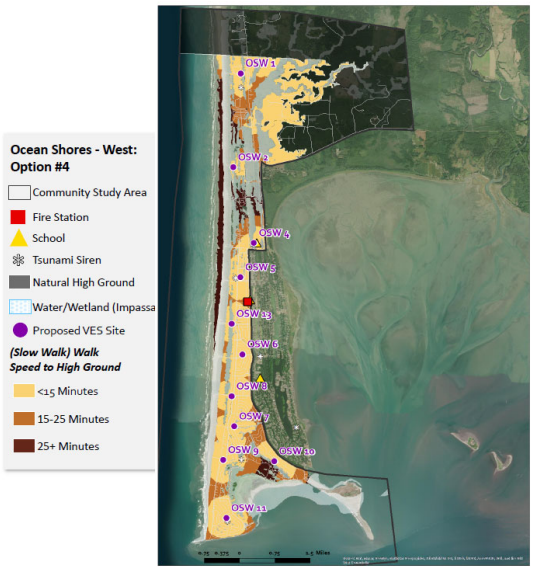
estimates assume local bridges will not be passable and that evacuees will be traveling by foot. However, they do not take into account other challenges such as delayed evacuation due to packing supplies, searching for family, injury, weather conditions, or blocked evacuation routes. The population totals do not include seasonal visitors, either.

The team used their findings, combined with the Project SafeHaven reports, to develop 4 vertical evacuation options for each study location:

1. *No vertical evacuation structure:* This option is considered the "baseline" for each community and assumes no new VES will be constructed in a community.
2. *Community-derived:* This option includes all VES locations proposed in the 2010 SafeHaven reports, which were chosen by a diverse team of community stakeholders and subject matter experts based on public land availability, walking distances/times, and population clusters.
3. *Broad spatial coverage:* This option attempts to achieve broad coverage in each community. In some cases, it added VES to option 2 to fill gaps. In other cases, option #2 was already sufficient.



4. *Efficient/lean:* This option presents the "biggest bang for your buck". Each proposed location in options #2 and #3 were analyzed to determine most efficient placement to maximize coverage. Some locations were moved or removed to develop an option that is both strong (in terms of coverage, number of people in walking distance) and realistic (in terms of cost).

Each community option is accompanied by maps showing proposed VES locations and minutes to high ground, satellite or street view photos of the proposed locations, the number of people within 15-25 minutes' walk to high ground, and charts comparing this data for all 4 options in an easily readable format. Summary tables per county are also available which identify the minimum number of proposed VES per option for the entire county, the minimum total VES capacity needed, and the percent/number of people in the tsunami zone who either are or are not within 15- or 25-minutes' walking distance of high ground.

Now that this assessment has been completed, Washington has a much more accurate idea of how many VES it will take to ensure the most vulnerable communities on the outer coast can quickly evacuate in the event of a Cascadia tsunami. Now the real work begins at the local level – designing, planning, and funding each VES project to transform the assessment's findings from wish list to reality. With each VES carrying a multi-million-dollar price tag, this is easier said than done. Fortunately, local jurisdictions can apply through WA EMD (or on their own if they are Tribal entities) for grant funding through FEMA's Building Resilient Infrastructure and Communities (BRIC) hazard mitigation grant program. Projects that design and/or construct tsunami VES or improve evacuation efficiency and access to VES post-earthquake have a good chance of being funded if their plan is realistic and feasible.

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Washington State Completes Vertical Evacuation Structure Assessment

By Elyssa Tappero, Washington State Emergency Management Division

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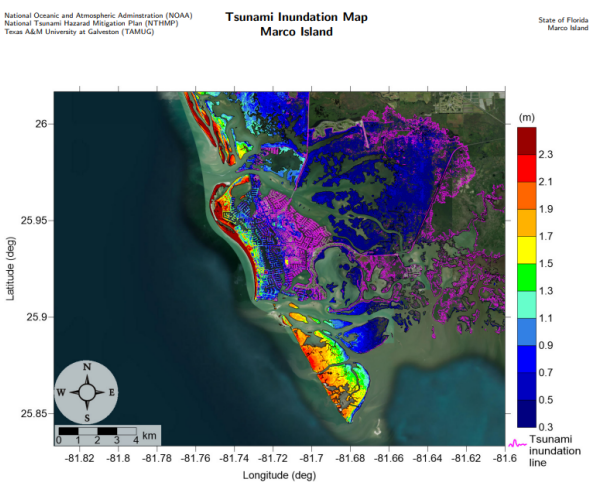
In the future WA EMD will continue to support such local efforts and focus also on conducting a wayfinding project on the outer coast. This project will assess the condition of evacuation routes and determine where additional signage, maintenance, or route improvement is needed to ensure navigability and safety during an actual tsunami event. Like the VES assessment, the wayfinding project results will also provide communities with the kind of hard data needed for grant applications and other funding requests. As long as stakeholders at all levels continue working together, Washington will keep making strides toward ensuring its coastal communities have access to nearby high ground.

New Tsunami Maps

By Texas A&M University at Galveston (TAMUG) Tsunami Research Group (TRG)

Potential tsunami sources for the Gulf of Mexico (GOM) are local submarine landslides. Submarine landslide in the GOM are considered a potential tsunami hazard. However, the probability of such an event (tsunamis generated by large landslides) is very low. The probability of occurrence is related to geological massive landslides which were probably active prior to 7,000 years ago when large quantities of sediments were emptied into the Gulf of Mexico. Nowadays, sediment continues to empty into the Gulf of Mexico mainly from the Mississippi River. This sediment supply contributes to the slope steepening and the increase of fluid pore pressure in sediments, which may lead to further landslide activities and hence, the reason for our concern in determining the potential tsunami hazard and its effects in the Gulf of Mexico. For the triggering mechanism (tsunami generation) we use nine submarine landslide sources, i.e., five geological sources and four synthetic sources calculate by a probabilistic methodology.



Our probabilistic approach confirmed a recurrence period of major landslide events of around 8000 years, consistent with findings from the USGS. Inundation maps are the most important tsunami mitigation products. The goal is to provide guidance to state emergency managers for tsunami hazard mitigation and warning purposes. These tsunami inundation maps, Pedro Island, Boca Grande, Captiva Island and Marco island, FL are our last development (FY20 cycle). Maximum tsunami inundation extent, water height or inundation are portrayed on these maps. Other products, like as momentum flux magnitude and direction, damaging current and vorticity can be found in the FY20 report that is currently on revision (coming soon). We hope that the results herein may assist GOM's emergency managers, the maritime communities and other NTHMP's interested parties.

Links to maps:

1. Don Pedro Island-Boca Grande-Captiva Island, FL
   a. Don Pedro Island-Boca Grande inundation, current, vorticity, momentum flux
   b. Captiva Island inundation, current, vorticity, momentum flux
2. Marco Island inundation, current, vorticity, momentum flux

Washington State Hosts Annual Tsunami Seminar and Workshop

By Elyssa Tappero, Washington State Emergency Management Division

On July 28th, 2021 the Washington State Emergency Management Division (WA EMD) hosted the 2021 Washington State Tsunami Seminar and Workshop. This 6-hour event provided emergency managers and other key tsunami stakeholders a chance to learn about tsunami response procedures at the state and federal level, discuss opportunities for collaboration and alignment of their own procedures, and identify potential areas of improvement in a no-fault learning environment.

The first half of the day included seminar presentations from WA EMD, the Washington Geological Survey, and the National Tsunami Warning Center (NTWC). Topics included newly published tsunami maps and resources, key communication methods and procedures during a tsunami event, and updates about collaborations between the WA tsunami team and the NTWC. The second half of the day took the form of a workshop which included two breakout room discussions and brief outs with the full group. Breakout rooms were divided into Outer Coast local/Tribal government and emergency management partners, Inner Coast local/Tribal government and emergency management partners, state/federal partners, and private sector partners. Everything took place virtually via Microsoft Teams.

With over 140 attendees representing federal and state agencies, Tribal jurisdictions, private ports and marine entities, and local jurisdictions across Washington's inner and outer coasts, the tsunami seminar and workshop was a resounding success. The event identified several areas where further planning is needed, as well as resulted in a list of realistic action items which the WA tsunami team is already tackling. It also provided stakeholders new to the "world of tsunamis" with tons of ideas for helping their own organizations or communities create response plans. Most importantly, it brought key players together to establish and reinforce collaborative relationships based around the shared hazard.

Stakeholders have long voiced their appreciation for this exercise format as it allows a greater opportunity for learning and discussion than tabletop exercises. And while the ongoing pandemic forced this year's event to be totally virtual, this also had its upsides: more people were able to attend, as they did not need to block out time in their schedules for traveling to and from the WA State Emergency Operations Center; seminar presentations could be recorded and posted online for those who were unable to attend; and it was very easy to provide accessibility in the form of live captioning and American Sign Language interpreters. Future exercises will continue to include a virtual component to take advantage of these positives - though the WA EMD tsunami team is surely not alone in expressing a sincere hope that next year will see us collaborating in person once more!

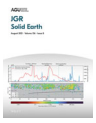
For those interested, the seminar recording can be found in full as an "unlisted" video on the WA EMD YouTube channel here: https://youtu.be/urL2YF3YrCg

TSUNAMI RESEARCH & EVENTS

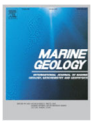
RESEARCH

Cheng, Wei; Horrillo, Juan; Sunny, Richards, 2021, Numerical analysis of meteotsunamis in the Northeastern Gulf of Mexico: Natural Hazards, https://doi.org/10.1007/s11069-021-05009-9.

Du, Yue; Ma, Shuo; Kubota, Tatsuya; Saito, Tatsuhiko, 2021, Journal of Geophysical Research Solid Earth, v. 126, no. 8, article e2021JB022098, https://doi.org/10.1029/2021JB022098.



Grilli, S. T.; Zhang, C.; Kirby, J. T.; et al., 2021, Modeling of the Dec. 22nd 2018 Anak Krakatau volcano lateral collapse and tsunami based on recent field surveys: Comparison with observed tsunami impact: Marine Geology, v. 440, p. 106566, https://doi.org/10.1016/j.margeo.2021.106566.



Pilarczyk, J. E.; Sawai, Y.; Namegaya, Y.; et al., 2021, A further source of Tokyo earthquakes and Pacific Ocean tsunamis: Nature Geoscience, v. 14, p. 796–800, https://doi.org/10.1038/s41561-021-00812-2.

Riquelme, Sebastián; Fuentes, Mauricio, 2021, Tsunami Efficiency Due to Very Slow Earthquakes: Seismological Research Letters, v. 92, no. 5, p. 2998–3006, https://doi.org/10.1785/0220200198.

Salazar-Monroy, E. F.; Melgar, D.; Jaimes, M. A.; Ramirez-Guzman, L., 2021, Regional Probabilistic Tsunami Hazard Analysis for the Mexican Subduction Zone From Stochastic Slip Models: Journal of Geophysical Research Solid Earth, v. 126, no. 6, article e2020JB020781, https://doi.org/10.1029/2020JB020781.

UPCOMING NTHMP & RELATED EVENTS

- November 5, 2020—World Tsunami Awareness Day https://tsunamiday.undrr.org/
- November 16, 2021 (1pm EST)—NTHMP MES Fall Meeting (Virtual) https://nws.weather.gov/nthmp/index.html
- November 18, 2021 (2pm EST)—NTHMP MMS Fall Meeting (Virtual) https://nws.weather.gov/nthmp/index.html
- November 18, 2021 (4pm EST)—NTHMP CC Fall Meeting (Virtual) https://nws.weather.gov/nthmp/index.html
- December 13-17, 2021—AGU Fall Meeting (New Orleans, LA) https://www.agu.org/fall-meeting
- February 1-4, 2022—NTHMP Winter Meeting (Portland, OR) https://nws.weather.gov/nthmp/index.html