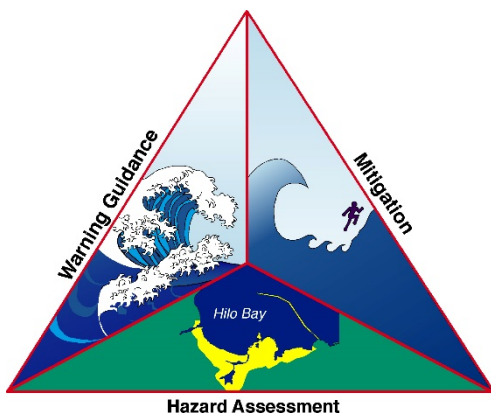




# 2018

Authored by National  
Tsunami Hazard Mitigation  
Program Coordinating  
Committee Members

June 2019



## Accomplishments of the National Tsunami Hazard Mitigation Program: An Annual Report

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The National Tsunami Hazard Mitigation Program (NTHMP) works to protect lives and reduce economic losses from tsunamis at the community level. The NTHMP includes the National Oceanic and Atmospheric Administration (NOAA), the Federal Emergency Management Agency (FEMA), the U.S. Geological Survey (USGS), and 28 U.S. states and territories. Through collaboration, coordination, and support to partner states and territories, the NTHMP focuses on three key functions: hazard assessment, warning guidance, and mitigation.

Calendar year 2018 was a busy and active year for the NTHMP. This annual report was informally produced to highlight some of the NTHMP's 2018 activities. It is a compilation of submissions from the following NTHMP subcommittees and partner states and territories:

- Alaska Division of Homeland Security and Emergency Management/University of Alaska Fairbanks Alaska Earthquake Center/Alaska Division of Geological and Geophysical Surveys
- American Samoa Territorial Emergency Management / Department of Homeland Security
- California Governor's Office of Emergency Services/California Geological Survey
- Guam Homeland Security
- Hawai'i Emergency Management Agency/University of Hawai'i
- Oregon Office of Emergency Management/Oregon Department of Geology and Mineral Industries
- Puerto Rico Bureau of Emergency Management/University of Puerto Rico Puerto Rico Seismic Network
- Santa Rosa County Emergency Management Agency/Texas A&M University at Galveston (Gulf Coast)
- Northeast States Emergency Consortium/Universities of Delaware and Rhode Island (East Coast)
- Washington Emergency Management Division/Washington State Department of Natural Resources

<https://nws.weather.gov/nthmp/>

# National Tsunami Hazard Mitigation Program (NTHMP) 2018 General Updates

## NTHMP Meetings

<https://nws.weather.gov/nthmp/Minutes/minutes.html>

### Winter Meeting

The NTHMP Winter Meeting and subcommittee meetings were held in Seattle, Washington, January 29–February 2. Due to a government shutdown the week before this meeting, participation by federal agency partners was reduced. Forty-eight people participated in these meetings throughout the week.



### NTHMP Summer Subcommittee Meetings

The NTHMP Mitigation and Education Subcommittee (18 attendees) and the Mapping and Modeling Subcommittee (15 attendees) plus three ex-officio leaders met August 2–4 in Sacramento, California.

### Other Meetings

- The NTHMP Coordinating Committee met twice in person and four times by teleconference.
- The Mapping and Modeling Subcommittee met twice in person and two times by teleconference.
- The Mitigation and Education Subcommittee met twice in person and five times by teleconference.
- The Warning Coordination Subcommittee met once in person and once by teleconference.
- The NTHMP Island Caucus met twice in person.
- A three-member NTHMP Allowable Grant Activities Work Group met twice by teleconference. The purpose of this work group was to review and update the list of allowable grant activities for FY19 grant applications.
- A five-member work group met six times by teleconference to write an NTHMP Subcommittee Structure and Workload Analysis paper for discussion by the Coordinating Committee.

### 2018 NTHMP Publications and Resources

<https://nws.weather.gov/nthmp/publications.html>

- *TsuInfo Alert* (six issues)
- NTHMP 2018–2023 Strategic Plan
- Annual Work Plans for three Subcommittees
- Updated NTHMP Rules of Procedures and respective Subcommittees' Terms of Reference
- FEMA Community Rating System tsunami fact sheets (two)
- Tsunami Evacuation Signs web page
- Tsunami Exercises web page
- 2018 World Tsunami Awareness Day Social Media shareables



## Grants

For the FY18 grant cycle (September 1, 2018–August 31, 2019), NOAA/National Weather Service (NWS) awarded \$5,557,537 to 12 NTHMP partners, and \$425,133 was transferred within NOAA (to the Pacific Marine Environmental Lab and the National Centers for Environmental Information) to support projects for the Mapping and Modeling Subcommittee and two state partners (Alaska and Washington) to meet critical needs within the scope of the NTHMP strategic plan. More information on FY18 NOAA/NWS grant-funded projects is available at <https://nws.weather.gov/nthmp/grants/2018grants/index.html>.

## Administration

The Coordinating Committee welcomed a replacement NTHMP Coordinating Committee member:

- Carlos Irigoyen, Puerto Rico emergency management member, Puerto Rico Bureau of Emergency Management, replacing Wilfredo Ramos

The Coordinating Committee welcomed newly elected or replacement subcommittee co-chairs:

- Dan Belanger, Alaska Division of Homeland Security and Emergency Management, state co-chair, Warning Coordination Subcommittee, completing unexpired term of Althea Rizzo, Oregon Emergency Management
- Marie Eblé, NOAA Pacific Marine Environmental Laboratory, NOAA co-chair, Mapping and Modeling Subcommittee, re-elected
- Kevin Richards, Hawai'i Emergency Management Agency, Island Caucus co-chair, two-year term
- Victor Huerfano Puerto Rico Seismic Network, Island Caucus co-chair, one-year term

The Coordinating Committee bid farewell to these NTHMP Coordinating Committee members:

- Paul Huang, National Tsunami Warning Center, Interim co-chair, Warning Coordination Subcommittee, retired.
- Mona Barnes, U.S. Virgin Islands emergency management member, Virgin Islands Territorial Emergency Management Agency (VITEMA), resigned upon completion of her term of service at VITEMA.

The NTHMP was led by Coordinating Committee Chair Grant Cooper, NWS Western Region director and supported by NTHMP Administrator Rocky Lopes, NWS Headquarters Tsunami Service Program.

## Other Major Actions

- The NOAA/NWS Tsunami Activities Grant Guidance and Allowable Grant Activities chart were updated for FY19.
- The NTHMP Warning Coordination Subcommittee Terms of Reference were changed to allow each NWS Tsunami Warning Center director to delegate a member of its staff to serve as that Tsunami Warning Center's designated subcommittee co-chair.
- A Mitigation and Recovery Work Group within the Mitigation and Education Subcommittee was approved.



# Mapping and Modeling Subcommittee (MMS) 2018 Accomplishments

## Supported Two USGS Powell Center Workshops on Tsunami Source Standardization

The Powell Center Working Group led by MMS members is focused on standardization of earthquake and landslide tsunami sources as well as the identification of potential new sources. This work transfers decades of USGS research on subduction zone earthquakes and coastal landslides to the mitigation community and MMS, in particular. The first workshop held in Fort Collins, Colorado, in April focused on the overall needs for developing a consistent tsunami source database and framework. The second workshop held at the same venue in October focused on Alaska-Aleutian tsunami sources. About 20–25 representatives from the USGS, NOAA, and NTHMP state/territory partners participated in each workshop.



## Made Progress on Development of the Tsunami Source Database

The MMS began a project to develop a tsunami source database. A standardized tsunami source template was produced and subsequently populated by each NTHMP state/territory partner to define existing tsunami sources used in statewide modeling. The database includes historical and hypothetical tsunami sources, both tectonic and landslide. This database will be refined as the MMS reviews it at future meetings.

## Reviewed Tsunami Modeling Guidance and Best Practice Documents

The MMS reviewed existing guidance for tsunami inundation modeling and discussed developing new guidance for modeling tsunami currents. An approach to map potential tsunami inundation zones in non-modeled areas was reviewed. MMS members explored the current state of sediment transport modeling research and initiated development of a catalog of studies with intent to help contribute to the development of new guidelines for modeling sediment transport caused by tsunamis.

## Facilitated an NTHMP Hazard Assessment Gap Analysis Workshop

The MMS initiated development of a hazard assessment gap analysis to determine what geographic areas of the United States lack mapping and modeling of the tsunami hazard as well as what geographic areas that were initially mapped or modeled years ago require updating since new data, such as digital elevation maps (DEMs), LIDAR, and bathymetry, have become available. This gap analysis was passed on to the Mitigation and Education Subcommittee, which will identify gaps for hazard mitigation and outreach/education products.

## Supported DEM Development via National Centers for Environmental Information

Accurate and up-to-date tsunami DEMs are the cornerstone of all tsunami modeling activities. In 2018, the MMS supported DEM development priorities for the following coasts: Rhode Island-Nantucket (Massachusetts), Western Washington, and Alaska's Port Alexander, Wrangell, Old Harbor, Akhiok, and Karluk.

## Updated the MMS Page on the NTHMP Website

The Sediment Transport Bibliography of Known Research and Projects and MMS Terms of Reference were added to the MMS page.

# Mitigation and Education Subcommittee (MES) 2018 Accomplishments

## MES Co-Chairs and Partners

- Provided significant input and guidance to the NTHMP Subcommittee Structure and Workload Analysis discussion paper and a list of recommendations, which were submitted to the Coordinating Committee in December for discussion at the 2019 annual meeting
- Developed agendas and priorities and coordinated and convened annual, summer, and business meetings
- Produced two Community Rating System tsunami fact sheets for FEMA
- Created a tsunami evacuation signs web page for the NTHMP website

## MES Meeting at Annual Meeting in Seattle, Washington

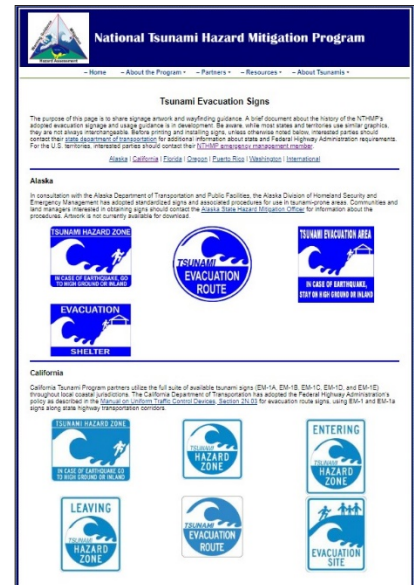
- MES Annual Work Plan
- Development of guidelines (e.g., education, evacuation, mapping)
- Social science research (develop/assess education, outreach, alerts, etc.)
- NTHMP-level outreach (website, materials, marketing, campaigns)
- Discussion of evaluating public understanding of evacuation mapping

## Four Business Meetings

- MES Annual Work Plan tasks
- Summer meeting planning
- 2019 workshop
- Recent tsunamis (January 10, Caribbean; January 23, Alaska)
- Future HAZUS training
- Tsunami wireless emergency alert (WEA) 300 character message expansion
- WEA West Coast polygons
- Survey for exercise feedback

## MES Summer Meeting in Sacramento, California

- Overview discussion of MES Annual Work Plan
  - Social science project
  - Maritime task
  - International maritime guidance
  - TsunamiZone website
  - Community Rating System Fact Sheets
  - NTHMP Tsunami Information Guide
- Guidance on grant-funded full-time employees
- State and territory program updates
- Puerto Rico and U.S. Virgin Islands hurricane recovery updates
- Mitigation and recovery project
- Alerts/notifications and recent events
- Exercises: LANTEX, PACIFEX, and CARIBE WAVE
- TsunamiReady and TsunamiReady Tier II (Fairhaven example)

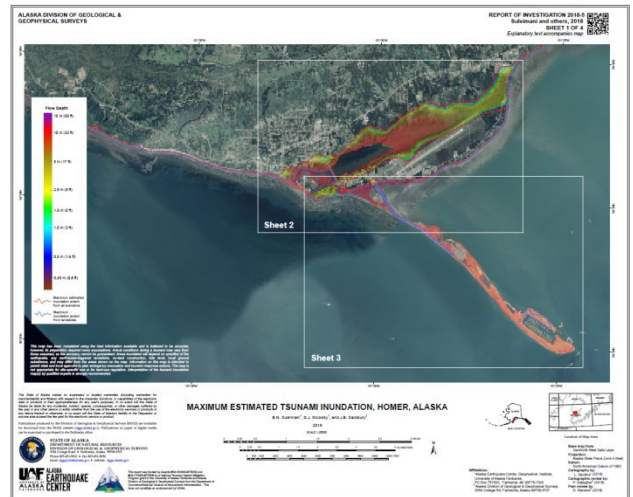


# Alaska 2018 Accomplishments

Alaska experienced numerous devastating tsunamis and the next tsunami is only a matter of time. To mitigate this risk, Alaskans need to assess the tsunami hazard for the coastal communities through scenario planning, mitigation tools, and broad education in support of the TsunamiReady program.

## Scenario Planning and Tsunami Hazard Assessment

- Completed high-resolution modeling and mapping of the potential tsunami inundation for Atka and Adak.
- Published the high-resolution tsunami inundation maps for Haines, Skagway, Homer, and Seldovia. Presented maps and reports in each community. Also presented high-resolution maps at the U.S. Coast Guard base in Kodiak.
- Published maximum potential subsidence maps for Cold Bay, Cordova, King Cove, Nikolski, Seward, Tatitlek, Unalaska, Valdez, Wittier, Yakutat, and other communities.
- Published approximate potential inundation zones for Atka and Adak. Inundation zones for other communities are in the publication process. Community meetings were conducted in Craig, Kasaan, and Klawock.
- Presented maritime guidance for Alaska communities, including Chenega and Tatitlek, at the Alaska Harbor Master Annual Conference.



*Tsunami inundation maps for Homer, Alaska: Alaska Division of Geological and Geophysical Surveys Report of Investigation (<http://dgg.alaska.gov/pubs/id/30095>)*

## Mitigation and Education

- Conducted assessment of pedestrian travel time to safety for Kodiak, Wrangell, and Perryville. Assisted Kodiak Borough with development of a tsunami evacuation line.
- Presented maps via public lectures and outreach to school students in many communities.



*Community outreach lecture in Craig, Alaska*

- Held a Tsunami Operations Workshop in Sitka. The 24 participants included nine southeast community leaders and local emergency managers.
- Developed evacuation brochures for Seldovia and Seward
- Developed new Alaska tsunami information brochures explaining the hazards and alerts for tsunamis across Alaska.
- Installed warning siren systems in Petersburg and Cordova.

## TsunamiReady

- Worked with NOAA's National Weather Service Forecast Offices in Alaska to promote the TsunamiReady program. Updated five coastal communities.



# American Samoa 2018 Accomplishments

## Tsunami Preparedness and Education and Outreach

- Tsunami Preparedness Week activities were held in late September to correspond with September 29, the date of the 2009 Samoa tsunami.
- The American Samoa Tsunami Program traveled to outer island Manu'a to conduct tsunami outreach activities for Olosega, Ofu, and Ta'u schools.
- The Tsunami Program conducted and participated in a number of outreach activities and evacuation drills for schools, communities, and other groups.
- American Samoa renewed its TsunamiReady recognition.
- The National Disaster Preparedness Training Center's Tsunami Awareness course (AWR-217) was held in Pago Pago with 31 participants.



## Mapping and Modeling

- The American Samoa Homeland Security Advisory Council (HSAC) approved and adopted new tsunami inundation maps.
- The HSAC approved and established a Tsunami Working Group to look at the inundation models and develop evacuation maps. The working group includes first responders and subject matter experts from the National Weather Service, the National Park Service, etc.

## Maritime Products

- Researchers at the University of Hawai'i completed the tsunami maritime hazard maps for American Samoa. Products are based on a maximum tsunami scenario, identify areas for vessels to evacuate to during a warning, and include in-harbor hazard maps of surge, drawdown, and currents for hypothetical advisory-level tsunamis.
- A workshop was held to introduce the completed products to the maritime community. They were well received.

## Tsunami Exercise

- A multi-organizational, tsunami exercise was held. The exercise, which included some full-scale components, simulated a distant tsunami with impacts to American Samoa. It was held, in part, to prepare for a broader full-scale exercise in 2019 in conjunction with the 10-year anniversary of the 2009 tsunami.



## Sirens

- The Tsunami Program completed the replacement of siren batteries on Manu'a as called for by the Siren Compulert system.
- American Signal Corporation conducted a siren system health audit in July and found that 56 sirens needed immediate attention.



## Two Samoa Meeting

- Tsunami Program representatives attended the 17th Two Samoa Coordination Meeting in Western Samoa. The meeting addressed issues associated with weather (tropical cyclones and severe weather), climate (climate variability and change), disaster management (disaster response, risk, recovery), geoscience (earthquakes and tsunamis), and ozone (ozone layer, air quality monitoring progress).



# California 2018 Accomplishments

The California Tsunami Program composed of the California Governor's Office of Emergency Services, California Geological Survey, National Weather Service (NWS), and the 20 coastal county emergency managers convened two meetings to guide priorities and coordinate statewide planning and activities.

## Year-round Preparedness Activities, Tsunami Preparedness Week 2018, and ShakeOut

- Conducted annual Tsunami Warning Test using Federal Communications Commission-approved live codes.
- Promoted registration of activities at TsunamiZone.org.
- Supported tsunami signs, kiosks, and TsunamiClear maps in San Francisco Bay and Southern California.
- Supported governor's proclamation and local activities during Tsunami Preparedness Week.
- Renewed 12/retired 1 TsunamiReady Communities in cooperation with the NWS



## California Technical Collaboration and Workshops

- Supported USGS Powell Center Working Group on Tsunami Sources.
- Provided presentations to and participated in Hawai'i Mitigation Workshop, Washington Maritime Guidance Workshop, and Oregon Tsunami Conference.
- Published papers on January 23, 2018, Alaska M 7.9 earthquake through the Earthquake Engineering Research Institute and on the California program and application of new probabilistic maps for the National Conference on Earthquake Engineering.

## Evacuation and Maritime Playbooks and Mitigation Planning (co-partnered with FEMA)

- Conducted State-NWS Tsunami Playbook Communications/Flood Prediction (FASTER) test.
- Completed a Tsunami Response Playbook Workshop with Santa Cruz County/Cities.
- Met with the U.S. Coast Guard about San Francisco Bay plans.
- Supported TsunamiCon exercise in Humboldt County.

## Mitigation and Probabilistic Hazard Analysis Products (co-partnered with FEMA)

- Worked with University of Southern California Tsunami Research Center on new harbor and pier improvement reports.
- Assisted communities with local Hazard Mitigation Grant applications.
- Completed probabilistic-based maps for 500-, 1000-, and 2500-year return periods.

## Pedestrian Evacuation Modeling

- Coordinated with USGS and Tsunami Advisory Panel to discuss completed, statewide work.
- Reviewed potential applications of pedestrian evacuation analysis, and provide tsunami travel time estimates for local, Cascadia, Alaska-Aleutians events.

## California Mitigation and Recovery Tsunami Advisory Groups (co-partnered with FEMA)

- Coordinated several meetings of the Core Planning Group for mitigation and recovery, including working with Humboldt County on use of probabilistic maps in local planning.
- Formed a special technical advisory panel to advise on new tsunami hazard zones for application under the Seismic Hazard Mapping Act.

## Response Actions

- Initiated tsunami response protocols during the M 7.9 Kodiak, Alaska, tsunami watch.
- Developed new response protocols for California based on after-action discussions.

# East Coast 2018 Accomplishments

## Modeling Tsunami Inundation and Hazard for the U. S. East Coast

- Work continued on modeling meteotsunamis that could potentially severely impact the U.S. East Coast on a 100-year return-period scale. An invited presentation was given at the American Geophysical Union on this work. Figure 1 shows the derecho that preceded the June 13, 2013, meteotsunami as well as a radar image for that day. Tsunami simulations using a moving pressure patch yield very good agreement with measurements at tide gauges.
- Proceedings of the 2017 NTHMP Landslide Tsunami Model Benchmarking Workshop (organized by the U.S. East Coast science members) were finalized, approved by the MMS, and posted online ([www.udel.edu/kirby/landslide/](http://www.udel.edu/kirby/landslide/)). A journal paper is nearly completed. Recommendations for landslide tsunami modeling are being developed in FY18.
- Continued simulating tsunami generation by deforming submarine mass failures (SMFs) and quantifying effects of slide rheology and frequency dispersion on the tsunami coastal hazard along the East Coast (Figure 2). A paper describing this work was published in *Pure and Applied Geophysics* (Schambach et al., 2018).
- A new gap analysis study of East Coast tsunami work is being conducted under the Northeast States Emergency Consortium to develop a five-year comprehensive tsunami work plan for the East Coast.

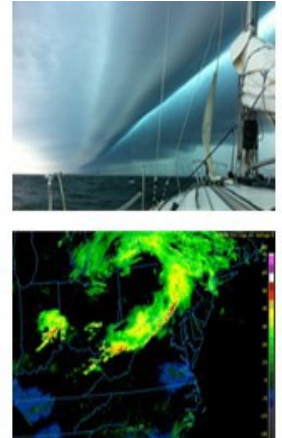


Figure 1: Derecho moving onto East Coast shelf (top), credit: Buddy Denham; Radar for June 13, 2013, meteotsunami (bottom)

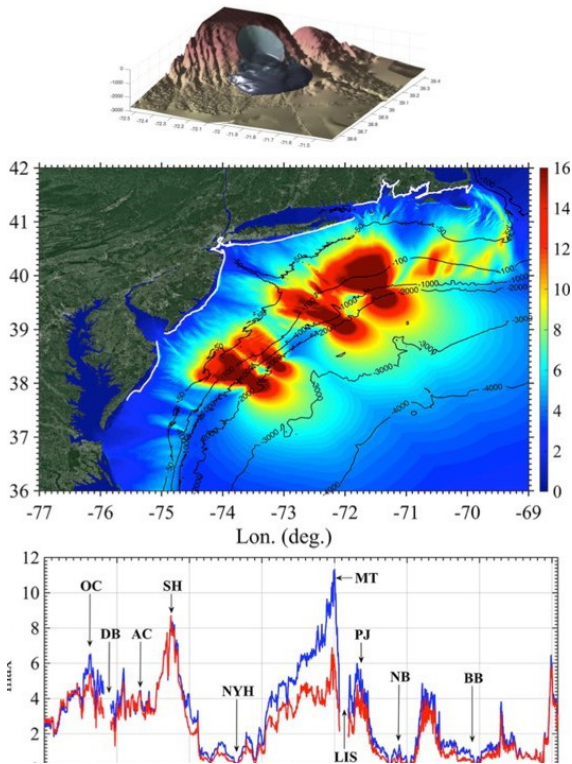


Figure 2: Tsunami generation and coastal impact from Virginia to Cape Cod for rigid/deforming SMFs (top); maximum elevation (middle); maximum elevation at 5 meter isobaths (rigid slumps (blue) and deforming slides (red)) (bottom)

- New simplified products showing coastal risk as categories are being developed based on the previously developed suite of East Coast tsunami sources. The purpose of these products is to help East Coast emergency managers better understand their tsunami risk.
- Work on the December 22, 2018, Anak Krakatau tsunami due to a volcanic flank collapse has been performed using East Coast modeling methodology and models (Figure 3). This will be discussed at the 2019 annual meeting.

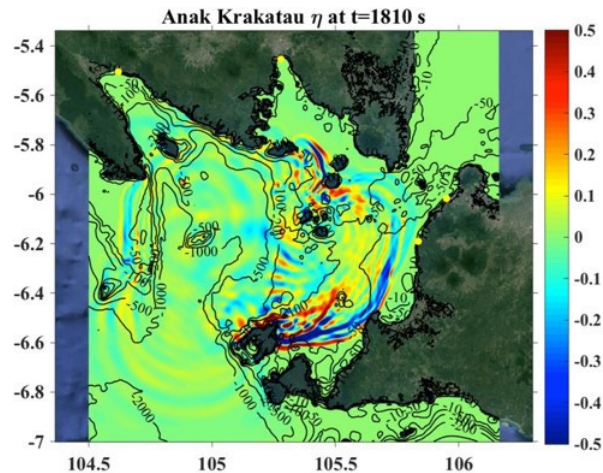


Figure 3: NHWAVE-FUNWAVE simulations of landslide tsunami generation and propagation

# Guam 2018 Accomplishments

## Tsunami Safety Products for Harbors and Marinas

- Continued modeling of tsunamis using NeoWave with multi-level, two-way nested grids from potential sources to Tumon Bay and Agana Bay, Guam.
- Completed modeling of tsunamis from potential sources to Apra Harbor, Guam. Developed tsunami safety products that include offshore safe zones, in-harbor hazard maps of currents, surge elevation, drawdown, and attenuation time.

## Community Outreach and Public Education Campaign on Preparing for and Responding to Tsunamis

- Conducted disaster awareness presentations for public and private schools and tsunami-earthquake puppet shows for Guam school students. Reached out to an estimated 8,000+ students island wide.
- Conducted tsunami awareness presentations for various government offices and private businesses.
- Supported local preparedness events, such as Tsunami Preparedness Week, Earthquake Preparedness Week, Typhoon Preparedness Month, National Preparedness Month, Great Guam ShakeOut, World Tsunami Awareness Day, etc.
- Printed and distributed tsunami evacuation maps, TsunamiReady cards (in various languages), tsunami evacuation wheels, boat owner brochures, and tsunami brochures and posters.
- Supported disaster/emergency management partners' events, such as Fire Prevention Week 2018, Boating Safety Week, Guam Police Week and Emergency Preparedness Campaign, First Lady's Christmas Bazaar, Relay4Life 2018, University of Guam's Charter Day, etc.



## Maintaining TsunamiReady Program and Sustaining Warning Dissemination

- Renewed TsunamiReady and StormReady recognition.
- Maintained tsunami evacuation signs and the All Hazards Alert Warning System throughout the island.

## Training, Seminars, and Workshops

- Hosted the Annual Tropical Cyclone, Disaster Preparedness, and Climate Workshop in collaboration with the National Weather Service (NWS) Guam Weather Forecast Office.
- Supported the Threat and Hazard Identification and Risk Assessment and Stakeholders Preparedness Review Workshop
- Hosted the Tsunami Awareness course (AWR 217), which was delivered by University of Hawai'i's National Disaster Preparedness Training Center and NWS Guam Weather Forecast Office.



## Disaster Response and Exercises

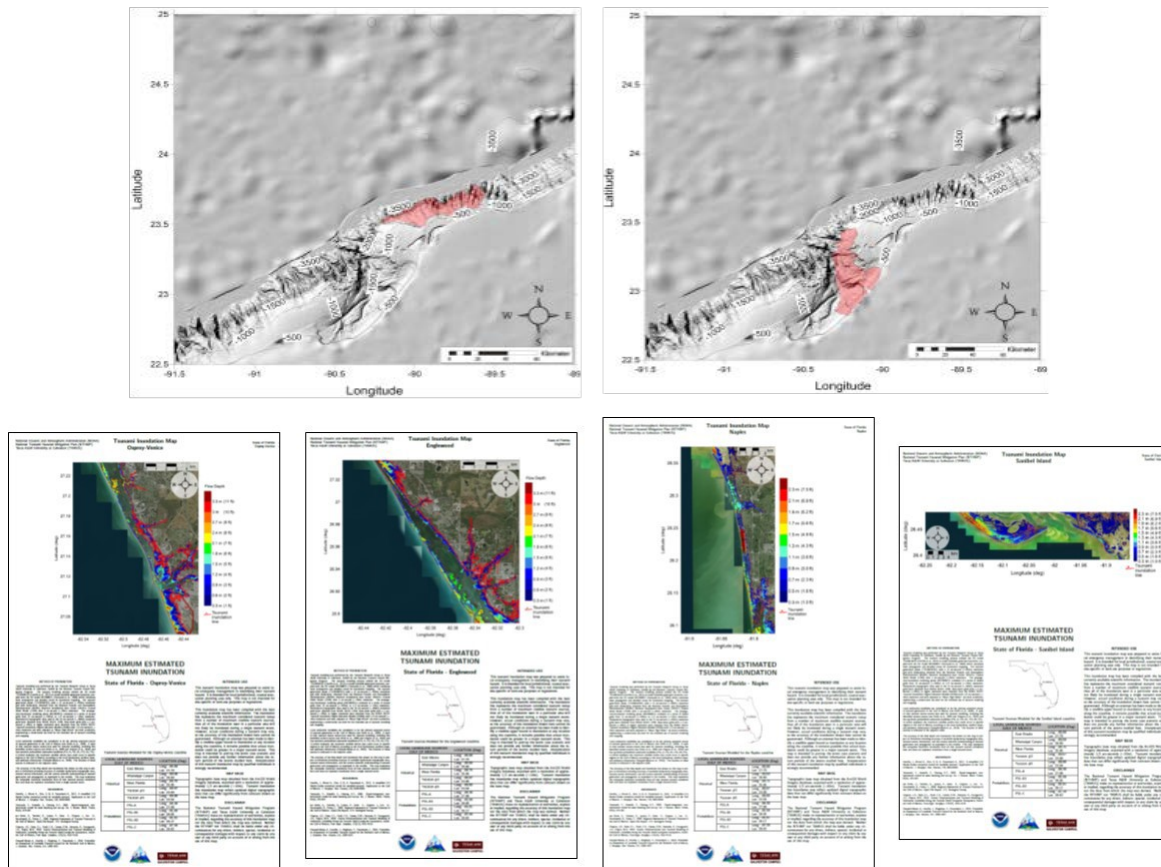
- Conducted the 2018 PacificWave Communication Exercise.
- Responded to disasters, such as: Typhoon Maria, flooding and mudslide incident, Super Typhoon Mangkhut, Typhoon Man-Yi, and Super Typhoon Yutu.



# Gulf of Mexico 2018 Accomplishments

During the calendar year of 2018, the Gulf of Mexico (GOM) group completed the following activities:

- The group developed two additional tsunami landslide sources on the Yucatan continental shelf.
- The sources were built as indicated in recent work by the USGS (see figure, top panel).
- The group also developed new high-resolution tsunami inundation maps for two regions in Florida: Osprey-Venice-Englewood and Sanibel Island-Naples (see figure, bottom panel). These maps include maritime products (i.e., current and vorticity) to identify where strong currents are possible and the associated damage levels. With these new maps, there are now 12 mapped locations or regions in the GOM, providing good coverage of the GOM coast's most populated regions. The intent of these maps is to help maritime communities, port managers, and other NTHMP-interested parties.
- In addition, the group continued implementation of low-order tsunami inundation maps for areas where maps have not been developed or where bathymetric and elevation data does not exist.
- In this work, tsunami results for an area were compared to the respective hurricane inundation categories, which allowed the group to draw meaningful conclusions that can be extrapolated to other regions where there is not enough information to develop tsunami inundation maps.



*New tsunami landslide sources on the Yucatan continental shelf based on recent work from USGS (top); Tsunami inundation maps for the Osprey-Venice-Englewood and Sanibel Island-Naples regions of Florida (bottom)*

- GOM emergency management partners presented on tsunami modeling at a tropical workshop for the National Weather Service Mobile region, which includes coastal Alabama along with some Florida and Mississippi counties. This was a joint effort of the Gulf Coast science and emergency management partners. The presentation heightened the interest in the TsunamiReady program, but no additional Gulf Coast counties have submitted an application, to date.



# Hawai'i 2018 Accomplishments

## State Activation and Events

- January 13—Ballistic Missile False Alert
- January 23—Alaska Earthquake and Tsunami Activation
- April 13—Storms, Flooding, Landslides, Mudslides (Kaua'i and O'ahu)
- September 11—Tropical Storm (Olivia)
- May 3—Kilauea Volcanic Eruption and Earthquakes
- August 22—Hurricane (Lane)



## Outreach

- TsunamiReady: 5 new communities, 3 renewals
- School Visits: 9 (includes exercises/presentations)
- Events/Presentations: 16 (includes TsunamiReady reviews)
- Tsunami Awareness Month Events: 10 (includes museum open house, siren sounding, interviews, etc.)

## Pacific Tsunami Museum

- Funding for refurbished “Locally Generated Tsunamis” exhibit and model train and tracks in “Hilo Town Model” exhibit
- Closed captioning for two tsunami videos in museum theater



## Foreign Language Radio

- Purchase of airtime for public service announcements (PSAs) on local radio and television stations during Tsunami Awareness Month
- Translation of PSAs airing on foreign language stations

## Mapping and Modeling

- Completion of tsunami safety products for Nawiliwili Harbor and Port Allen on Kaua'i



## Alert and Warning

- Maintenance of the world's largest siren system: Approximately 400 sirens with ongoing efforts to add to and update the system with a goal of 500 sirens



# Oregon 2018 Accomplishments

## Tsunami Safe: Hospitality Begins with Safety

Oregon redeveloped its Tsunami Safe training module to allow for modifications (<https://www.oregon.gov/tsunamisafe/Pages/default.aspx>). Enhancements also included improved user tracking.

## Tsunami Evacuation Wayfinding

The goal here has been to work with local communities to identify high-priority tsunami evacuation routes, develop a “beach to safety destination” plan for needed signage along the routes, and provide funding for tsunami signage. In 2018, several communities participated in this effort, including Florence, Yachats, Newport, Lincoln City, and Tillamook.

## Entering and Leaving Tsunami Hazard Zone Signs

The Oregon Department of Geology and Mineral Industries (DOGAMI) and the Oregon Department of Transportation installed ~115 new “Entering and Leaving Tsunami Hazard Zone” signs on Highway 101 on the central to south central Oregon coast (Lincoln, Lane, and Douglas counties).

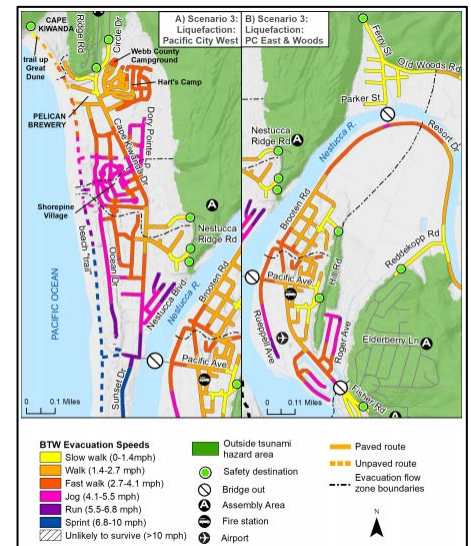
## You Are Here Signs

DOGAMI completed and disseminated 33 large format “You are here” signs for Neskowin (11), Douglas County (18), and Oregon State Parks (4). Additional signs were developed for Lincoln County parks (9), Gardiner (2), and U.S. Fish and Wildlife Service parks (3).

## Beat the Wave Modeling

DOGAMI completed “Beat the Wave” (BTW) modeling and evacuation route analysis for Pacific City (<https://www.oregongeology.org/pubs/ofr/p-O-18-06.htm>). The map plates depict minimum pedestrian evacuation speeds needed to reach safety and are important for evaluating mitigation options such as evacuation route improvement, location of wayfinding signage, land use planning, and establishment of vertical evacuation structures.

Modeling was also completed for Newport. Finally, DOGAMI worked with the University of Oregon to develop a BTW template for evacuation travel speed and route maps for the public.



## Maritime Guidance

DOGAMI completed modeling for two local and two distant source tsunamis for the Columbia River system (<https://www.oregongeology.org/pubs/sp/p-SP-51.htm>). Modeling incorporated dynamic tides, friction, and various river flows to develop a comprehensive understanding of how tsunamis interact with tides and river flows. The results were used to develop port-specific maritime tsunami response guidance ([https://www.oregongeology.org/pubs/mtrg/MTRG-2018-OR-01\\_Port-of-Astoria.pdf](https://www.oregongeology.org/pubs/mtrg/MTRG-2018-OR-01_Port-of-Astoria.pdf)) for the Columbia River estuary.

## Tsunami Conference

Oregon’s second Tsunami Conference was held in Newport. Guest speakers explored a wide range of topics including the latest science on Cascadia, efforts by the Quileute tribe in Washington State to relocate their facilities, economic impacts of a tsunami, recovery response planning, education and outreach, and experiential knowledge of having survived a major disaster. The diverse group of participants (~160) included representatives from federal, state, and local agencies, private industry, and the hospitality industry as well as emergency response volunteers.

# Puerto Rico 2018 Accomplishments

Puerto Rico has been impacted by several natural events, including hurricanes, earthquakes, and tsunamis. After Hurricanes Irma and Maria in 2017, Puerto Rico has seen tremendous positive change in community preparedness. One hundred years ago, on October 11, 1918, Puerto Rico was devastated by a Mw 7.3 earthquake that generated a tsunami that impacted the island with recorded wave heights of ~7 meters. Based on the data collected from trusted sources, ~116 people were killed by the earthquake and tsunami. Because of these recent and historic events, 2018 efforts focused on tsunami program recovery, educational activities related to the centennial anniversary of the 1918 earthquake and tsunami, and TsunamiReady community renewals and new TsunamiReady supporters.

## Tsunami Program Infrastructure Recovery

On September 20, 2017, Hurricane Maria, a powerful Category 4 storm, made direct landfall on Puerto Rico, crossing the entire island from southeast to northwest and drenching it with more than 30 inches of rain. The effects for Puerto Rico, from essential services to infrastructure, were catastrophic. In regard to the Tsunami Alerting System infrastructure, 80% of the tsunami signage, 78% of the siren systems, and 60% of the Emergency Managers Weather Information Network (EMWIN) terminals were damaged. In 2018, special efforts were made to help communities recover this system infrastructure. All the communities that renewed their TsunamiReady recognition in 2018 reported complete recovery.

## Centennial Anniversary of the 1918 Earthquake and Tsunami

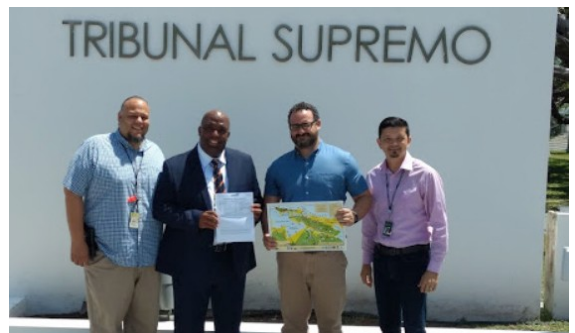
Three major activities were performed related to the centennial of the 1918 event:

- Material was curated, and a traveling museum exhibition, including pictures, artifacts, and other materials, toured the Island, exposing thousands of people to related educational activities. The exhibition included materials from Puerto Rico's National Library, the National Digital Archive of Puerto Rico, University of Puerto Rico, and other historical archives around the island. Materials included original newspaper clippings, magazines, and photos. A Facebook page was dedicated to the collection of pictures and testimonies from people around the world impacted by the 1918 event. The Puerto Rico Genealogy Society collaborated on research regarding victims of the event.
- A commemorative event, with participation of federal, commonwealth, and local officers and the community was held on the day of the centenary (October 11).
- A full-scale tsunami evacuation exercise was held in March in three Mayagüez communities as part of the CARIBE WAVE tsunami warning exercise.



## TsunamiReady

Despite the difficulties and other official priorities, 13 communities renewed their TsunamiReady recognition. All communities updated tsunami evacuation maps and tsunami vulnerability profiles and performed public education and outreach activities. This year, four Integrated Public Alert and Warning System (IPAWS) tests were executed to provide an alternative way to disseminate messages via the Island's public communication infrastructure. An additional TsunamiReady success was the designation of the Supreme Court of Puerto Rico as a TsunamiReady supporter.

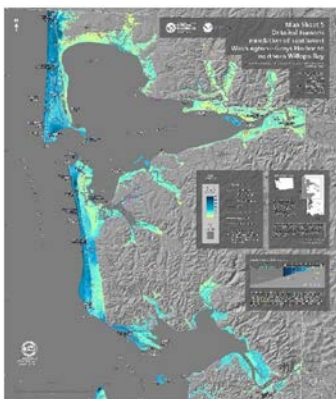
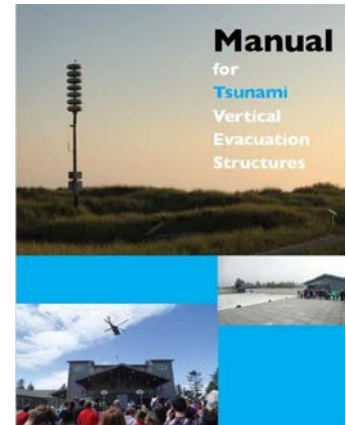




# Washington 2018 Accomplishments

## Mitigation and Preparedness

- In collaboration with the University of Washington (UW), developed a Manual for Tsunami Vertical Evacuation Structures to help coastal communities navigate the process (<http://bit.ly/TsunamiManual>).
- Washington Emergency Management Division (EMD), Washington Department of Natural Resources (DNR), the National Weather Service, and UW Sea Grant went on a tsunami roadshow, providing eight community presentations covering tsunami science, tsunami alerts, warning dissemination, what to do, and how to prepare. The presentations reached over 900 coastal community members.
- EMD and DNR participated as subject matter experts at several coastal community disaster preparedness fair booths and community presentations.
- Developed a media outreach campaign (radio, TV, social media) focused on improving siren awareness, highlighting where to find evacuation maps and online resources and encouraging participation in tsunami evacuation drills during the 2018 Great Washington ShakeOut. The campaign reached over half a million people, and 1.38 million people in Washington participated in Shakeout, an increase of 121,000.
- With support from the National Tsunami Warning Center, EMD facilitated a communications tabletop exercise that reviewed state tsunami-focused standard operating procedures, notifications, messaging, and conference calls (50+ participants).
- In collaboration with the Cascadia Region Earthquake Workgroup, the U.S. Coast Guard District 13, and DNR, EMD facilitated a maritime workshop with guest speakers from California to encourage tsunami hazard awareness and spark community engagement in maritime risk reduction activities.



## Hazard Assessment

- DNR used tools developed by the USGS to map pedestrian evacuation walk times out of inundation zones in Bellingham, Anacortes and vicinity, Aberdeen, Hoquiam, and Cosmopolis.
- DNR published Cascadia subduction zone (CSZ) L1 inundation and velocity map series for Southwest Washington, Port Angeles, Port Townsend, Anacortes, and Bellingham.
- UW completed tsunami modeling of the Whatcom County coastline using the CSZ L1 and ~ Mw 7.3 Seattle fault sources.
- UW and NOAA's Pacific Marine Environmental Laboratory (PMEL) completed a comparison study of GeoClaw and MOST model results for Bainbridge Island using the CSZ L1 and Seattle fault sources.
- PMEL completed tsunami inundation models for the CSZ L1 and ~ Mw 7.3 Seattle fault sources for northern King County.



## Alert and Warning

- Completed installation of three All Hazard Alert Broadcast sirens and updated siren voice messages (English and Spanish).
- Purchased and distributed NOAA weather radios for community outreach events and training.
- Sustained the state's tsunami alert and warning infrastructure through routine repairs, technical assistance, and providing for satellite activation capabilities.



## Other 2018 Subcommittee and Partner Updates

2018 was a difficult year for some of the NTHMP partners. As a result, some work was delayed, as described below.

### **Warning Coordination Subcommittee (WCS)**

The WCS is led by three co-chairs, one representative from each of the following: the National Tsunami Warning Center (NTWC), the Pacific Tsunami Warning Center, and a state or territory. Due to the vacancy of the NTWC's director position since 2017 and other demands on the other co-chairs, the work of the WCS had largely stalled. In 2018, the WCS met once in person during the winter meeting, and once informally to share Tsunami Warning Center updates, but there was no active subcommittee work.

In December 2018, the National Weather Service's Alaska Region hired a new director for the NTWC. Renewed activity is anticipated for the WCS in 2019.

### **Commonwealth of Northern Mariana Islands**

The Commonwealth of Northern Mariana Islands did not provide a summary of their 2018 tsunami-related accomplishments for this report. The territory continues to recover from two major typhoons in September and October, 2018.

### **U.S. Virgin Islands**

The U.S. Virgin Islands did not provide a summary of their 2018 tsunami-related accomplishments for this report. The territory continues to recover from two major hurricanes in September 2017. Most infrastructure was lost on the islands, and significant damage to housing and other structures displaced tens of thousands of people. Throughout 2018, emergency management staff focused on response to and recovery from these presidentially declared disasters and the associated coordination with FEMA. Thus, they were limited in their ability to carry out tsunami preparedness, mitigation, and warning coordination activities.