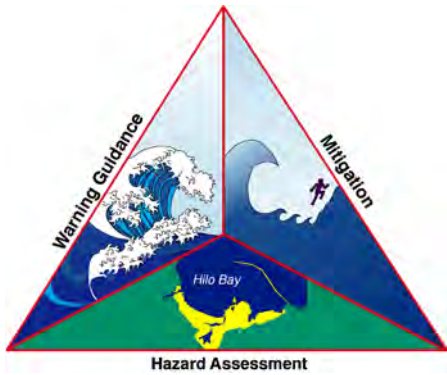




2017

Authored by National Tsunami
Hazard Mitigation Program
Coordinating Committee Members
January 2018



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 2017 was a busy and active year for the NTHMP. This annual report was informally produced to highlight some of the NTHMP’s 2017 activities. It is a compilation of submissions from the NTHMP’s three subcommittees and partner states and territories.

Summaries provided by the following state and territorial agencies and institutions:

- 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 Coordination
- California Governor’s Office of Emergency Services/California Geological Survey
- Commonwealth of the Northern Mariana Islands Homeland Security and Emergency Management
- Guam Homeland Security
- Hawaii Emergency Management Agency/University of Hawaii
- Oregon Office of Emergency Management/Oregon Department of Geology and Mineral Industries
- University of Puerto Rico Puerto Rico Seismic Network
- Santa Rosa County Emergency Management Agency/Texas A&M University at Galveston (Gulf Coast)
- University of Delaware/University of Rhode Island (East Coast)
- U.S. Virgin Islands Territorial Emergency Management Agency
- Washington Emergency Management Division/Washington State Department of Natural Resources

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

National Tsunami Hazard Mitigation Program (NTHMP) 2017 General Updates

NTHMP Meetings

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

Annual Meeting

The NTHMP Annual Meeting and subcommittee meetings were held in Portland, Oregon, January 30–February 3. Seventy-one people participated in these meetings throughout the week. The five-year external review of the NTHMP by five independent reviewers was also conducted during these meetings.



NTHMP Summer Subcommittee Meetings

The NTHMP Mitigation and Education Subcommittee (24 attendees) and the Mapping and Modeling Subcommittee (22 attendees) met August 1–3 in Salt Lake City, Utah.

Other Meetings

- The NTHMP Coordinating Committee met four times by teleconference .
- The Mapping and Modeling Subcommittee met three times by teleconference.
- The Mitigation and Education Subcommittee met three times by teleconference.
- The Warning Coordination Subcommittee met three times by teleconference.
- A five-member external review team met in person during the Annual Meeting in Portland and nine times by teleconference and joined a Coordinating Committee teleconference to go over key points of the external review report.
- A five-member NTHMP Allowable Grant Activities Work Group met in person during the summer meetings and six times by teleconference. The purpose of this work group was to review the language of the Tsunami Warning, Education, and Research Act of 2017 (TWERA) and make recommendations to NOAA/National Weather Service (NWS) regarding NOAA/NWS Tsunami Activities Grants for FY18 (and future).
- An 11-member NTHMP Strategic Plan Work Group composed of members of the NTHMP subcommittees and the NTHMP chair met in person during the summer meetings and seven times by teleconference to write and edit the 2018-2023 NTHMP strategic plan. The draft strategic plan was presented to the Coordinating Committee during a regularly scheduled teleconference.

2017 NTHMP Publications and Resources

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

- *TsuInfo Alert* (six issues)
- Guidance for Safe Minimum Offshore Depth for Vessel Movement for Tsunamis
- Benchmarked Tsunami Models list (updated)
- Proceedings and Results of the National Tsunami Hazard Mitigation Program 2015 Tsunami Current Modeling Workshop
- Tsunami Maps Interactive web page
- 2017 World Tsunami Awareness Day Social Media shareables (no longer online)

Grants

For the FY17 grant cycle (September 1, 2017–August 31, 2019), NOAA/NWS awarded \$5,263,296 to 12 NTHMP partners, and \$629,552 was transferred within NOAA (to the Pacific Marine Environmental Lab and the National Centers for Environmental Information) on behalf of the Mapping and Modeling Subcommittee and two state partners (Washington and the U.S. Virgin Islands) to meet critical tsunami modeling needs within the scope of the NTHMP strategic plan. More information on FY17 NOAA/NWS grant-funded projects is available at <http://nws.weather.gov/nthmp/grants/2017grants/index.html>.

Administration

The Coordinating Committee welcomed replacement NTHMP Coordinating Committee members:

- Diego Arcas, NOAA voting member, NOAA Center for Tsunami Research, replacing Vasily Titov
- Leo Espia, Guam emergency management member, Guam Department of Homeland Security and Emergency Management, replacing Pilar Carbullido
- Corina Forson, Washington science member, Washington Department of Natural Resources, replacing Tim Walsh
- Daniel Hahn (Brad Baker, alternate), Gulf Coast emergency management member, Santa Rosa County Emergency Management Agency, replacing Chayne Sparagowski
- Christa von Hillebrandt-Andrade, NOAA voting member, NWS Caribbean Tsunami Warning Program, replacing Paul Whitmore

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

- Tamra Biasco, FEMA Region X, FEMA co-chair, Mitigation and Education Subcommittee, replacing Gala Gulascik
- Paul Huang, National Tsunami Warning Center, National Tsunami Warning Center co-chair, Warning Coordination Subcommittee, replacing Paul Whitmore
- Dmitry Nicolsky, University of Alaska at Fairbanks, state co-chair, Mapping and Modeling Subcommittee, re-elected
- Kevin Miller, California Governor's Office of Emergency Services, state co-chair, Mitigation and Education Subcommittee, re-elected
- Althea Rizzo, Oregon Emergency Management, state co-chair, Warning Coordination Subcommittee, re-elected
- Christa von Hillebrandt-Andrade, NOAA co-chair, Mitigation and Education Subcommittee, replacing Laura Kong

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

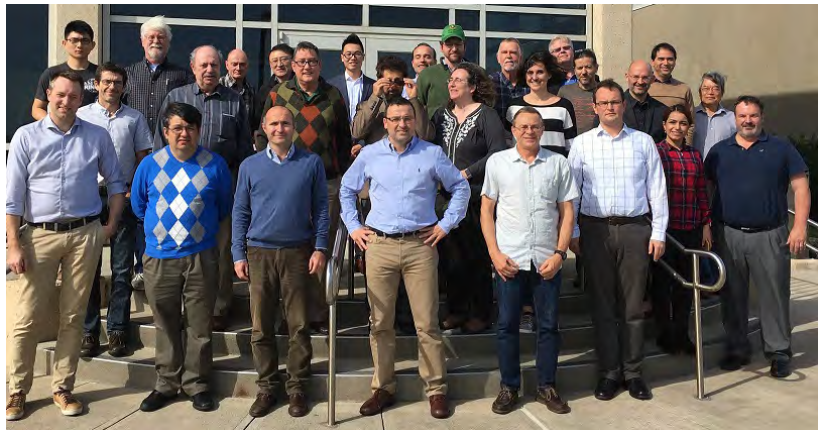
Other Major Actions

- The NTHMP external review report was completed and delivered to the Coordinating Committee. <http://nws.weather.gov/nthmp/assessments/2017assessment/assessment2017.html>
- The NOAA/NWS Tsunami Activities Grant Guidance and Allowable Grant Activities chart were updated for FY18. As directed by TWERA, the guidance now includes procedures to allow participation by local governments, quasi-government agencies, and tribes in the federal assistance provided through this grants process.
- The NTHMP passed a formal policy regarding official endorsement of NTHMP products. The new policy includes disclaimer language.
- The NTHMP subcommittees updated their respective terms of reference to include a commitment to develop annual work plans for 2018 and subsequent years.

Mapping and Modeling Subcommittee (MMS) 2017 Accomplishments

Facilitated a Tsunamigenic Landslide Model Benchmarking Workshop

To determine accuracy/adequacy of tsunami models in simulating landslide-generated tsunamis, and hence to ensure consistent development of hazard reduction products for use by NOAA and NTHMP partners, MMS (led by the U.S. East Coast science members) facilitated and organized the “Landslide Tsunami Model” Benchmarking Workshop in Galveston, Texas, January 9–11. Nine different tsunami modeling groups presented and evaluated the results.



The nearly 30 participants included a dozen modelers and many other experts from U.S., U.K., French, Spanish, Norwegian, Iranian, and Italian academic institutions and government agencies.

The workshop web page (<http://www.udel.edu/kirby/landslide/>) has presentations, reports, and discussions and will be maintained as a public repository for data and model results. It is anticipated that the workshop will help MMS to establish the appropriate guidelines for modeling nonseismic sources. A journal paper is being written to summarize and disseminate workshop findings to the national and international communities.

Published the 2015 NHTMP Tsunami Current Modeling Workshop Proceedings

Verification and validation of numerical tsunami models is crucial to the production of hazard mitigation and public safety products for maritime and coastal communities. The MMS acknowledges receipt of the proceedings and expresses gratitude and appreciation for the success of the current modeling workshop. The recommendations will be considered by the MMS such that appropriate improvements and guidelines are developed for state and federal tsunami modelers to ensure the most consistent and accurate products nationally.

Participated in Development of the NTHMP Strategic Plan

Members of the MMS participated in the strategic plan work group that met multiple times to develop a five-year strategic plan for the NTHMP spanning 2018–2023. The MMS will use the overarching strategic plan to set goals for one- to five-year plans. The main theme that impacts the MMS is the Hazard and Risk Assessment theme with several main strategies, including identification of gaps in tsunami source characterization, modeling completion of inundation and evacuation maps for all unmapped U.S. coastal communities, and development and implementation of a strategy for using HAZUS and product guidance.

Prioritized Digital Elevation Model Development by the National Centers for Environmental Information

Digital elevation models (DEMs) are the cornerstone of all tsunami modeling activities. In their absence, development of accurate tsunami hazard assessment products would be significantly impeded. In 2017, MMS set DEM development priorities as Bristol Bay, Alaska; Bellingham Bay, Washington; and Miramar Beach to Laguna Beach, Florida. The list of DEM priorities is pending for 2018.

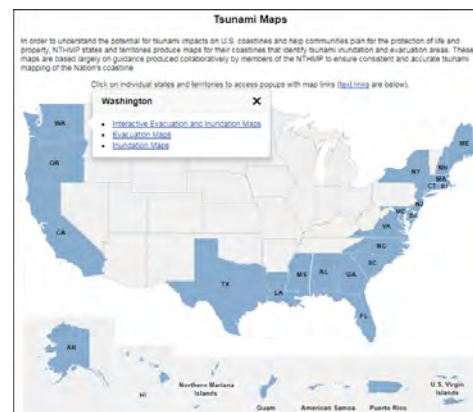
Mitigation and Education Subcommittee (MES) 2017 Accomplishments

- **MES Co-Chairs and Partners**

- Assisted with development of a new, five-year NTHMP strategic plan
- Provided input and guidance to Allowable Grant Activities informed by TWERA
- Developed agendas and priorities and coordinated and convened annual, summer, and business meetings
- Conducted work on a replacement for the media guide for release in 2018
- Developed an interactive map for the Tsunami Maps web page

- **MES Meeting at Annual Meeting in Portland, Oregon**

- Updates on Post-Tsunami Protocol
- TsunamiReady
- Evacuation modeling
- Maritime guidance
- Media and social media outreach
- MES/MMS guidelines and best practices series
- Oregon wayfinding techniques and technology
- Earthquake Engineering Research Institute School Earthquake Safety Initiative Tsunami Subcommittee
- FEMA ATC-122 “Reducing the Risk to our Schools from Natural Hazards and Improving the Safety of Our Children”
- Strategic planning (2018–2023)
- External review team discussion



- **Three Business Meetings**

- Status of 2013-2017 strategic plan work
- Path forward for future strategic plan 2018–2023
- NTHMP Annual Meeting follow-up
- TWERA update as it applies to NTHMP
- 2017 NTHMP external review report
- Tsunami exercises: 2017 lessons learned, 2018 plans (Caribe Wave, Lantex, Pacifex)

- **MES Summer Meeting in Salt Lake City, Utah**

- Working sessions
 - › TsunamiReady Tier 2
 - › Strategic planning
 - › Allowable Grant Activities feedback and prioritization
- Reports and discussion
 - › HAZUS tsunami module
 - › Preparedness campaign reports
 - › World Tsunami Awareness Day
 - › Tsunami evacuation sign discussions
 - › Pedestrian evacuation updates
 - › National Centers for Environmental Information update
 - › Role of MES in nationally developed exercises
 - › Strategy for developing NTHMP talking points on important topics



Warning Coordination Subcommittee (WCS) 2017 Accomplishments

Through the WCS, the NTHMP provides input to the operational U.S. Tsunami Warning System. Recommendations from the NTHMP help refine warning system messages, graphics, procedures, exercises, and dissemination systems so that warning system products are effective during a tsunami warning. Membership is made up of federal, state, and territorial partners.

This is a brief report on the accomplishments of the WCS.

- There was an initial discussion held at the summer NTHMP meetings on alerting, warning, and response. Four talking points were developed.
 - Ensure understandable and effective Tsunami Warning Center products.
 - Provide effective, sufficient, and reliable warning dissemination to people at risk.
 - Ensure effective tsunami response.
 - Support and implement post-tsunami event protocol for U.S. states and territories
- A procedure was instituted to conduct conference calls whenever tsunami information statements are issued with indications of potential danger.
- The National Tsunami Warning Center (NTWC) tracked both St. Pierre and Miquelon during eastern communication tests. The results were detailed in the communication test summary that was sent to partners.
- Updates were made to the Northern California tsunami product break points to clarify boundaries.
- Updates were made to the procedures charts on the Tsunami.gov website with combined EQI/TIB.

While not WCS-led actions, the following activities were supported by NTHMP partners:

- The NTWC conducted Tsunami Warning System training at their center in Palmer, Alaska. The training was held April 4–6 and had 14 students.



- Websites for the NTWC and the Pacific Tsunami Warning Center (PTWC) were combined into Tsunami.gov so that all tsunami alerts are visible on one map-based platform.

Alaska 2017 Accomplishments

Alaska experienced major destructive tsunamis in 1938, 1946, 1957, and 1964, and has over 60 communities at risk of future near- and far-field tsunamis. The Alaska tsunami hazard is essentially local. A local tsunami can reach Alaskan coastal communities within minutes after the associated earthquake. Therefore, saving lives and property depends on community preparedness through maps, mitigation, and education.

To mitigate this risk, Alaskans need to understand tsunami hazards for their coastal communities through the Alaska Tsunami Preparedness and Hazard Mitigation Program, hazard assessment (mapping), scenario planning, mitigation tools, and broad education in support of the TsunamiReady program.

Scenario Planning and Tsunami Hazard Assessment

- Completed high-resolution tsunami inundation modeling and mapping for Homer, Seldovia, Haines, and Skagway. Draft maps and technical reports were presented in each city.
- Conducted tsunami DEM verification for St. George, St. Paul, Perryville, and Nanwalek.
- Modeled tsunami wave heights in Bering Sea; developed an approximation to the potential inundation zones in St. Paul, St. George, Plantinum, Port Nelson, and Dillingham; and verified the proposed methodology for Adak.
- Published the tsunami inundation maps for Juneau and Kodiak.
- Conducted live code test in March to 87 coastal communities covering over 2,000 linear miles (see map above).



Mitigation and Education

- Presented a Tsunami Operations Workshop in Homer for nine southcentral communities (see photo at right).
- Presented the pedestrian travel time to safety maps in communities of Homer, Unalaska, Chignik Bay, and King Cove and conducted outreach to school students.
- Developed evacuation brochures for the communities of Cordova and Seward.
- Created new earthquake and tsunami playing cards specific to Alaska.
- Developed new Alaska tsunami information brochures explaining the hazards and warnings for tsunamis across Alaska.
- Installed warning siren systems in Petersburg and Cordova.



TsunamiReady

- Worked with the NTHMP and NWS Weather Forecast Offices in Alaska in promoting the TsunamiReady program.
 - Whittier was recognized as TsunamiReady.
 - Cordova held a "race the wave" community preparedness event (see photo at right).



American Samoa 2017 Accomplishments

Tsunami Functional Exercise

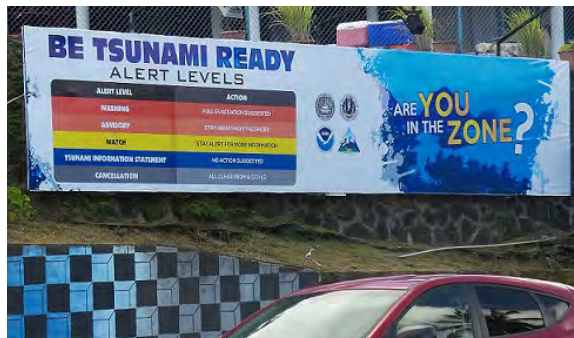
The Tsunami 2017 Functional Exercise was conducted on August 16. It was planned for one eight-hour day at the American Samoa Department of Homeland Security (ASDHS)/Territorial Emergency Management Coordinating Office. Exercise play was limited to the American Samoa Government, PTWC, NWS, U.S. Army (headquarters and headquarters company), and FEMA Region IX, where they performed actions associated with a distant tsunami.

Maritime Hazard Maps (1st Round Kick-Off)

The first round of a maritime hazard map project for Pago Pago Harbor was kicked off August 17–18. Meetings were held with the University of Hawaii researcher conducting the work, ASDHS, local port administration staff/port users and the U.S. Coast Guard District 14 to discuss maritime hazard products assisting in terms of decision support, tsunami awareness, and evacuation procedures for the maritime community.

Tsunami Preparedness Week

The Tsunami Preparedness Campaign Week took place September 24–30. The American Samoa Tsunami Program conducted media outreach on radio stations and social networks. Evacuation drills and public outreach were also scheduled during the week of the tsunami campaign, targeting schools along the coast and including participation by nongovernmental agencies such as the American Red Cross.



Tsunami Billboard

A tsunami alert levels billboard was installed to promote public awareness and enhance tsunami preparedness within the community with information related to tsunamis and their impact. New and improved technologies have contributed to modern ways to expand tsunami awareness. Billboards serve as a constant reminder to the public as an extension to tsunami signage.

Siren Preventive Maintenance

The American Signal Corporation (ASC) was contracted initially to install sirens around American Samoa. Daily environmental factors contributing to siren damage required siren maintenance and additional service by ASC to prolong warning dissemination capabilities. Corrective maintenance was conducted for 44 preassessed and preselected sirens. The Siren Compulert (above) shows that after maintenance tasks were completed, 44 sirens were functioning and operational. (Red flagged sirens are awaiting replacement parts.)



California 2017 Accomplishments

The California Tsunami Steering Committee composed of the California Governor's Office of Emergency Services, California Geological Survey, NWS, and the 20 coastal county emergency managers convened two statewide meetings to guide priorities and coordinate statewide planning and implemented this annual plan over the past year.

Year-Round Preparedness Activities, Tsunami Preparedness Week 2017, and ShakeOut

- Conducted statewide playbook communications test.
- Participated in Tsunami Warning System training at the NTWC.
- Promoted registration of activities on TsunamiZone.org.
- Purchased community tsunami warning signs created plans.
- Offered two Tsunami Awareness trainings (AWR-217).
- Supported local activities (e.g., Oxnard and Ventura County town halls, San Diego media event, San Francisco, Long Beach, and Marina Del Rey School tsunami walks) and local brochure development.



California Tsunami Evacuation Playbooks

- Held county workshops and exercises testing playbooks/FASTER approach.
- Provided draft playbooks for San Luis Obispo, Alameda, and Santa Cruz Counties.
- Met with the Tsunami Warning Centers, Hawaii, and other states/territories to initiate a plan for evaluating forecast accuracy and applying playbook/FASTER approaches.

Maritime Tsunami Response Playbooks and Mitigation Planning (co-partnered with FEMA)

- Held maritime planning meetings with various harbor authorities. Meetings with similar entities in Puerto Rico and Hawaii leveraged product standards.
- Presented playbooks to U.S. Coast Guard. Will coordinate incorporating playbooks into the Coast Guard's Contingency Plan for port areas.
- Developed harbor improvement reports for six pilot harbors to assist with mitigation and recovery.

Probabilistic Tsunami Hazard Analysis (PTHA) maps (co-partnered with FEMA)

- Completed modeling statewide and conducted field work review.
- Completed PTHA report with review by the Tsunami Advisory Group.

Pedestrian Evacuation Modeling

- Provided probabilistic 1,000- and 2,475-year average return period inundation lines to USGS to complete evacuation time evaluation.
- Met with USGS and tsunami advisory group to guide project workplan.



Real-Time Coastal Flood Hazard Observation Web-Camera Network

- Researched Pacific Rim camera locations and attributes and coordinated with the NTWC.
- Built an easy-to-use beta internet map interface to access cameras during response.

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

- Worked with Coastal Commission and other partners on three major risk reduction goals:
 - Maritime multihazard risk reduction
 - PTHA product application
 - Community recovery planning guidance

Commonwealth of the Northern Mariana Islands

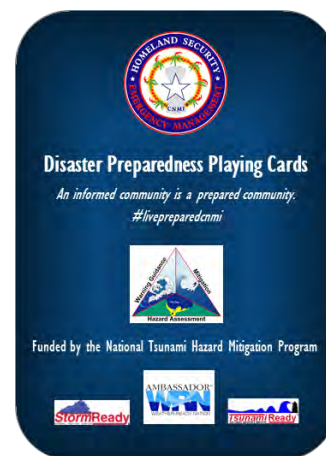
2017 Accomplishments

Tsunami/Siren Warning Alert System

- Commonwealth of the Northern Mariana Islands (CNMI) Homeland Security and Emergency Management (HSEM) procured 25 sirens for local responding agencies to install in response vehicles. Ten were issued to local police and fire departments. An additional 15 will be distributed in early 2018.

Tsunami Awareness and Education Outreach Materials

- New and updated pamphlets with emergency tips and evacuation routes are being finalized and will be ready for production in early 2018.
- Playing cards with useful tsunami emergency tips are being finalized for production and will be ready for distribution in early 2018.
- Through the creation of a work group comprising appropriate local agencies and spearheaded by CNMI HSEM, discussions have begun covering a way forward to create and mass produce tsunami evacuation route maps leading to assembly points for each village located on the western coast of the island of Saipan.



Tsunami Awareness Training and Preparedness Exercises

- In February and March, local government employees participated in a two-day tsunami awareness workshop on the island of Saipan.
- In April, CNMI HSEM Emergency Operations Center (EOC) State Warning Point, along with Joint International Tsunami Information Center based out of Guam, conducted a tsunami exercise testing communication capabilities and procedures. The purpose of the exercise was to open the floor to discuss ways forward to improve time-sensitive information dissemination during tsunami emergency alerts.
- In June, a Tropical Cyclone, Disaster Preparedness, and Climate Workshop was held covering topics of tsunami awareness. Participants included school principals and hotel industry employees of those located along the western coast of Saipan.
- In September, CNMI HSEM transported 230 students from school campuses in inundation zones to the CNMI EOC to participate in an hour-long tsunami workshop conducted by the CNMI HSEM Planning Team. Positive feedback was received for the week-long event, and goals to progress in this effort will continue throughout 2018.
- In October, more outreach was facilitated by the CNMI HSEM Planning Team to local healthcare and daycare facilities and security teams from hotels along the inundation zones of the island of Saipan.
- In December, members of the CNMI HSEM Tsunami Exercise and Preparedness Taskforce met with school principals and Headstart directors in preparation for the 2018 Calendar of Events set to heavily focus on tsunami awareness and education outreach for faculty and staff and evacuation route drill exercises for faculty, staff, and students.

Tsunami Evacuation, Assembly, and Hazard Zone Signage

- In November, the CNMI HSEM completed the installation of 13 signs on the island of Tinian. The islands of Saipan and Rota continue to maintain surrounding areas where signs have been previously installed through funding provided by NOAA/NWS grants.



East Coast 2017 Accomplishments

- Worked on NOAA/NWS-funded work on modeling meteotsunamis that could potentially severely impact the U.S. East Coast. For example, Figure 1a shows observed and modeled nontidal surface elevations at Atlantic City, New Jersey, for the June 13, 2013, event illustrated more broadly in Figure 1b that caused flooding and resonance of many U.S. East Coast harbors. (Note that model/data comparisons will require additional removal of subtidal oscillations at longer time scales from observed data.) The U.S. East Coast science members are conducting a probabilistic analysis of events of the type illustrated as well as events generating forced edge wave responses.

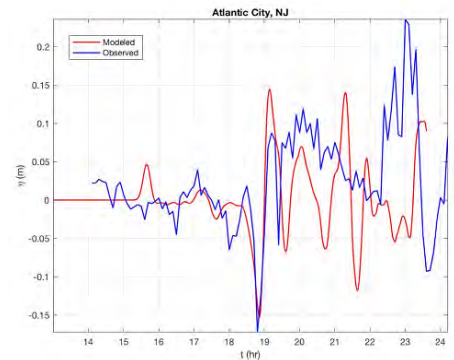


Figure 1a

- Work continues on simulating tsunami generation by deforming submarine mass failures (SMFs) and quantifying effects of slide rheology on the tsunami coastal hazard along the U.S. East Coast. Figure 2 shows Areas 1-4 where large Currituck SMF proxies are modeled (i.e., with similar geometry and characteristics as the historical Currituck slide complex) as rigid slumps or deforming slides. Figure 3a illustrates the motion of a deforming slide in Area 1, and the maximum envelope of surface elevation computed at the five-meter depth isobaths is shown in Figure 3b for tsunamis generated by the four rigid slump or deforming slides. Results show that the rigid slump hypothesis used in earlier inundation mapping may be too conservative in some locations (Schambach et al. 2017).

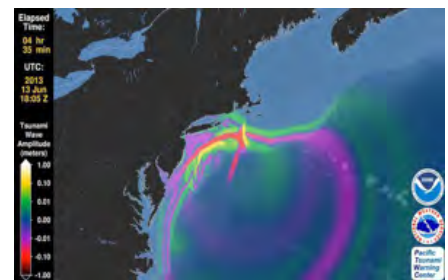


Figure 1b

- Journal papers describing the development of a coupled wave/morphology model for tsunami events, and its use in an investigation of impact of morphology change on hazard levels during events, are in preparation.
- Work on tsunami detection methods continues, with a focus on development of models for hydroacoustic wave generation and propagation, including developing extensions to the Boussinesq model FUNWAVE-TVD to account for ocean compressibility and earth elasticity, both of which affect tsunami propagation speed and thus affect the spatial distribution of wave energy in the far field of an event.

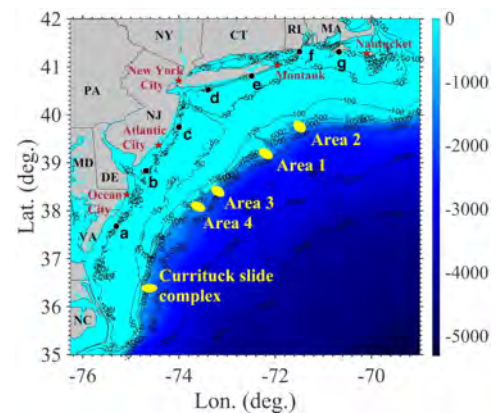


Figure 2

- An East Coast tsunami map briefing was held by the science members for emergency managers in Framingham, Massachusetts, on July 12. This briefing was very well received. It was organized by the NTHMP East Coast emergency management member.

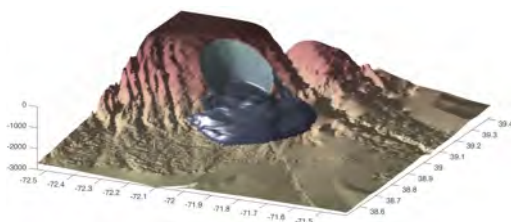
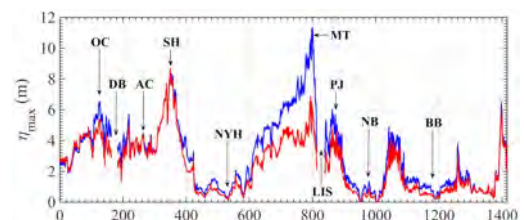


Figure 3a, left;
Figure 3b, right



Guam 2017 Accomplishments

Tsunami Awareness through Community Outreach and Public Education Campaign

- Completed more than 83 outreach events with an estimated 6,000+ people reached.
- Supported the following events: Service Learning and Youth and Community Preparedness Summit for teachers and community partners, January 18–19; Service Learning and Youth and Community Preparedness Summit for students, January 20; Tsunami Preparedness Week, April 2–8; World Tsunami Awareness Day, November 5; National Preparedness Month, September; Great Guam ShakeOut, October 19; etc.
- Conducted the Annual Tropical Cyclone, Disaster Preparedness, and Climate Workshop, June 6.
- Conducted a series of Hazard and Risk Awareness with Service Learning/Community Service Project Development Workshops (at least once every two months).
- Regularly conducted Disaster Preparedness and Tsunami-Earthquake Puppet Shows in various schools (one-two times a week).
- NWS-Guam Weather Forecast Office (WFO) conducted tsunami and earthquake seminars to 16 students participating in three Pacific Desk month-long training classes at the Guam WFO for Weather Service officials from Yap, Palau, Pohnpei, Chuuk, and the Marshall Islands.



Improve Community Awareness and Education Preparing for and Responding to Tsunamis as a Community, Including Maritime Community

- Printed and distributed updated tsunami brochures, tsunami evacuation wheels, tsunami ready cards in various languages, tsunami posters, boat owners brochures, and updated tsunami evacuation maps to accommodate the growing population of local, military, and visitors to the island to ensure the community is aware of the tsunami hazard, safety information, evacuation routes, and designated assembly areas.
- Enhanced the media campaign via radio, television, movie theaters, food court screens, and college campuses.

Maintenance of TsunamiReady Program and Enhancement of Alert Warning Notification

- Maintained the tsunami evacuation signs throughout the island. Continued expansion of the All Hazards Alert Warning System through purchase of additional three units to address the tsunami hazard zones and/or low-lying areas not covered by the existing system.

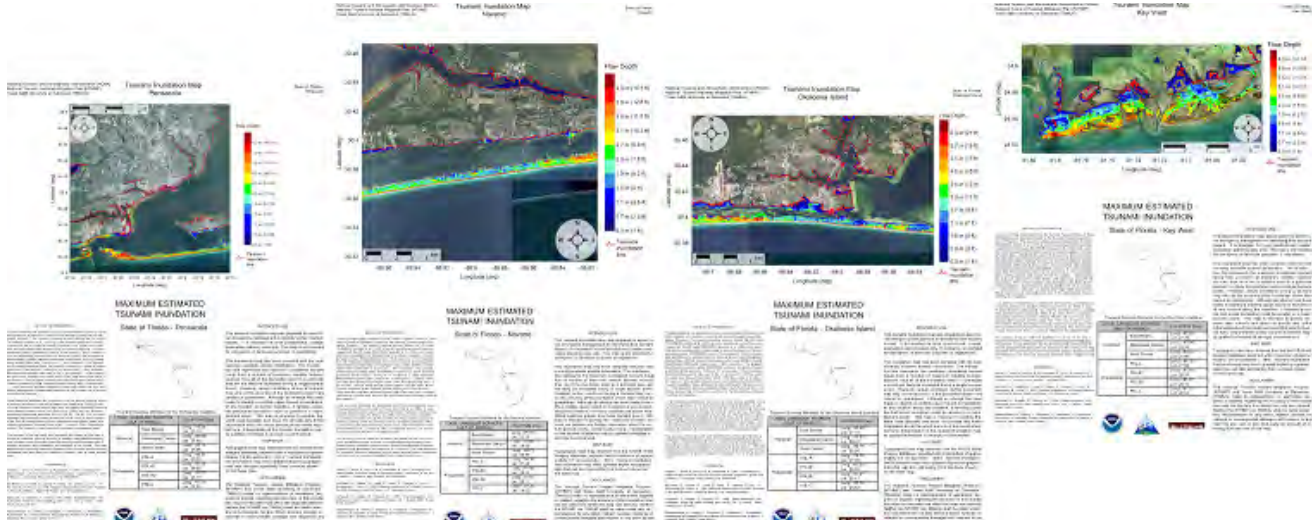
Tsunami Safety Products for Apra Harbor, Guam

- Continued modeling of tsunamis using NeoWave with multilevel, two-way nested grids 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.

Gulf of Mexico 2017 Accomplishments

During the calendar year of 2017, the Gulf of Mexico group completed the following:

The first is the development of four new high resolution tsunami inundation maps for Pensacola, Santa Rosa County, Okaloosa County, and Key West, Florida. These maps include maritime products (i.e., current and vorticity). With this information, location of strong currents and associated damaging levels can be identified. We are hoping that these results assist the maritime communities, port managers, and other interested parties.



Maximum of maximum tsunami inundation maps for Pensacola, Santa Rosa County, Okaloosa County, and Key West, Florida.

The second is the continuation of the implementation of low-order tsunami inundation maps where maps have not yet been developed or where no bathymetric and elevation data exist. In the study, we compared tsunami results with hurricane categories. This study has been executed for all communities mapped, allowing us to withdraw meaningful conclusions that can be extrapolated to regions where there is not enough information to develop tsunami inundation maps.

Third, in 2016, Santa Rosa County, Florida, was recognized as TsunamiReady by the NWS WFO in Mobile, Alabama, making the county the first TsunamiReady community along the Gulf Coast, which includes five states and about 50 counties. The emergency management team has done multiple tsunami presentations to various groups around the county. For example, during the 2017 annual emergency operations center (EOC) activation exercise, we included a tsunami component and briefing to EOC staff. Condominium owners on Navarre Beach agreed that condos could serve as a vertical evacuation area from a tsunami threat. With this partnership, we have signs along beach walkovers directing evacuations off the island and vertical evacuation signs for the condo walkovers. This accomplishment was made possible by the Santa Rosa County, Florida, Emergency Management Agency.



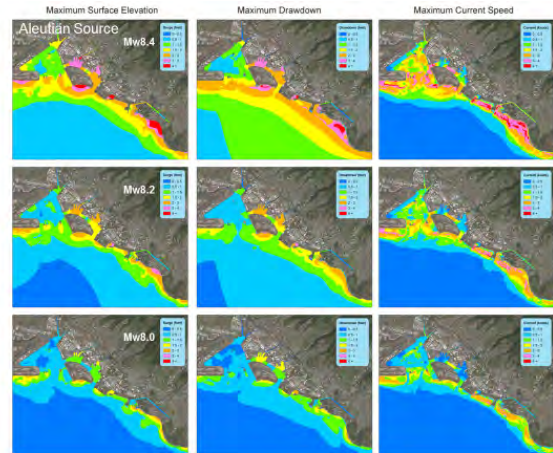
Tsunami signs on public walkover (above) and condominium walkover (below)



Hawaii 2017 Accomplishments

Tsunami Harbor Modeling

In collaboration with the maritime community of Hawaii, a priority list of harbors for development of tsunami safety products was created. These include: Pearl Harbor, Honolulu Harbor, and Barbers Point Harbor on Oahu; Hilo and Kawaihae Harbors on Hawaii; Kahului Harbor on Maui; Nawiliwili Harbor and Port Allen on Kauai; Kaunakakai Harbor on Molokai; and Kaunapali Harbor on Lanai. A maritime working group provided guidance to the project. Their input has helped define the data products, which include offshore safe zones and in-harbor hazard maps of current, surge, and drawdown for potential tsunamis.



TsunamiReady/Hawaii Hazards Awareness and Resilience Program

Hawaii Emergency Management Agency, in collaboration with Hawaii National Guard, continues to build resilient communities in Hawaii. One additional community (Manoa) was recognized as TsunamiReady in 2017.

Tsunami Schools

Tsunami educational material and support for public schools, children, and parents located within the tsunami evacuation zone, which will include the development of a comprehensive evacuation plan.

Foreign Language Radio

Partnership with local radio stations that broadcast our messages in 16 languages.

Tsunami Observer Program

We continue to align both the Tsunami Observers Program and the Post-Tsunami Protocol.

Tsunami Awareness Month

April 1 marks the anniversary of a massive tsunami generated by an earthquake in the Aleutian Islands in 1946. It caused widespread deaths, damage, and devastation to the entire state, but Hilo Harbor on Hawaii Island was hit especially hard. Our 2017 objective was to encourage the public to take tsunami safety into their own hands by preparing their homes and families during Tsunami Awareness Month.

Pacific Tsunami Museum

Located on Hawaii Island, the Pacific Tsunami Museum plays an important role year-round by providing a venue for the public and our visitors to learn and develop awareness of tsunamis and their potential impact.



Siren System

The State of Hawaii develops and maintains a large siren system as a major alert system for the public. Currently there are 386 sirens on all islands at an average \$100,000 to install and approximately \$2,500 to maintain annually.



Oregon 2017 Accomplishments

Tsunami Safe: Hospitality Begins with Safety

Oregon is continuing to promote its Tsunami Safe program to train staff and management members of the hospitality industry along the Oregon Coast.

Tsunami Evacuation Wayfinding Project

Cannon Beach completed its “beach to safety” tsunami wayfinding project for selected critical evacuation routes. The purpose of the study was to evaluate existing wayfinding signage capabilities, implement new approaches to improve local and visitor knowledge of tsunami hazards, and help guide the public to safety along identified high-priority evacuation routes. Major project components included three tsunami kiosks (illuminated at night), new signage from the beach (to help guide people to the nearest evacuation route), and fluorescent signage markers on the sidewalk along 10 key evacuation routes. In addition to Cannon Beach, Oregon Office of Emergency Management and the Oregon Department of Geology and Mineral Industries (DOGAMI) are working with four other coastal communities to establish “blue lines” along key evacuation routes.

“Entering and Leaving Tsunami Hazard Zone” and “You are here” Signs

DOGAMI and the Oregon Department of Transportation (ODOT) are partnering to install new “Entering and Leaving Tsunami Hazard Zone” signs on Highway 101. In 2017, 100 signs were installed in Clatsop and Tillamook Counties. An interagency agreement was developed between DOGAMI and ODOT District 4 to install 72 signs in Lincoln County, and DOGAMI is working with District 5 to install 44 signs along the south-central Oregon coast. DOGAMI produced 84 large “You are here” signs for Tillamook County (6), Oregon State Parks (69), Bureau of Land Management (8), and the Lincoln County School District (1).

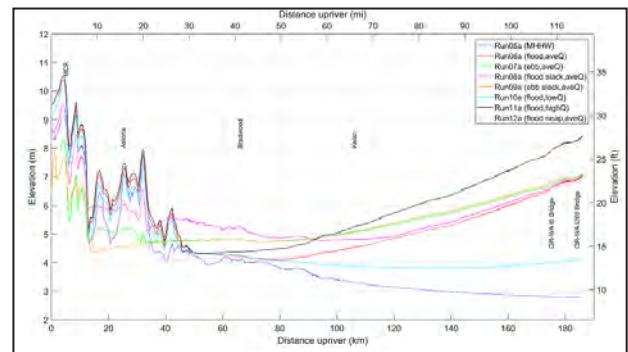


Beat the Wave Modeling

DOGAMI completed “Beat the Wave” (BTW) modeling and evacuation route analysis for Rockaway (<http://www.oregongeology.org/pubs/ofr/p-O-17-06.htm>). Map plates depict minimum pedestrian evacuation speeds needed to stay ahead of the wave for two levels of increasing evacuation difficulty: 1) all bridges intact, ten-minute delay from start of earthquake before starting evacuation and 2) only retrofitted bridges intact, ten-minute delay. BTW maps support evaluating mitigation options such as evacuation route improvement, wayfinding signage, land use planning actions, and vertical evacuation structures. Modeling is nearing completion at Pacific City. In addition, DOGAMI and the Department of Land Conservation and Development are working to complete evacuation time distance modelling for two other communities (Reedsport and Florence) that includes population exposure analyses.

Maritime Guidance

DOGAMI completed port-specific maritime response guidance for distant source tsunamis for the Ports of Gold Beach and Port Orford. A peer-reviewed journal article examining a range of offshore maritime evacuation zones is in review. Tsunami modeling of the Columbia River that incorporates dynamic tides, friction, and various river flows for the purposes of developing maritime guidance is nearing completion.



Puerto Rico 2017 Accomplishments

Puerto Rico has been struck by two destructive tsunamis generated by local earthquakes in the past 150 years, and tsunami modeling indicates that its whole coastline is threatened by this natural hazard. In 2000, the Puerto Rico Tsunami Warning and Mitigation Program was established by the Puerto Rico Seismic Network and the Department of Marine Sciences of the University of Puerto Rico at Mayagüez. In 2005, efforts were strengthened with funding from NOAA/NWS. Some of Puerto Rico's accomplishments of over the past year are summarized as follows:

TsunamiReady

- Twelve communities (municipalities) had their TsunamiReady recognition renewed. That included the update of plans and evacuation maps as well as revision of tsunami outreach activities.
- A new TsunamiReady template for the maritime community was implemented.
- Thousands of people have been reached about tsunami preparation through talks, presentations, workshops, mall exhibits, open house activities, and television and radio clips.
- Hundreds of tsunami signs have been installed throughout the island, including poster-size tsunami displays at highly visited beaches.
- Dozens of NOAA weather radios were distributed to schools, nonprofit organizations, and government offices.
- Two new EMWIN systems were installed and ten were upgraded at tsunami focal points.
- Tsunami drills were actively coordinated, i.e., Caribe Wave (more than 150,000 registered participants on TsunamiZone.org)
- Several workshops were held for emergency management staff (see photo), media, and the community.
- Two TsunamiReady supporters were recognized by the NWS.
- Materials and related products were updated and maintained online.



Threat and Hazard Assessment

- Twelve tsunami evacuation maps were updated.
- The Ports of Fajardo (Marina) and Salinas/Aguirre were studied for tsunami current impacts. The Ports of San Juan, Mayagüez, and Ponce were previously studied.
- A pilot report was prepared to review tsunami propagation and effects in rivers.
- Pedestrian tsunami evacuation models were developed for four communities.
- The Puerto Rico Tsunami Decision Support Tool was improved, and new information layers are available online for communities and to help in tsunami planning.



Hurricane Aftermath Recovery Plan

Puerto Rico, the Virgin Islands, and the Northeastern Caribbean were affected by two category 5 hurricanes (Irma and Maria). These events severely affected the tsunami program's coordination plans, signs, and equipment. As an initial recovery activity, an inventory is being compiled to help the affected communities reinstall signs and replace damaged tools.

U.S. Virgin Islands 2017 Accomplishments

TsunamiReady

- Completed renewal of TsunamiReady recognition for the islands of St. Croix, St. Thomas, and St. John.
- Continued the project to enhance and maintain the emergency warning siren system:
 - Installed a server in the St. Croix District.
 - Installed 20 additional sirens on St. Croix (7), St. Thomas (6), St. John (5), and Water Island (2).
 - Upgraded the siren system, including:
 - › Installation of prerecorded messages in Spanish and French.
 - › Purchase of an emergency control center (ECC) audio system to provide 911 dispatchers the capability to hear messages within the ECC.
- Purchased a Digital Alert Systems emergency operations center box to improve our ability to distribute critical alerts to the public via the Integrated Public Alert and Warning Systems and to provide flexibility to originate alerts from any networked computer.
- Purchased additional tsunami route signage for rural areas and hotels territory-wide.
- Purchased 225 NOAA weather radios (WR120) to distribute to critical facilities and public venues across the territory.

Tsunami Education and Outreach

- Participated in the Caribe Wave 2017 exercise held March 21 that included testing of all 24 sirens and activating our emergency operation centers.
- Tsunami evacuation drills were conducted by public and private sector entities during Tsunami Preparedness Week. VITEMA staff on St. Croix did a tsunami walk to their safe zone and were joined by area businesses and other government agencies.
- Aired VITEMA's Tsunami Awareness public service announcements from July to August via radio and television to educate the public about how to recognize the natural warning signs of a tsunami and what to do when a tsunami is imminent.
- Printed a children's book called "Oh, No! A Tsunami!" Other printed material included a VITEMA Tsunami Awareness Guide, bookmarks, coloring books, safety and awareness brochures, teen fact sheets, and disaster kit checklists for school and community outreach events.
- Created information stickers for all sirens to enhance public awareness of the siren system and to provide information for reporting problems with a siren.
- Continued to run tsunami displays (at right) at the Henry E. Rohlsen Airport on St. Croix and Cyril King Airport on St. Thomas providing a high visibility outreach opportunity for visitors to the territory.



Workshops and Exercises

- Conducted a territory-wide tabletop tsunami exercise as part of Caribe Wave 2017.
- Conducted Vigilant Guard 17-3 U.S. Virgin Islands, a territory-wide full-scale exercise in May using a tsunami-based scenario.



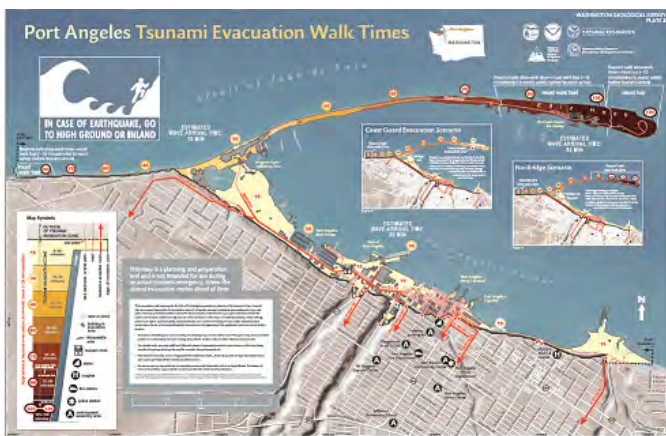
Washington 2017 Accomplishments

Mitigation and Preparedness

- Washington Emergency Management Division, Department of Natural Resources (DNR), and the NTWC director went on a tsunami roadshow in April providing six community presentations covering tsunami science, warnings they will receive, what to do, and how to prepare. The meetings were well attended, with the largest crowd reaching 300 people. Media coverage of events reached an additional 70,000.
- Participated as subject matter experts at a number of coastal community disaster/preparedness fair booths to directly communicate tsunami risk and preparedness to the public.
- DNR created a tourist/hospitality tsunami preparedness video.
- Conducted outreach to coastal communities on participation in the Great Washington Shakeout's drop, cover, hold-on earthquake and tsunami evacuation drills. Washington had over 1.26 million people participate in the drill (160,000 increase from last year). We also conducted preparedness outreach via numerous TV, radio, and social media interviews and presentations.



Hazard Assessment



- DNR worked collaboratively with FEMA to create a 3D viewer that shows tsunami-generated inundation heights in the greater Aberdeen, Washington, area.
- DNR used tools developed by the USGS in order to map the pedestrian evacuation walk times out of the inundation zone in two communities: Port Angeles and Port Townsend.
- DNR completed L1 and Seattle fault modeling of the Snohomish County coastline and parts of the Puget Sound.

Alert and Warning

- Completed the installation of five new All Hazards Alert Broadcast sirens, updated the tsunami warning message to play in both English and Spanish, and replaced warning lights with brighter more durable LED blue lights.
- Purchased and distributed NOAA weather radios for community outreach to low-income families.
- Attended a very informative week-long Tsunami Warning System training at the NTWC.
- Sustained the state's tsunami alert and warning infrastructure through routine repairs, technical assistance, and providing for satellite activation capabilities.

