



# TsuInfo Alert

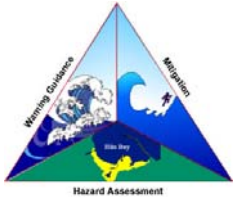
prepared by the Washington State Department of Natural Resources on behalf of the

## National Tsunami Hazard Mitigation Program

a state/federal partnership funded through the National Oceanic and Atmospheric Administration (NOAA)

DECEMBER 2018

Volume 20, Number 6



### New Director of National Tsunami Warning Center

By Rocky Lopes, NOAA/National Weather Service Tsunami Program

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The Alaska Region of the National Weather Service is pleased to announce that Dr. James Gridley was selected for the position of Director, National Tsunami Warning Center (NTWC). Dr. Gridley began his position in Palmer on December 10, 2018.

Dr. Gridley is an applied geophysicist with a substantial background in geophysical instrumentation, measurements, analysis, and fieldwork. He joins NOAA's National Weather Service from recently consulting on surface microseismic and induced seismic problems related to oil and gas exploration and teaching. Prior to that, he was with Halliburton as a chief technical adviser, working on the same topics.



Dr. Gridley worked for the Incorporated Research Institutions for Seismology (IRIS) as the Polar and an EarthScope program manager. He was with BBN Technologies, a well-known consulting firm with offices in the Washington, DC area. While at BBN Technologies, as well as his previous position with the US Navy, he conducted classified research programs pertaining to seismic and other geophysical instrumentation for measurements and analyses of "exotic sources."

Prior to that, he worked in the oil and gas industry for 11 years where he was responsible for several innovations in exploration research and development. He is familiar with NOAA programs and looks forward to supporting the Tsunami program and working with the numerous people and groups involved in make the program an ongoing success.

In his career to date, Dr. Gridley's primary focus has been on geophysical problems requiring a transformational vision of geophysical applications, with nontraditional aspects such as unique sources, new and innovative sensing systems, and challenging environmental conditions. His success has come from sound application of forward-looking science and innovative technology, and he brings these talents to the NWS with a strong commitment to advancing future seismological research.

Dr. Gridley has a B.S. from Northern Illinois University, a M.S. from New Mexico Tech., and a Ph.D. from the University of Texas at El Paso. He also has a law degree from University of Tulsa, related to his tenure as a private consultant in the oil and gas industry. He maintains relationships with the oil and gas industry, as well as with the Department of Defense and Department of Energy communities.



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

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

<http://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/tsunamis/tsuinfo-alert>

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**NATIONAL TSUNAMI HAZARD MITIGATION PROGRAM LIBRARY CATALOG:**

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

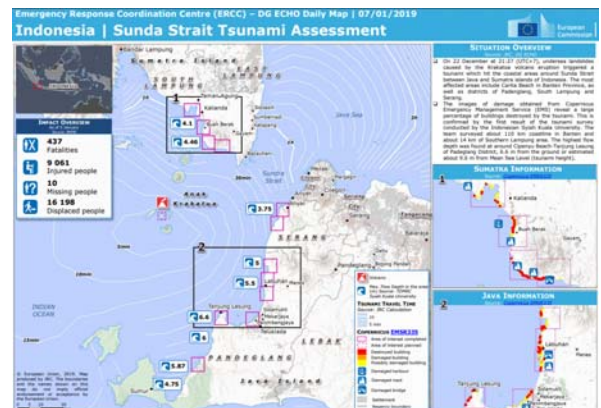
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## Significant Tsunami Event: Anak Krakatau, Sunda Strait, Indonesia December 23rd, 2018

On December 23, 2018, a landslide and tsunami occurred at the Anak Krakatau volcano located in the Sunda Strait, Indonesia. It is reported that the landslide that caused the deadly tsunami was composed of more than two-thirds of the original volume of the Anak Krakatau caldera. Planet Labs was able to capture before and after images, which can be seen in one of the various articles listed below. At the time of publication of this edition of TsuInfo Alert, this event and its impacts are still being studied. In future editions we expect to be able share more official information. As with all tsunamis, state, territory, and Federal partners in the National Tsunami Hazard Mitigation Program hope to learn from this event and make improvements to their own tsunami preparedness and planning.

See the following articles for more details:

- BBC article: <https://goo.gl/Ej9fns>
- [https://blogs.agu.org/landslideblog/2018/12/26/anak-krakatau-1/?utm\\_source=aguniverse&utm\\_medium=email](https://blogs.agu.org/landslideblog/2018/12/26/anak-krakatau-1/?utm_source=aguniverse&utm_medium=email)
- <https://www.cnn.com/2018/12/22/asia/deadly-tsunami-indonesia/index.html>



## Community Pedestrian Maps for Tsunami Evacuation in the Municipality of Loíza, Puerto Rico

By Alejandro Torres Padilla, Roy Ruiz Vélez, and Victor Huerfano, Puerto Rico Seismic Network

Puerto Rico is prone to the impacts of tsunamis due to its location in the seismically active zone of the northeastern Caribbean Ocean. The municipality of Loíza, located on the northeastern coast of Puerto Rico, has around 23,000 people residing in the tsunami hazard zone, which amounts to 77% of the total population (Census 2010). Because such a significant portion of the population reside in the evacuation zone, the Puerto Rico(PR)-NTHMP developed 3 community pedestrian maps for the people of Piñones, Medianía Alta, and Medianía Baja. As part of the TsunamiReady Guideline, Loíza has an official tsunami evacuation map for the municipality. In addition to these maps, a pedestrian evacuation analysis was done to alert the residents of Loíza about the estimated time to evacuate the zone.

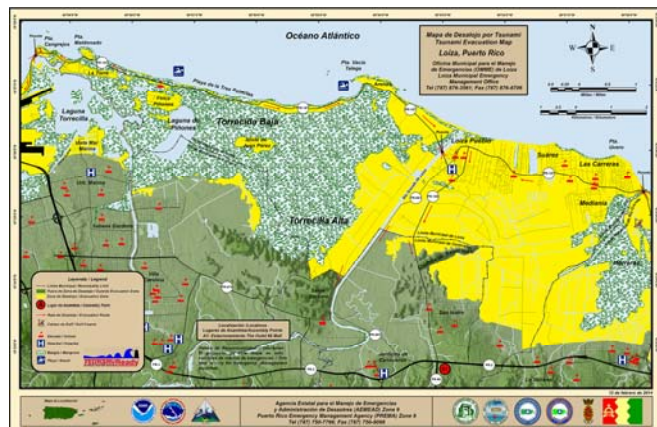


Figure 1: Loíza Tsunami Evacuation Map

The **Pedestrian Evacuation Analyst**, developed by the United States Geological Survey (USGS), uses GIS to allow the user to evaluate the time it would take to travel an evacuation route at different moving speeds. The speed options for the model are: slow walk (2.4mph), average walk (2.7mph), and fast walk (3.4mph). The results obtained from the model showed that for these communities, the estimated time range is between 2.5hrs and 3.5hrs to evacuate the zone.

The rather high estimates from the pedestrian evacuation analysis were the motivation to supplement the tsunami evacuation map for Loíza with the additional community pedestrian maps. Two of the maps for the communities of

Loíza were developed using horizontal evacuation, and a third option used an existing parking lot building in the area for vertical evacuation. The total evacuation time for the community of Piñones was reduced by an hour and a half after running the analysis using the vertical evacuation method.

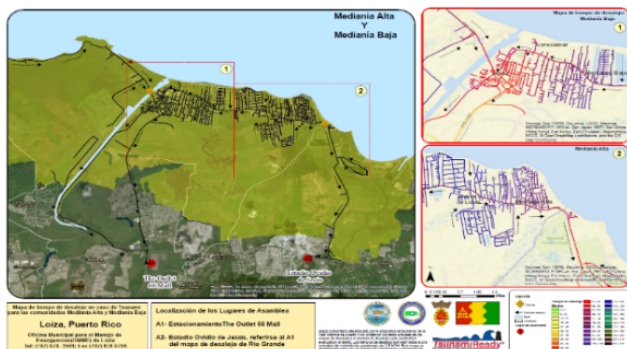


Figure 2: Example of Pedestrian Evacuation Map

The objective of these maps is to educate and guide the communities about the evacuation routes and the time it will take to evacuate the tsunami hazard zone. Also, this analysis will be used to justify the need for vertical evacuation structures.

The PR-NTHMP is collaborating with the Local Emergency Management Office and the Puerto Rico Emergency Management Agency to find additional methods to further reduce evacuation times for the people of Loíza in the future.

## New Manual Will Help Local Communities with Tsunami Vertical Evacuation Proposals

By the Washington Emergency Management Division

Ocean Shores, like most of Washington State's coast, will be prone to a tsunami when an earthquake strikes off the Strait of Juan de Fuca – or even a distant tsunami like Japan or Alaska. But getting to high ground is going to take a hefty walk for many residents. And, for a city that boasts a lot of retired residents, the concern is real.

Earthquake Program Manager Maximilian Dixon with the Washington Emergency Management Division has been working with city officials for months to help cultivate the support needed to move forward with plans to design and ultimately construct a vertical evacuation structure designed to withstand earthquakes, aftershocks, liquefaction and multiple tsunami waves.

Now, Dixon, working with researchers at the University of Washington, has developed a manual that will help any coastal city, county, or tribal entity figure out what it would take to design and then build a similar project.

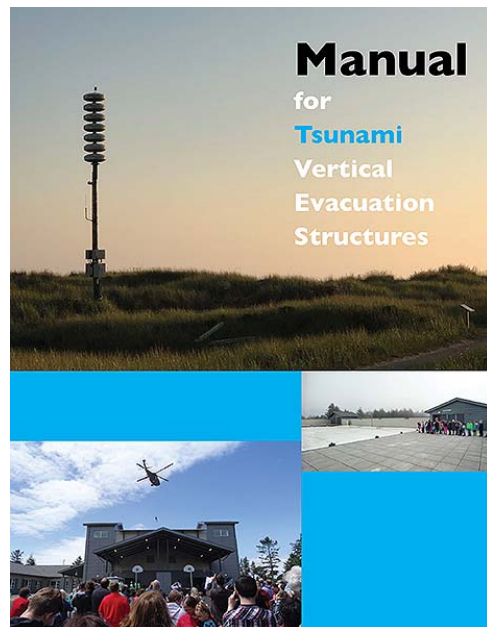
“Our state has the second highest earthquake risk in the nation and we do a great job talking about our tsunami threat, but we really need community support, local champions and we hope this manual will help us generate that interest,” Dixon said.

The manual will help champions work with their local governments showcasing the different funding mechanisms that could be used for construction and design, including the possible grants that are available – and the specific notations that need to be added into planning documents to help qualify for those grants.

In June, the Shoalwater Bay Indian Tribe received \$2.2 million in federal funding to help pay for the construction of a safe refuge for hundreds of residents. This was the first time federal funding from FEMA had gone toward construction of a vertical evacuation structure in Washington State. Previously, the state worked with local jurisdictions in Long Beach and Pacific County Fire District 1 at Ocean Park to do design work toward potential vertical evacuation structures.

“The success from our partners in the Shoalwater Bay Indian Tribe proved that federal dollars are out there, not just for design, but to construct life-saving towers, berms, buildings and hybrid structures,” Dixon said.

The first tsunami vertical evacuation structure in North America was unveiled in 2016 at Ocosta Elementary School near Westport. School district officials applied for federal funding and were determined to be eligible by FEMA, but didn't get the funding. Instead, taxpayers voted to foot the entire bill, noting it was critical to protect the kids.



*(Continues on Page 5)*



## New Manual Will Help Local Communities with Tsunami Vertical Evacuation Proposals

By the Washington Emergency Management Division

*(Continued from page 4)*

The new “how-to” guide helps jurisdictions figure out how to navigate the bureaucracy and, hopefully, help get more projects off to a better start. The 100-page manual provides a seven-step process and a check list to help as the process moves along.

Phase 1: Involve Emergency Management Partners

Phase 2: Assess Tsunami Risks and Current Evacuation Options

Phase 3: Engage the Community

Phase 4: Identify and Evaluate Potential Sites

Phase 5. Develop a Funding Plan with Alternatives

Phase 6. Assemble Project Team, Complete Design, and Confirm Budget

Phase 7. Oversee Construction, Completion, and Operation



Researchers from the University of Washington worked with Washington Emergency Management Division and the state Department of Natural Resources on two forums in the spring in Grays Harbor County to come up with ideas to help streamline items needed for the manual. In addition, a research team from New Zealand also conducted focus groups in Long Beach, Tokeland, Westport, and Ocean Shores to provide insights into the process of developing community-led, agency-supported vertical evacuation structure development.

At the forum in Ocean Shores, a survey of attendees found that 87 percent had a “strong certainty” that tsunami vertical evacuation structures could save their lives and the lives of the people in their community. And nearly half of respondents looked to their elected officials and emergency managers for leadership and acknowledged local funding would need to be part of the solution.

“The process in Ocean Shores is progressing and I’d say they’re about step four in the process,” Dixon said. “We’re definitely using what worked on other projects to help them along. Each time we have a successful project, it will help everyone else get through the steps easier.”

The manual suggests that as more structures are completed, there will be more available cost information and a better understanding of the process.

“These are costly projects for communities with limited resources, and some communities will require multiple structures,” the manual notes. “Those interviewed expressed support for approaches that could reduce project costs. For example, towers may provide the most commonly used vertical evacuation option, particularly for communities that need many structures. Developing a prototype tower design could reduce project costs. Such a tower design could be appropriately modified for various site conditions, height requirements, and appearance criteria. The design could be optimized to use common steel shapes and connections to increase efficiency during design and construction. Similarly, tsunami modelers could be commissioned to model a variety of typical coastal sites and to determine tsunami depth and velocity for design purposes. These approaches may also work with berm design.”

The NOAA/National Weather Service Tsunami Activities Grant provided funding for the manual.

Download the manual and assorted material at: [mil.wa.gov/tsunami](http://mil.wa.gov/tsunami)

See original article: <https://www.mil.wa.gov/blog/news/post/new-manual-will-help-communities-with-tsunami-vertical-evacuation-proposals>

# NTHMP NEWS

## TsunamiReady® Recognition Milestones

By Rocky Lopes, NTHMP Coordinator

As of November 30, 2018, there are 200 sites recognized as TsunamiReady®. During the period from June 1, 2018, to November 30, 2018, the following sites received the first TsunamiReady® recognition:

- Manila, California
- Beaufort County, South Carolina
- Hilton Head Island, South Carolina



We would particularly like to recognize the work done by Dr. Jim Kirby (University of Delaware) and Dr. Stephan Grilli (University of Rhode Island) as the inspiration of East Coast Emergency Management partner Ed Fratto for conducting tsunami map workshops for the East Coast. Those workshops directly resulted in two new East Coast communities receiving TsunamiReady recognition.

The following sites renewed their TsunamiReady® recognition between June 1, 2018, and November 30, 2018:

- American Samoa
- National Park of American Samoa
- Camp Lejeune Marine Corps Base, NC
- Carmel Heights Fire Protection District, CA
- Carolina, PR
- Charleston County, SC
- Craig, AK
- Cypress Fire Protection District, CA
- Guam
- Guánica, PR
- Guayama, PR
- Indian River County, FL
- Ketchikan, AK
- Naval Base, Guam
- Guayanilla, PR
- Juana Díaz, PR
- Lajas, PR
- Loiza, PR
- Los Angeles, CA
- Los Angeles Unified School District, CA
- Monterey County, CA
- Ocean Isle Beach, NC
- Onslow County, NC
- Pebble Beach, CA
- Peñuelas, PR
- Quebradillas, PR
- San Juan, PR
- Sitka, AK
- Skagway, AK
- Toa Baja, PR
- Yakutat City, AK

There were no additional TsunamiReady Supporter sites recognized during this period.

Also during this period, three previously recognized TsunamiReady® sites (one in each of California, Hawaii, and Puerto Rico) were not renewed. The jurisdictions were unable or not interested in renewal of TsunamiReady® recognitions despite support and encouragement offered.

During the past six months, the United States gained three and lost three recognitions for TsunamiReady® communities, retaining the number of U.S. recognitions at an even 200.

# NTHMP NEWS

## 2018 Oregon Tsunami Conference

By Brian Nieuwenhuis, NOAA NWS

On December 3rd and 4th, 2018, professionals and volunteers from across Oregon converged on the city of Newport, Oregon for the 2nd state Tsunami Conference, funded and supported by a NOAA/NWS Tsunami Activities grant through the National Tsunami Hazard Mitigation Program. Representatives from local, state, and federal government agencies, along with local tribes, university students and professors, civilian volunteer groups, the U.S. armed services, and private businesses were all in attendance to share and learn about Oregon's tsunami preparedness and mitigation efforts, and to discuss strategies for response and emergency support for when the unthinkable, but inevitable, Cascadia tsunami occurs.

The conference began with welcome speeches from several state and federal officials, including: Althea Rizzo, the Geologic Hazards Program Coordinator for Oregon Office of Emergency Management (OEM); Bob Cowen, director of Oregon State University's (OSU) Hatfield Marine Science Center; Mike Harryman, Oregon State Resilience Officer; Oregon Representative David Gomberg; and U.S. Representative Suzanne Bonamici.



"This is an opportunity to bring together professionals on the coast to get us prepared for the inevitable tsunami that we're expecting," said Althea Rizzo, organizer of the conference. "...Preparing for Cascadia, it's kind of the gold standard. When you're prepared for Cascadia, you're prepared for anything the coast can throw at you."

Oregon's efforts to mitigate and save lives through investments in critical infrastructure such as airports, schools, hospitals and ports, were a major point of discussion from the beginning of the conference. Talks on the first day began with an extensive background of the earthquakes and tsunamis generated by the Cascadia Subduction Zone, presented by Dr. Chris Goldfinger of OSU. Next, Larry Burtness, a representative of the Quileute Tribe of Washington, spoke about the efforts of the tribe to move the village of La Push to higher ground outside of the tsunami inundation zone. Yong Chen from OSU discussed the far-reaching and lasting economic impacts of a Cascadia event.

The second day of the conference featured speakers from OEM, OSU, California Governor's Office of Emergency Services, and the Oregon Department of Land Conservation and Development. Each offered in-depth discussions on the main topics of the conference: response and recovery, mitigation funding, education and outreach, land use planning and economic issues, and policy making. Following lunch, breakout sessions expanded on those topics, each group brainstorming and collaborating to solve common problems within their respective themes. Having such a diverse group of participants offered a unique opportunity to share ideas and plans from across many different perspectives.

Attendees were treated to an engaging and eye-opening talk by keynote speaker Mona Barnes, Director of the Virgin Islands Territorial Emergency Management Agency and Homeland Security Advisor to the Governor of the Virgin Islands. She spoke not just about how the Virgin Islands are preparing and planning for tsunami hazards, but also about the challenges faced and lessons learned from hurricanes Irma and Maria, both Category 5 hurricanes which struck the territory within two weeks of one another in 2017. While proper preparation and planning are extremely important for saving lives and recovering after disaster, Mrs. Barnes stated that real preparation begins much closer to home than at the state or even local levels. "Talk to your family and have your own plan of what you will do if an event happens. The key...is don't depend on the government to determine your survivability."

## TsunamiCon 2018 Humboldt County, California

By Yvette LaDuke and Kevin Miller, California Governor's Office of Emergency Services

The California Tsunami Program participated in the Humboldt County 2018 Tsunami Conference (TsunamiCon) hosted by the County Office of Emergency Services on September 26th-27th, 2018 at the Blue Lake Rancheria Casino Sapphire Palace.

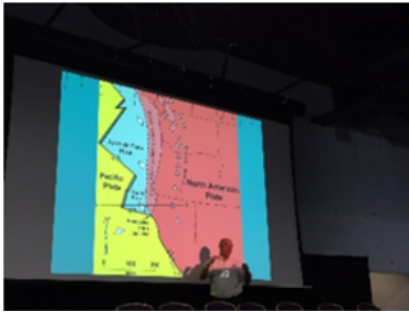


Figure 2: Troy Nicolini, NWS

This 2-day event provided an opportunity for local decision-makers to receive information regarding the tsunami hazard along California's north coast from representatives from the National Weather Service, Eureka Weather Field Office (NWS), California Geological Survey (CGS), and the California



Figure 1: Kevin Miller & Yvette LaDuke, Cal OES; Troy Nicolini, NWS, Rick Wilson, CGS

Governor's Office of Emergency Services (CalOES).

The first day of the event started with a discussion of lessons learned from the 2011 Japan Earthquake and Tsunami, and resulting mitigation efforts and response planning led by the NWS, U.S. Coast Guard, CGS and a representative from Del Norte County Office of Emergency Services. Humboldt County Office of Emergency Services (Humboldt OES) and the Humboldt County Planning & Building Department facilitated a tsunami planning



Figure 3: Kevin Miller, Cal OES

roundtable discussion to facilitate local planning activities, followed by a maritime tsunami evacuation discussion that was open to the public.



Figure 4: Yvette LaDuke, Cal OES

A Tsunami Evacuation Tabletop Exercise (TTX) hosted by Humboldt OES and Eureka NWS with Cal OES and CGS

serving as subject matter experts was conducted on the second day of the conference. Participants of the TTX were local decision-makers who were challenged to identify response priorities, immediate activities, available and needed resources and challenges for a distant-source tsunami (Kuril Islands), regional-source tsunami (Alaska) and, local-source tsunami threat (Cascadia Event).



Figure 5: Tsunami Con 2018



# NTHMP NEWS & CURRENT RESEARCH

## CURRENT TSUNAMI RESEARCH

Abdollahi, Abbas; Mason, H. B., 2019, Coupled Seepage-Deformation Model for Predicting Pore-Water Pressure Response during Tsunami Loading: Journal of Geotechnical and Geoenvironmental Engineering, v. 145, no. 3, [https://doi.org/10.1061/\(ASCE\)GT.1943-5606.0002012](https://doi.org/10.1061/(ASCE)GT.1943-5606.0002012).



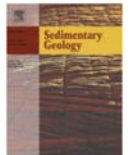
Goff, J.; Goto, K.; Chagué, C.; Watanabe, M.; Gadd, P.; King, D., 2018, New Zealand's Most Easterly Palaeotsunami Deposit Confirms Evidence for Major Trans-Pacific Event: Marine Geology, v. 404, p. 158-173, [doi.org/10.1016/j.margeo.2018.08.001](https://doi.org/10.1016/j.margeo.2018.08.001).



Kempf, Philipp; Moernaut, Jasper; De Batist, Marc, 2018, Bimodal Recurrence Pattern of Tsunamis in South-Central Chile: A Statistical Exploration of Paleotsunami Data: Seismological Research Letters, v. 90, no. 1, p. 194-202.



Mannen, K.; Yoong, K.H.; Suzuki, S.; Matsushima, Y.; Ota, Y.; Kain, C.L.; Goff, J., 2018, History of Ancient Megathrust Earthquakes beneath Tokyo Metropolis Inferred from Coastal Lowland Deposits: Sedimentary Geology, v. 364, p. 258-275, <https://doi.org/10.1016/j.sedgeo.2017.11.014>.

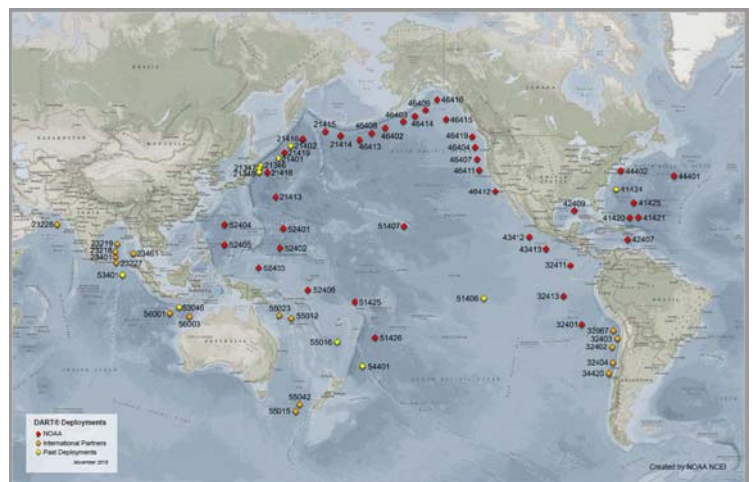
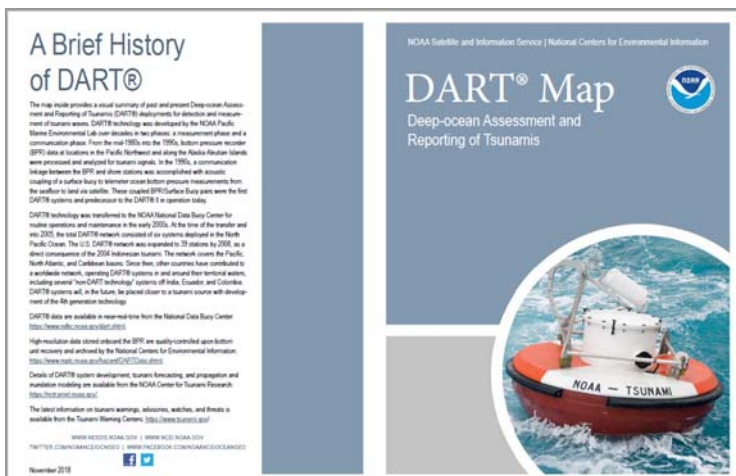


Rajendran, C. P., 2019, Historical Accounts of Sea Disturbances from South India and Their Bearing on the Penultimate Predecessor of the 2004 Tsunami: Seismological Research Letters, doi: <https://doi.org/10.1785/0220180355>.



## New DART Map Flyer

Published by National Centers for Environmental Information (NCEI) November 2018



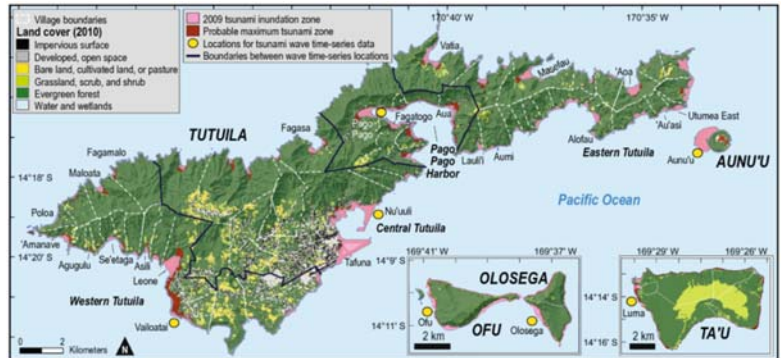
Access flyer: [https://www.ngdc.noaa.gov/hazard/data/publications/DART-map\\_508\\_comp\\_attr.pdf](https://www.ngdc.noaa.gov/hazard/data/publications/DART-map_508_comp_attr.pdf)

# TSUNAMI RESEARCH & NTHMP EVENTS

## Population Vulnerability to Tsunami Hazards Informed by Previous and Projected Disasters: A Case Study of American Samoa

By Nathan Wood, J. M. Jones, Yoshiki Yamazaki, Kwok-Fai Cheung,  
Jacinta Brown, J. L. Jones, Nina Abdollahian

**ABSTRACT:** Population vulnerability from tsunamis is a function of the number and location of individuals in hazard zones and their ability to reach safety before wave arrival. Previous tsunami disasters can provide insight on likely evacuation behavior, but post-disaster assessments have not been used extensively in evacuation modeling. We demonstrate the utility of post-disaster assessments in pedestrian evacuation modeling for tsunami hazards and use the US territory of American Samoa as our case study. We model pedestrian travel times out of tsunami inundation zones recreated for the 2009 Mw 8.1 Samoa earthquake, as well as for a probable maximum tsunami zone for future threats. Modeling assumptions are guided by fatality trends and observations of 2009 evacuation behavior, including insights on departure delays, environmental cues, transportation mode, and demographic characteristics. Differences in actual fatalities from the 2009 disaster and modeled population vulnerability suggest that a single set of estimated travel times to safety does not fully characterize evacuation potential of a dispersed, at-risk population. Efforts to prepare coastal communities in American Samoa for future tsunamis may be challenging given substantial differences in wave characteristics and evacuation potential of the probable maximum hazard compared to the 2009 event.



**CITATION:** Wood, Nathan; Jones, J. M.; Yamazaki, Yoshiki; Cheung, Kwok\_Fai; Brown, Jacinta; Jones, J. L.; Abdollahian, Nina, 2018, Population vulnerability to tsunami hazards informed by previous and projected disasters: a case study of American Samoa: Natural Hazards, 24 p., DOI: 10.1007%2Fs11069-018-3493-7.

<https://link.springer.com/article/10.1007%2Fs11069-018-3493-7>

## UPCOMING NTHMP & RELATED EVENTS

- ◆ January 28–31, 2019—NTHMP Annual Meetings (San Diego, California)  
<https://nws.weather.gov/nthmp/2019annualmeeting/index.html>
- ◆ March 14, 2019—CARIBE WAVE 2019 (Caribbean and adjacent regions)  
<https://www.weather.gov/ctwp/caribewave19>
- ◆ April 23–26, 2019—Seismological Society of America (SSA) Annual Meeting (Seattle, Washington) <https://www.seismosoc.org/annual-meeting/>
- ◆ June 16–21, 2019—8th Tsunami and Safety Symposium ISOPE-2019 (Honolulu, Hawaii) <https://goo.gl/pA972R>
- ◆ September 16–20, 2019—OceanOBS'19 (Honolulu, Hawaii)  
<http://www.oceanobs19.net/>

