TsuInfo Alert

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Maritime tsunami planning products in California*

By Wilson, RI; Miller, KM; Admire, A; Borrero, J; Curtis, E; Dengler, L; Eskijian, M; Lynett, P; Pridmore, C; Thio, HK

*Modified subset of text from draft proceedings paper for the 10th National Conference in Earthquake Engineering; Anchorage, AK; July 21-25, 2014

In this issue:

The State of California tsunami program is a hazard-reduction program managed by the California Governor's Office of Emergency Services (Cal-OES) with assistance from the California Geological Survey (CGS) and tsunami experts from other government agencies, academic institutions, and private companies. The program promotes tsunami planning, preparedness and hazard mitigation among California's coastal communities and participates in the National Tsunami Hazard Mitigation Program (NTHMP), which is responsible for setting U.S. policy and guidance for tsunami warning and long-term planning. Most of the activities of the state program are funded through partnerships with the NTHMP and the Federal Emergency Management Agency (FEMA).

Figure 1: Photo showing damage and recovery efforts in Crescent City Harbor shortly after the March 11, 2011 tsunami (Credit: Rick Wilson).

After the 2010 Chile and 2011 Japan tsunamis, post-event survey teams and questionnaires were used to gather information on both the physical effects of the tsunamis and the emergency response activities by local jurisdictions (Wilson et al., 2012a; Lynett et al., 2012). The 2010 tsunami caused approximately $3 Million in damage to a dozen harbors in California, while the 2011 tsunami caused over $100 Million in damage to 27 harbors. During both events, people on docks and near the ocean were at risk to injury with one fatality occurring during the 2011 tsunami at the mouth of the Klamath River. In addition, the significant sediment deposition and damage within Crescent City and Santa Cruz harbors during the 2011 event caused long delays in recovery of those harbors because of regulatory and reconstruction issues (Figure 1; Wilson et al., 2012b). Even with the fatality and damage to harbors, California has been fortunate that the most significant tsunami surge activity for both the 2010 and 2011 tsunamis, as well as several of the historically larger events, occurred coincident with relatively low-tide conditions along the coast, greatly reducing the amount of inundation and more severe damage (Wilson et al., 2012a).

Maritime communities in California were impacted the most during the 2010 and 2011 tsunamis, and would be again in similar or larger future tsunamis. Although millions of dollars were lost during the 2010 and 2011 events, the eye-witness accounts and video information collected after each event provided a resource for improving tsunami hazard

(Story continues on page 4)

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ERRATUM (TsuInfo Alert, Volume 15, Number 5, 2013):

It was brought to my attention that there were a number of errors in the list of historical tsunamis in the last issue of TsuInfo Alert. Please refer to the NOAA/WDS Global Historical Tsunami Database at NGDC for correct information:
http://www.ngdc.noaa.gov/hazard/tsu_db.shtml

Response guidance for tsunamis on the Oregon coast

By George Priest, The Oregon Department of Geology and Mineral Industries (DOGAMI)

The Oregon Department of Geology and Mineral Industries (DOGAMI), with FY 2013 support from the National Tsunami Hazard Mitigation Program (NTHMP) of NOAA, is leading an effort to establish response guidance for tsunamis that might strike the Oregon coast. Phase I of this effort will be to establish an offshore safety zone or zones for maximum-considered distant and local tsunami scenarios. Design of the offshore zone (s) and general response guidance will be coordinated through the Maritime Advisory Committee (MAC), consisting of members from adjacent states, Oregon stakeholders, including our NTHMP partner, Oregon Emergency Management (OEM), and federal representatives (US Coast Guard, Navy, and NOAA Corps). Phase I Oregon guidance products should be complete by the May 31, 2014. Pending appropriate support and recommendations of the MAC, there may be additional phases that will address detailed guidance for individual ports.

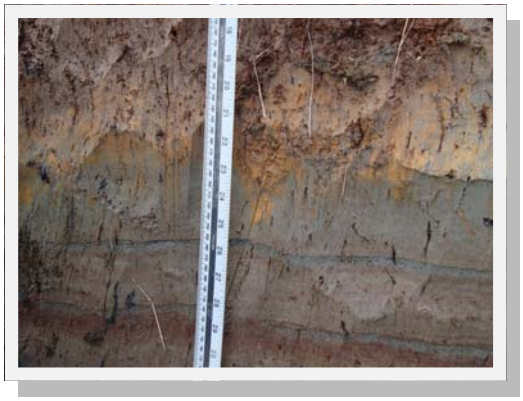
For more information, visit the Oregon Tsunami Clearinghouse: http://www.oregongeology.org/tsuclearinghouse

Tsunamis in the Strait of Juan de Fuca*

By Ian Miller, Washington Sea Grant

*Adapted from the Coast Nerd Gazette[1]

It is well known that what are called "far field" tsunamis impact the Strait of Juan de Fuca. Indeed, tsunami waves propagating into Port Angeles Harbor in the central Strait of Juan de Fuca were documented after the Tohoku earthquake and tsunami that hit Japan in March 2011[2]. Certainly within the academic and emergency management community it is also well known that the Strait of Juan de Fuca is at risk from potentially catastrophic "near field" tsunamis that are generated near to our coast. In particular a so-called "mega-thrust" earthquake on the Cascadia subduction zone could generate a large and potentially catastrophic earthquake and tsunami that could impact much of the Pacific Northwest coast[3]. As a result, entities like the Washington Emergency Management Department are very focused on tsunami education and risk reduction throughout the coastal areas of Washington State, including along the Strait of Juan de Fuca[4].



A photo of probable "tsunami sands" in the Salt Creek salt marsh, Strait of Juan de Fuca. Credit: Sarah Sterling

However, there hasn't been a large earthquake or tsunami in this part of the world since the historic period started, and as a result it can be hard to really accept the risk, especially in the relatively protected waters of the Strait of Juan de Fuca. Communities on the outer coast of Washington State seem to have embraced their risk, and are taking various steps to reduce it, either by building vertical evacuation structures[5], practicing evacuation drills[6], or even moving entire communities to higher ground[7].

Increasingly, though, the traces of pre-historic tsunamis that have impacted the shoreline of the Strait of Juan de Fuca are being uncovered. Ian Hutchinson, Curt Peterson and Sarah Sterling just published a paper documenting their discovery of sand layers in the Salt Creek salt marsh[8], west of Port Angeles. They detail the evidence that leads them to conclude that these sand layers were almost certainly deposited by tsunamis occurring 1000-2000 years ago. This paper adds to a growing body of literature, including work documenting multiple tsunami sand beds in Discovery Bay[9], Curt Peterson's recently published work from Neah Bay[10], and tsunami sand beds documented on Whidbey Island[11]. Taken together, it is clear that numerous sites on the Strait of Juan de Fuca appear to record relatively large and repeated tsunami inundation events.

Quite a bit is at risk along the Strait of Juan de Fuca[12]. Fortunately, communities are taking notice[13,14]. Any time new information like Hutchinson et al, 2013 comes out, though, should be a moment to reconsider preparations, and redouble efforts to plan and prepare.

[1]Miller, I.M.M. 6 November 2013. "Tsunamis in the Strait of Juan de Fuca". Blog post at http://coastnerd.blogspot.com/2013/11/tsunamis-in-strait-of-juan-de-fuca.html

[2]Miller, I.M.M. 11 March 2011. "Time Lapse of PA Harbor during Tsunami". Blog post at http://coastnerd.blogspot.com/2011/03/time-lapse-of-pa-harbor-during-tsunami.html

[3]Atwater, et al., 2005. "The Orphan Tsunami of 1700-Japanese Clues to a Parent Earthquake in North America". Available at http://pubs.usgs.gov/pp/pp1707

[4]see, for example, http://www.emd.wa.gov/hazards/haz_tsunami.shtml

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[9]Williams, et al., 2005. Multiple sources for late-Holocene tsunamis at Discovery Bay, Washington State, USA.

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[11]Williams, H., and I. Hutchinson. 2000. Stratigraphic and microfossil evidence for late Holocene tsunamis at Swantown marsh, Whidbey Island, Washington. Quaternary Research 54:218-227.

[12]Wood, N., and Soulard, C., 2008. Variations in Community Exposure and Sensitivity to Tsunami Hazards on the Open-Ocean and Strait of Juan de Fuca Coasts of Washington. Geological Survey (U.S.) Scientific Investigations Report 2008-5004. Available at: http://pubs.usgs.gov/sir/2008/5004/

[13]see, for example, http://www.clallam.net/tsunami/documents/FactSheet_ClallamCounty.pdf

[14]see, for example, http://www.konp.com/local/6710

Maritime tsunami planning products in California

By Wilson, RI; Miller, KM; Admire, A; Borrero, J; Curtis, E; Dengler, L; Eskijian, M; Lynett, P; Pridmore, C; Thio, HK

(continued from page 1)

analysis in ports and harbors (Figure 2; Wilson et al., 2012b; Admire et al., in press). Through a Co-operative Technical Partnership developed between the state and FEMA, observed strong tsunami currents and areas of damage are being used to validate/calibrate numerical tsunami model currents. A maritime damage index was used to determine the relationship between tsunami currents and damage severity (Lynett et al., in preparation). Using validated modeling, hazard maps with four current-damage categories can be generated to identify areas of potential damage within harbors from multiple modeled scenarios.

The state tsunami program has initiated a plan to develop three sets of products for these maritime communities: (1) detailed maps identifying in-harbor tsunami hazards, such as strong currents and eddies, peak amplitude surges, and large water level fluctuations, as well as the potential duration of hazardous currents and safe areas within harbors; (2) offshore safety zones and low current areas within harbors where ships can evacuate to and safely gather during a tsunami; and (3) preparedness, mitigation, and recovery/continuity plans to help maritime communities be more resilient to tsunami hazards. To help identify the safe water depth during various large tsunamis, evaluations of maximum, numerically modeled tsunami currents versus water depth demonstrate that non-damaging, straight-line currents greater than 3 knots (1.5 m/sec) do not generally occur at water depths greater than 30 fathoms (54 m). Therefore, this likely represents a safe depth for offshore evacuation.

Figure 2: Tsunami flow-regime map for Crescent City Harbor. Current directions and velocities, and areas of sediment erosion and deposition are based on observations of the various (30) ground-level and aerial video, pre- and post-tsunami bathymetry, and sediment analyses (modified from Wilson et al, 2012b).

Harbor-specific guidance will be created to help California maritime communities better prepare for, respond to, and recover from future tsunamis. Most of this mapping and guidance work with the maritime communities will be completed by the year 2015. California is also working with other states (such as Oregon) in the NTHMP on national protocol for developing tsunami hazard preparedness products and guidance (Wilson and Eble, 2013).

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Lynett, P., Borrero, J., Son, S., Wilson, R., and Miller, K., in preparation, Assessment of current-induced tsunami hazards for maritime planning: Geophysical Research Letters.

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IN THE NEWS

Governor de Jongh and VITEMA director Lewis unveil V.I. tsunami evacuation maps

By Christa von Hillebrandt-Andrade, Manager US NWS Caribbean Tsunami Warning Program

Gov. John P. De Jongh Jr. and VITEMA Director Elton Lewis, at a press conference Wednesday, unveiled the first-ever US Virgin Islands Tsunami Evacuation Maps for the islands of St. Croix, St. John and St. Thomas, hailing a milestone that significantly advances the Virgin Islands Tsunami Readiness Program.

At Government House news conference on December 4, 2013. From left to right: VITEMA Director Lewis, Christa von Hillebrandt-Andrade , Governor de Jongh, FEMA Region II Caribbean Area Division Director Alejandro de La Campa, Interim Director of the Puerto Rico Seismic Network Victor Huerfano, and retired UVI Professor of Physics Roy Watlington.

The tsunami evacuation maps delineate coastline inundation in the event of the Territory is impacted by a tsunami, as well as safe areas, evacuation route directional arrows, assembly points and denotes public schools and other public facilities within the inundation area. With this tool, residents and businesses are now armed with information to better develop their disaster readiness plans for tsunamis.

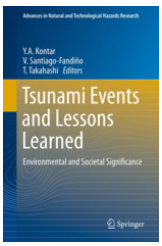
To define the evacuation zone for the USVI an 82-foot elevation profile was used; it was reached within 2 miles of the coast, another factor considered. This evacuation criterion was based on historical events, tsunami modeling results from Puerto Rico and the BVI and the US National Tsunami Hazard Mitigation Program guidelines.

See full press release and evacuation maps here: http://www.vitema.gov/news/releases/2013/12/governor-dejongh-and-vitema-lewis-unveil-evacuation-maps.html

NEW TSUNAMI BOOK PUBLISHED: Tsunami Events and Lessons Learned

Edited by: Yev Kontar; V. Santiago-Fandino; Tomoyuki Takahashi

This book is a collective effort by world experts, bringing together assorted contributions presented during the Ocean Science Session OS-017, of the AOGS-AGU Joint Assembly held in Singapore in 2012 (the Asia Tsunami and Great East Japan Earthquake and Tsunami events) and other conferences. The chapters cover assessment, evaluation, forecast, policy and lessons learned as well as environmental and societal impacts of the latest tsunamis that occurred in the Indian Ocean in 2004 and the Pacific Ocean in Japan 2011 as well as the Central Pacific Ocean in 2012.



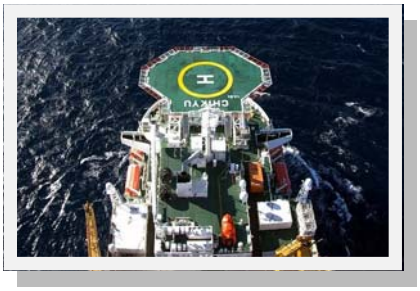
CITATION: Kontar, Y.A., Santiago-Fandiño, V. & Takahashi, T. 2014. Tsunami Events and Lessons Learned – Environmental and Societal Significance. Advances in Natural and Technological Hazards Research 35, Springer Netherlands, Dordrecht, 467 p. doi:10.1007/978-94-007-7269-4.

IN THE NEWS

Slippery, Weak Fault Zone Caused Massive 2011 Japan Tsunami

By Allie Bidwell, U.S. News & World Report

A weak fault zone and an unusually slippery clay were responsible for the enormous earthquake that caused the 2011 tsunami that devastated Japan's Tohoku region, scientists have found.



Credit: Japan Agency for Marine-Earrh Sicence and Technology (JAMSTEC)/ Integrated Ocean Drilling Program (IODP)

In a series of reports published in the journal Science Thursday, a team of 27 scientists from 10 different countries explain several factors that contributed to the magnitude 9.0 earthquake off the coast of Japan in March 2011.

For one, the earthquake occurred in a subduction zone, an area in which one tectonic plate is diving underneath another. In this case, the Pacific plate plunged beneath the North American plate. Typically, earthquakes displace plates by less than 20 meters (about 66 feet), but in the Tohoku earthquake, the slip was up to 50 meters (164 feet). Also unusual in this situation, researchers said, was the fact that the earthquake ruptured all the way up to the sea floor.

"That large slip at shallow depths contributed to the tsunami that caused so much damage in Japan," said Patrick Fulton, a researcher at the University of California, Santa Cruz, in a statement. "Usually, these earthquakes don't rupture all the way to the surface."

See full article: http://www.usnews.com/news/articles/2013/12/05/slippery-weak-fault-zone-caused-massive-2011-japan-tsunami

Sumatra coastal cave records stunning tsunami history

By Jonathan Amos, BBC News

A cave on the northwestern coast of Sumatra holds a remarkable record of big tsunamis in the Indian Ocean.

The limestone opening, close to Banda Aceh, retains the sandy deposits washed ashore by huge, earthquake-induced waves over thousands of years.

Scientists are using the site to help determine the frequency of catastrophes like the event of 26 December 2004.

This is being done by dating the cave's tsunami-borne sediments, which are easy to see between layers of bat droppings.

See full article: http://www.bbc.co.uk/news/science-environment-25269698

Study uncovers new evidence for assessing tsunami risk from very large volcanic island landslides

By National Oceanography Centre

The risk posed by tsunami waves generated by Canary Island landslides may need to be re-evaluated, according to researchers at the National Oceanography Centre. Their findings suggest that these landslides result in smaller tsunami waves than previously thought by some authors, because of the processes involved.

The researchers used the geological record from deep marine sediment cores to build a history of regional landslide activity over the last 1.5 million years. They found that each large-scale landslide event released material into the ocean in stages, rather than simultaneously as previously thought.

See full article: http://noc.ac.uk/news/study-uncovers-new-evidence-assessing-tsunami-risk-from-very-large-volcanic-island-landslides