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 2014 Volume 16, Number 6

In this issue:

WASHINGTON STATE DEPARTMENT OF Natural Resources
Peter Goldmark - Commissioner of Public Lands
Division of Geology and Earth Resources
David K. Norman - State Geologist

NOAA reflects on 10 years since Indian Ocean tsunami

By Christa Rabenold, NOAA/National Weather Service Tsunami Program

Since the devastating Indian Ocean tsunami in 2004, NOAA has made great improvements in tsunami detection, forecasting, warning, and preparedness capabilities. As a result, U.S. and international coastal communities are far better prepared to respond to a tsunami.

In 2004, NOAA's National Weather Service staffed two tsunami warning centers eight hours a day, five days a week with on-call coverage, providing service for a limited geography. These centers relied on seismic data from the Global Seismographic Network (GSN)—only 80 percent of which was transmitted in real-time, water-level data from six experimental Deep-Ocean Assessment and Reporting of Tsunamis (DART) buoy stations in the Pacific Ocean, and a network of coastal water-level stations that provided data in one-hour cycles.

Today the centers are staffed 24 hours a day, seven days a week, and their areas of responsibility have been expanded to include all U.S. and Canadian coastlines. In addition, the Pacific Tsunami Warning Center is the primary international forecast center for the Pacific and Caribbean Basins. The GSN has been fully upgraded (thanks to the U.S. Geological Survey and its partners) to transmit 100 percent of its data in real-time, and NOAA has upgraded its seismic networks in Alaska and Hawaii. A global network of 60 DART buoy stations (39 are U.S. owned and operated) now monitor tsunami activity in the Pacific, Indian, and Atlantic Oceans; 188 coastal water-level stations have been installed or upgraded to support tsunami warning operations by providing data in one-minute cycles.

The centers use data from these networks as inputs to tsunami forecast models developed by NOAA. These models enable accurate, reliable, and real-time inundation forecasts, significantly improving upon the capability that existed in 2004. Inundation models, also developed by NOAA, are used by coastal states and communities to create maps that define tsunami hazard and evacuation zones and support community planning.

The last decade also marked the completion of the U.S. States and Territories National Tsunami Hazard Assessment and improvements to the quality of the long-term archive of tsunami events. As knowledge about the threat increased, so did interest in efforts to improve tsunami awareness and preparedness. In the last 10 years, the National Tsunami Hazard Mitigation Program has expanded from 5 to 28 partner states and territories, the National Weather Service's TsunamiReady® program has grown from 14 designated sites to 181.

Continued on page 2

TsuInfo Alert

Prepared and published bimonthly by the Washington State Department of Natural Resources,
Division of Geology and Earth Resources,
on behalf of the National Tsunami Hazard Mitigation Program (NTHMP),
a state/federal partnership funded through 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/researchscience/topics/geologypublicationslibrary/pages/tsuinfo.aspx

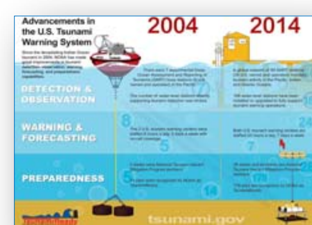
Assembled by Stephanie Earls, Librarian
Washington Geology Library
Washington Dept. of Natural Resources
Division of Geology and Earth Resources
1111 Washington St. SE, MS 47007
Olympia, WA 98504-7007
360-902-1473 (p) 360-902-1785 (f)
stephanie.earls@dnr.wa.gov

NATIONAL TSUNAMI HAZARD MITIGATION PROGRAM LIBRARY CATALOG:
http://69.63.217.22/D92019/OPAC/Index.aspx

NOAA reflects on 10 years since Indian Ocean tsunami (continued)

By Christa Rabenold, NOAA/National Weather Service Tsunami Program

Despite the advances in technology and hazard assessment, people who live, work, or play at the coast must understand and be prepared for tsunamis. While tsunamis cannot be prevented, there are things that individuals can do to protect themselves and their loved ones. To help educate the public about what to do before, during, and after a tsunami, the National Weather Service has launched a new online tsunami safety resource at http://www.weather.gov/tsunamisafety.



Additionally, NOAA has taken on a vital role in the global tsunami warning system. This includes providing international warning, training, data exchange, and outreach and education assistance. NOAA uses international data, communications, and research to carry out the agency's mission, both internationally and domestically.

NOAA's work is not done. The 2004 Indian Ocean tsunami was a catalyst for the development of a national plan for tsunami research and the transfer of the resulting technology to operations. Through this plan, NOAA continues to make advances in tsunami detection, forecasting, and warning, with an aim to further improve the accuracy and timeliness of alerts and the accessibility of actionable information.

Follow link to learn more: http://1.usa.gov/1Ivmf7i

PROJECT UPDATES

Caribbean sea level training course held in Mayagüez, Puerto Rico

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

The IV Training Course on Sea Level Station Installation, Maintenance and Leveling, Quality Control and Data Analysis for the Caribbean and Adjacent Regions took place November 3rd–7th, 2014 in Mayagüez, Puerto Rico. Forty four representatives from 18 Member States and Territories of the Intergovernmental Coordination Group for Tsunamis and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (CARIBE EWS), as well as Belgium, Germany, and the U.S. (Alaska, Colorado, Georgia, Hawaii and Virginia) participated as lecturers, trainees, and staff. Several participants representing institutions that are actively involved in sea level data efforts in the Caribbean and adjacent regions, as well as the U.S. Pacific and National Tsunami Warning Centers. The course was conducted as part of the efforts to strengthen the sea level component of the tsunami and other coastal hazards warning system coordinated through UNESCO. The course was organized by the Puerto Rico Seismic Network of the University of Puerto Rico at Mayagüez in combination with the Caribbean Tsunami Warning Program of the U.S. National Weather Service National Oceanic and Atmospheric Administration (NOAA). The purpose of the training was to provide the sea level station operators and data analysts in the region lectures and hands-on exercises for the installation and maintenance of stations, as well as analysis and applications of sea level data for tsunami and other coastal hazards purposes. The participants agreed that the training was invaluable for the sustainability of the stations and felt that the majority of knowledge and tools acquired could be implemented. Currently there are 67 coastal sea level stations within the region (up from five in 2004) that contribute data to the Tsunami Warning Centers and other agencies in support of the Tsunami Warning System. Courses like these are critical for the sustainability of these expanded operations.

Maritime tsunami workshops reveal new challenges – What boaters should know

Virgin Islands Territorial Emergency Management Agency (VITEMA) Press Release

On November 18th and 19th, on St Thomas and St Croix respectively, VITEMA and the Caribbean Tsunami Warning Center sponsored workshops intended to familiarize the maritime community in particular, but also the general public, with the most recent understanding of the behavior of tsunamis and how boaters and people working near the sea should respond to imminent threats of tsunamis.

VITEMA

Christa von Hillebrandt, Manager of the Caribbean Tsunami Warning Program (CTWP), brought participants up to date on new conventions, as well as expected changes, in tsunami alert messages and procedures. CTWP is an office of NOAA's National Weather Service. Von Hillebrandt also identified procedures followed by the National Tsunami Warning Center for USVI alerts as well as guidelines and best practices for the maritime community. Discussed, for example, were recommendations for boaters when they are threatened by tsunamis from sources that are local (less than 100 kilometers) compared to sources that are regional (more than 100 km) or distant (more than 1000 km).

See full press release: http://www.vitema.gov/news/releases/2014/tsunami-workshop.html

IN THE NEWS

CHRN recognizes DGER award-winning report by network member

Blogpost by Washington Coastal Hazards Resilience Network (CHRN)

In April 2014, the Washington Division of Geology and Earth Resources (DGER) received the 2014 Western States Seismic Policy Council Award in Excellence for Response Plans/Materials. Stephen Slaughter, a hazards geologist and member of the Washington Coastal Hazards Resilience Network (CHRN) was a primary author to the award-winning document: *Report of Investigations 36. Earthquake-induced landslide and liquefaction susceptibility and initiation potential maps for tsunami inundation zones in Aberdeen, Hoquiam, and Cosmopolis, Grays Harbor County, Washington for a M9+ Cascadia subduction zone event.* The report assesses the earthquake-induced ground failure potential, including soil liquefaction and landslides on specific areas within Grays Harbor County.

"The objective of this report is to assist city and emergency management officials in evaluating the suitability of existing evacuation routes and assembly areas for potential susceptibility to ground failure from a M9+ Cascadia subduction zone earthquake. Results of this report could indicate the need to modify current evacuation routes and assembly areas."

See full blogpost: http://www.wacoastalnetwork.com/blog/chrn-recognizes-dger-award-winning-report-by-chrn-member

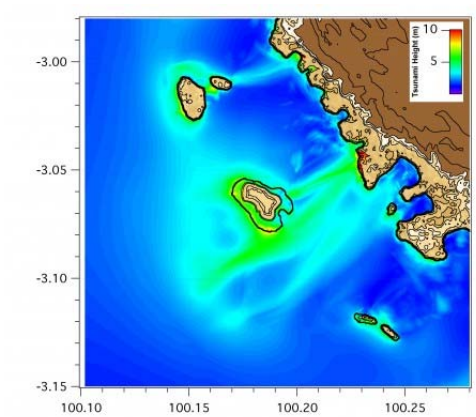
Offshore islands won't offer buffer from tsunami's power

By Robert Perkins, University of Southern California Media Relations Specialist

A long-held belief that offshore islands protect the mainland from tsunamis turns out to be the exact opposite of the truth, according to a new study.

Common wisdom—from Southern California to the South Pacific—for coastal residents and scientists alike has long been that offshore islands would create a buffer that blocked the power of a tsunami. In fact, computer modeling of tsunamis striking a wide variety of different offshore island geometries yielded no situation in which the mainland behind them fared better.

Instead, islands focused the energy of the tsunami, increasing flooding on the mainland by up to 70 percent.



2010 survey focused on the Mentawai Islands off of Sumatra. (Image/Jose Borrero and eCoast)

"This is where many fishing villages are located, behind offshore islands, in the belief that they will be protected from wind waves. Even Southern California residents believe that the Channel Islands and Catalina will protect them," said Costas Synolakis of the USC Viterbi School of Engineering, a member of the multi-national team that conducted the research.

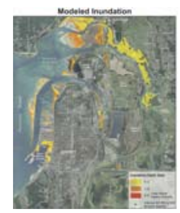
See full article: https://news.usc.edu/70790/offshore-islands-wont-offer-buffer-from-tsunamis-power/

RECENTLY PUBLISHED

Tsunami Hazard Map of Everett, Washington: Model Results for Magnitude 7.3 and 6.7 Seattle Fault Earthquakes

By T. J. Walsh, Diego Arcas, V. V. Titov, and C. C. Chamberlin (Washington Div. of Geology Earth Resources)

In 1995, Congress directed the National Oceanic and Atmospheric Administration (NOAA) to develop a plan to protect the West Coast from locally generated tsunamis. A panel of representatives from NOAA, the Federal Emergency Management Agency, the U.S. Geological Survey (USGS), and the five Pacific coast states wrote the plan and submitted it to Congress, which created the National Tsunami Hazard Mitigation Program (NTHMP) in October 1996. The NTHMP is a program designed to reduce the impact of tsunamis through warning guidance, hazard assessment, and mitigation. A key component of the hazard assessment for tsunamis is delineation of areas subject to tsunami inundation. These maps are produced using computer models of earthquake-generated tsunamis from nearby seismic sources. The modeling for this map was performed by the NOAA Center for Tsunami Research (NCTR) at NOAA's Pacific Marine Environmental Laboratory (PMEL) in Seattle.



This map is part of a series of tsunami inundation maps produced by the Washington Division of Geology and Earth Resources (WADGER), in cooperation with the Washington Emergency Management Division (WAEMD), as a contribution to the NTHMP. Completed maps are the southern Washington coast (Walsh and others, 2000), Port Angeles (Walsh and others, 2002a), Port Townsend (Walsh and others, 2002b), Neah Bay (Walsh and others, 2003a), Quileute area (Walsh and others, 2003b), Seattle (Walsh and others, 2003c), Bellingham (Walsh and others, 2004), Anacortes–Whidbey Island (Walsh and others, 2005), and Tacoma (Walsh and others, 2009).

See full map: http://www.dnr.wa.gov/publications/ger_ofr2014-03_tsunami_hazard_everett.pdf

Washington County plans U.S.' first vertical evacuation tsunami building

By Eric Holdeman, Emergency Management Magazine

What are the significant hazards in your community?

The most significant hazards in Grays Harbor County begin with the fact we are within 20 to 30 minutes of a devastating tsunami, which could be triggered by an event along the Cascadia Subduction Zone earthquake fault line. The majority of the critical infrastructure along the coastal region of the county — such as schools, government buildings, business and industry, police and fire stations — is situated within the tsunami inundation zone. Grays Harbor County also lies within the earthquake region of the Pacific Northwest and is susceptible to inland earthquakes, severe winter storms with hurricane force winds and major flooding events.

How do you feel about the general disaster readiness of governments, public safety agencies, businesses and individuals that live and work in your county?

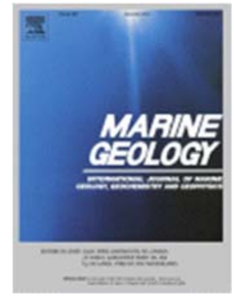
If one looks at Japan, considered the best prepared country in the world for disaster and the impacts of the 2011 Tohoku earthquake and tsunami, and New York City, considered the most prepared area of the U.S. in terms of homeland security funding, training and preparation, and the impact of Superstorm Sandy in 2012, I don't believe any of us are prepared to handle our worst-case scenarios.

See full article: http://www.emergencymgmt.com/disaster/Washington-County-Plans-Vertical-Evacuation-Tsunami-Building.html

RECENTLY PUBLISHED

Special Issue of Marine Geology:
In the wake of the 2011 Tohoku-oki tsunami—Three years on

Edited by Kazuhisa Goto, Catherine Chagué-Goff, James Goff, Ken Ikehara and Bruce Jaffe
Marine Geology, v. 358, p. 1-150.



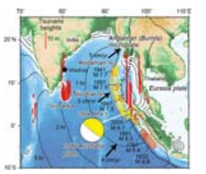
Access articles: http://www.sciencedirect.com/science/journal/00253227/358

Tsunami research

Advances in earthquake and tsunami sciences and disaster risk reduction since the 2004 Indian ocean tsunami

By Kenji Satake. *Geoscience Letters, v. 1, no. 1, 15 p.*

Abstract: The December 2004 Indian Ocean tsunami was the worst tsunami disaster in the world's history with more than 200,000 casualties. This disaster was attributed to the giant size (magnitude M ~9 source length >1000 km) of the earthquake and the lacks of expectation of such an earthquake, tsunami warning system, knowledge and preparedness for tsunamis in the Indian Ocean countries. In the last ten years, seismology and tsunami sciences as well as tsunami disaster risk reduction have significantly developed. Progress in seismology includes implementation of earthquake early warning, real-time estimation of earthquake source parameters and tsunami potential, paleoseismological studies on past earthquakes and tsunamis, studies of probable maximum size, recurrence variability, and long-term forecast of large earthquakes in subduction zones. Progress in tsunami science includes accurate modeling of tsunami source such as contribution of horizontal components or "tsunami earthquakes", development of new types of offshore and deep ocean tsunami observation systems such as GPS buoys or bottom pressure gauges, deployments of DART gauges in the Pacific and other oceans, improvements in tsunami propagation modeling, and real-time inversion or data assimilation for the tsunami warning. These developments have been utilized for tsunami disaster reduction in the forms of tsunami early warning systems, tsunami hazard maps, and probabilistic tsunami hazard assessments. Some of the above scientific developments helped to reveal the source characteristics of the 2011 Tohoku earthquake, which caused devastating tsunami damage in Japan and Fukushima Dai-ichi Nuclear Power Station accident. Towards tsunami disaster risk reduction, interdisciplinary and trans-disciplinary approaches are needed for scientists with other stakeholders.



Link to article: http://www.geoscienceletters.com/content/1/1/15

Source and progression of a submarine landslide and tsunami: The 1964 Great Alaska earthquake at Valdez

By Tom Parsons; Eric L. Geist; Holly F. Ryan; Homa J. Lee1; Peter J. Haeussler; Patrick Lynett; Patrick E. Hart; Ray Sliter; Emily Roland. *Journal of Geophysical Research Solid Earth, Nov. 2014.*

Abstract: Like many subduction zone earthquakes, the deadliest aspects of the 1964 M 9.2 Alaska earthquake were the tsunamis it caused. The worst of these were generated by local submarine landslides induced by the earthquake. These caused high runups, engulfing several coastal towns in Prince William Sound. In this paper, we study one of these cases in detail, the Port Valdez submarine landslide and tsunami. We combine eyewitness reports, preserved film, and careful post-tsunami surveys with new geophysical data to inform numerical models for landslide tsunami generation. We review the series of events as recorded at Valdez old town and then determine the corresponding subsurface events that led to the tsunami. We build digital elevation models of part of the pre-tsunami and post-tsunami fjord-head delta. Comparing them reveals a ~1500 m-long region that receded 150 m to the east, which we interpret as the primary delta landslide source. Multibeam imagery and high-resolution seismic reflection data identify a ~400 m wide chute with hummocky deposits at its terminus, which may define the primary slide path. Using these elements we run hydrodynamic models of the landslide-driven tsunamis that match observations of current direction, maximum inundation, and wave height at Valdez old town. We speculate that failure conditions at the delta front may have been influenced by manmade changes in drainage patterns as well as the fast retreat of Valdez and other glaciers during the past century.

Link to article: http://onlinelibrary.wiley.com/doi/10.1002/2014JB011514/abstract

RECENTLY PUBLISHED

Tsunami research

Earthquake and tsunami forecasts: Relation of slow slip events to subsequent earthquake rupture

By Timothy H. Dixon; Yan Jiang; Rocco Malservisia; Robert McCaffrey; Nicholas Vossa; Marino Protti; Victor Gonzalez. *Proceedings of the National Academy of Sciences, v. 111, no. 48.*

Abstract: The 5 September 2012 Mw 7.6 earthquake on the Costa Rica subduction plate boundary followed a 62-year interseismic period. High-precision GPS recorded numerous slow slip events (SSEs) in the decade leading up to the earthquake, both up-dip and down-dip of seismic rupture. Deeper SSEs were larger than shallower ones and, if characteristic of the interseismic period, release most locking down-dip of the earthquake, limiting down-dip rupture and earthquake magnitude. Shallower SSEs were smaller, accounting for some but not all interseismic locking. One SSE occurred several months before the earthquake, but changes in Mohr–Coulomb failure stress were probably too small to trigger the earthquake. Because many SSEs have occurred without subsequent rupture, their individual predictive value is limited, but taken together they released a significant amount of accumulated interseismic strain before the earthquake, effectively defining the area of subsequent seismic rupture (rupture did not occur where slow slip was common). Because earthquake magnitude depends on rupture area, this has important implications for earthquake hazard assessment. Specifically, if this behavior is representative of future earthquake cycles and other subduction zones, it implies that monitoring SSEs, including shallow up-dip events that lie offshore, could lead to accurate forecasts of earthquake magnitude and tsunami potential.

Link to article: http://www.pnas.org/content/111/48/17039.abstract

The Eltanin impact and its tsunami along the coast of South America: Insights for potential deposits

By Robert Weiss; Patrick Lynett; Kai Wünnemann. *Earth and Planetary Science Letters, v. 409, p. 175-181.*

Abstract: The Eltanin impact occurred 2.15 million years ago in the Bellinghausen Sea in the southern Pacific. While a crater was not formed, evidence was left behind at the impact site to prove the impact origin. Previous studies suggest that a large tsunami formed, and sedimentary successions along the coast of South America have been attributed to the Eltanin impact tsunami. They are characterized by large clasts, often several meters in diameter. Our state-of-the-art numerical modeling of the impact process and its coupling with non-linear wave simulations allows for quantifying the initial wave characteristic and the propagation of tsunami-like waves over large distances. We find that the tsunami attenuates quickly with $\eta(r)\propto r-1.2$ resulting in maximum wave heights similar to those observed during the 2004 Sumatra and 2011 Tohoku-oki tsunamis. We compute a transport competence of the coastal flow and conclude that for the northernmost alleged tsunami deposits, especially for those in Hornitos, Chile, the transport competence is about two orders of magnitude too small to generate the observed deposits.

Link to article: http://www.sciencedirect.com/science/article/pii/S0012821X14006773