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)

Contents **Volume 14, Number 6 December 2012**

REPORT FROM MASSACHUSETTS

Massachusetts Emergency Management Agency

http://www.mass.gov/eopss/agencies/mema/

MEMA's MISSION

Welcome to the Massachusetts Emergency Management Agency (MEMA). MEMA is the state agency with primary responsibility for ensuring the state's resilience to disasters. MEMA's staff of professional planners, communications specialists, operations managers and support personnel is committed to an all hazards approach to emergency management. By building and sustaining effective partnerships with federal, state and local government agencies, and with the private sector - - individuals, families, non-profits and businesses - - MEMA ensures the Commonwealth's ability to rapidly recover from large and small disasters by assessing and mitigating hazards, enhancing preparedness, ensuring effective response, and building the capacity to recover. ♦

State Offices and agencies of emergency management:
Gives mailing addresses, phone and fax numbers, websites. Does not give personnel names or job titles.
http://www.fema.gov/about/contact/statedr.shtm

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is prepared by the Washington State Department of Natural Resources
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REGIONAL REPORTS

AMERICAN SAMOA

American Samoa tsunami study
Source: U.S. Army Corps of Engineers and EA/HHF

This report summarizes a major planning effort by the U.S. Army Corps of Engineers and the American Samoa Government to increase coastal community resilience to the devastating effects of tsunamis in American Samoa.

According to the report's abstract, the process involved broad stakeholder involvement, regular interaction with a Governor-appointed Tsunami Advisory Committee, extensive research into a variety of coastal resilience topics, and the development of recommendations and a multi-year implementation plan focused on improving community resilience. The study recognizes and builds on the inherent resilience of Pacific Island cultures developed over thousands of years of oceanic living, and Fa'asamoa, the traditional approach Samoans follow to govern village life. In addition to the final report, the study's website includes links to working papers, briefing materials, and resources gathered throughout the study.

To download the final report, visit: http://astsunamiresilience.org/reports/

From: WSSPC e-Newsletter, Summer 2012, p. 15
http://www.wsspc.org/news/news_files/eNews_Summer12.pdf

FEMA invests $100 million in post-tsunami disaster relief, emergency preparedness improvements for American Samoa

NOAA will certify Territory as TsunamiReady this week (Sept. 28, 2012)

Honolulu, Hawaii -- The Federal Emergency Management Agency has awarded nearly $100 million dollars in post-tsunami improvements to American Samoa for lifesaving emergency management systems that include an early warning siren system, 9-1-1 emergency call center and the completion of a formal tsunami hazard plan that proved instrumental in helping the island achieve the coveted status of TsunamiReady.

To be recognized as TsunamiReady, a community must establish a 24 hour warning point and emergency operations center, develop multiple ways to receive tsunami warnings and alert the public, develop a formal tsunami hazard plan, conduct emergency exercises and promote public readiness through community education. Given that American Samoa is located 120 miles away from the Tonga Trench, one of the fastest moving subduction zones in the world, tsunami readiness is paramount to the island's safety posture.

After meeting all federal requirements, this week the islands of Tutuila, Aunuu, Ofu, Olosega and Tau and all of the National Park of American Samoa have attained the federal NOAA/NWS designation of TsunamiReady and will be officially designated as TsunamiReady in a ceremony with senior American Samoan Government, NOAA and FEMA officials.

"This subduction zone will continue to produce earthquakes and potentially damaging tsunamis," said Regional Administrator Nancy Ward. "American Samoa Government officials have truly made preparedness one of their most important priorities. Their training and outreach programs have achieved remarkable results that will help save future lives."

On September 29, 2009 the South Pacific tsunami was generated by a series of earthquakes that took place at possibly the closest point of this trench to American Samoa, causing fatalities and regional devastation. Resources have been invested by federal, territorial, voluntary and private sectors partners since the killer wave came ashore in 2009 that have helped the territory to achieve a heightened level of preparedness.

The whole community of American Samoa has come together during the past three years to make the citizens of the islands safer and better prepared to meet a wide variety of threats.

"This is a perfect example of the resilience of the Pacific Islanders and the value of government coordination and cooperation. Everyone met this disaster head on and never stopped moving forward. This recognition is something that the people of American Samoa and their many partners can be very proud of," said Jeff LaDouce, Director of NOAA's National Weather Service Pacific Region.

Post-tsunami FEMA funded projects include: the purchase of a generator and two ambulances for LBJ hospital and establishing an Emergency 9-1-1 Call Center. In addition, funds were used to purchase and install an early warning siren system complete with 48 sirens throughout American Samoa. Funds were also used to improve airport security and to purchase equipment for American Samoa Department of Homeland Security's Emergency Operation Center. Communications equipment and official vehicles for the American Samoa Department of Homeland Security were also acquired. The Land-Mobile-Radio project contract has been awarded and is the next phase to be

implemented to improve communication capability on the island.

FEMA's aggregated financial assistance to long term recovery have included: awarding more than $37 million in FEMA's Individual Assistance programs. This includes assistance under various FEMA programs, including housing assistance, other needs assistance that provided support for dental, medical, moving, storage and a variety of other needs.

The award of more than $54 million to the ASG to rebuild public infrastructure, mitigate against future disasters and reimburse the American Samoa government for some of the money spent during the initial response.

In consultation with the American Samoan Government, FEMA has rebuilt and turned over 39 permanent replacement homes to deserving American Samoan families who lost their homes as a result of the devastating tsunami.

The award of more than $8 million in Homeland Security Grant Program funds and public safety interoperable communications funding used for planning and to help American Samoa to be more prepared for natural disasters, train first responders and citizens of American Samoa and provide much needed communication equipment.

The TsunamiReady program is administered by the National Weather Service as a way to increase and strengthen the ability of communities to prepare for, mitigate, and recover from natural hazards. The TsunamiReady ceremony for the Territory of American Samoa and the National Park of American Samoa, will be held at 10:30 a.m. at the Maota Samoa at Utulei Beach on Friday, September 28, 2012, one day before the 3rd anniversary of the devastating 2009 South Pacific Tsunami.

An American Samoa tsunami study was conducted by the U.S. Army Corps of Engineers, Honolulu District in cooperation with the American Samoa Government to help strengthen American Samoa's ability to prepare for, respond to, and recover from tsunami hazards. To view the study visit: http://astsunamiresilience.org/reports/

To learn more about this disaster, please visit: https://www.fema.gov/disaster/1859

BRITISH COLUMBIA, CANADA

Tracking tsunami debris in the hands of citizens

By Natalie North, Saanich News
Published November 30, 2012, 11:00 AM
Updated November 30, 2012, 12:09 PM
Given reprint permission by Editor Edward Hill
Saanich News (Black Press)

Tracking tsunami debris in the hands of citizens

Murray Leslie, a software developer for Ocean Networks Canada, snaps a photo of a box marked with Japanese characters at Telegraph Cove in Cadboro Bay for a demonstration of Coastbuster, the mobile app. The program is designed to allow anyone to help Canadian and U.S. authorities catalogue and track marine debris, especially objects swept to sea following the 2011 Japanese tsunami.

A wooden box stamped with Japanese characters sits hidden beneath a pile of seaweed and a sizeable chunk of kelp near the waters of Telegraph Cove – an image of what is expected to hit West Coast beaches this December.

This prop didn't actually float over from Japan following the devastating earthquake from March, 2011. But if it did, Murray Leslie, a member of Ocean Networks Canada's software development team, would be doing the right thing, as he kneels down on the beach and snaps a photo with his smartphone.

Logged into Coastbuster, an app designed to get the public reporting marine debris, Leslie captures an image of the box and with a few strokes across the phone's touchscreen, categorizes his finding, simply answering what he has found and whether or not it appears hazardous.

"Pretend we're on the West Coast and there's nothing but wild ocean out there," Leslie says at the Cadboro Bay beach in Saanich. "Stuff can just wash in here; it's very difficult for it to wash out again. They expect debris like this to accumulate for at least the next two or three years."

To catalogue actual debris, Leslie would wait until he got back on a Wi-Fi network and upload his curious photo to Ocean Networks Canada via Coastbuster.

Ocean Networks vets all such images, then sends them along to authorities from the Department of Fisheries and Oceans, the Ministry of Environment, and the U.S. National Oceanic and Atmospheric Administration (NOAA). The lab uploads also the photos to the Coastbuster Flickr account, where anyone can browse, share and comment on the findings.

"It's important that (debris) gets recorded and the people who will be able to do that are the ones who live or work in the area, the people who are actually out walking the beach on a daily basis and able to say, 'Hey, that wasn't here yesterday,"' Leslie says.

Residents on the West Coast, from Washington to Alaska are about to start seeing a lot of debris that wasn't there yesterday. The bulk is projected to be a mere few hundred kilometres from the coastline, and expected within a matter of weeks with the normal circulation of the ocean. Winter storms could see that debris – more than a million tons – wash up anytime between now and Christmas.

Winds have already pushed lighter objects floating closer to the surface of the ocean to our shores, says Kate Moran, president and CEO of Ocean Networks Canada. Oceanographers are now expecting denser objects below the surface and floating too deep for satellite recognition, she says.

"If (an object) is large enough and we can get good dimensions on it, it might help scientists understand the ocean currents better, because it has a certain density and they can calculate the depth at which it was floating," Moran says.

Uses for the app, developed through a partnership with Simon Fraser University's spatial interface research lab, could also be applied to a range of tracking initiatives.

"Say there's some kind of impact on coastal fauna, like oyster beds, or muscles, or clams – we could actually have a campaign and people could document where they are and where they're not.

"It could be applied for other things: surfers could use it to document where the best waves are," Moran adds with a laugh. "It's for people to suggest and we're open to promoting other campaigns if there's a need."

Last June, Cara Lachmuth, volunteer co-ordinator for the Vancouver Island chapter of the Surfrider Foundation, a coastal preservation group, led a group of 16 during an annual clean up of Vargas Island north of Tofino. The group picked up one whole ton of debris in a single day on Vargas Island – a hefty load given their requirement to log all of their findings and submit an annual report to NOAA.

"That's fairly intensive work, to take an entire year of data and write a report," Lachmuth says "To have an app available, so we can submit it all instantaneously with pictures is amazing. We're volunteers and anything that lets us get more done, we're all for."

The free Coastbuster app is currently available on Android smartphones and tablets. The iPhone/iPad apps are awaiting approval from Apple in the coming weeks. Check out information on the project at oceannetworks.ca/coastbuster.

"It was designed to be used even by a kayaker, someone who only has one free hand," Leslie says

"You can become a citizen scientist."

CALIFORNIA

California tsunami policy working group forms
Submitted by Charles Real, California Geological Survey - 07/13/12

A working group of specialists from government and industry, from diverse fields including tsunami, seismic,and flood hazards, local and regional planning, structural engineering, natural hazard policy, and coastal engineering have come together to facilitate the development of policy recommendations for tsunami hazard mitigation.

The group is acting on findings from two major efforts: the U.S. Geological Survey, the Science Application for Risk Reduction (SAFRR) Project – Tsunami Scenario, assessing the impact of a large credible tsunami originating from a M 9.0 earthquake on the Aleutian Islands striking California's coastline, and the State's Tsunami Hazard Mitigation and Education Program carried out by the California Emergency Management Agency and the California Geological Survey.

The latter program is currently involved with several projects to help local coastal communities become *TsunamiReady*™, two pilot projects (Crescent City in Del Norte County and the City of Huntington Beach in Orange County) where tsunami risk is among the highest in California, and a third pilot study focusing on the maritime community. The pilot projects are developing and testing new tsunami hazard products that will assist land-use and construction decision-making in coastal regions. The role of the group is to identify current issues and impediments to achieving tsunami resiliency and offer solutions, and to provide advice on effective use of the new tsunami hazard products.

Members of the California Tsunami Policy Working Group are: *Charles Real* (Co-Chair) – Manager, Seismic Hazard Zonation, California Geological Survey, *Patti Sutch* - Executive Director, Western States Seismic Policy Council, *Lesley Ewing* – Senior Coastal Engineer, California Coastal Commission, *Laurie Johnson* (Co- Chair) – Consultant, Laurie Johnson Consulting + Research, *Ken Topping* – Consultant, Topping Associates International/Lecturer, Cal Poly, *Arrietta Chakos* – Consultant, Urban Resilience Policy/EERI Policy Committee, *Rune Storesund* – Consulting Engineer, Storesund Consulting/ASCE local Chapter

President, *James Barnts* – Director, Crescent City Public Works, *Mary Beth Broeren* – Planning Manager, Huntington Beach Department of Planning, *Brian Tucker* – President, Geohazards International, *Ray Lenaburg* – Chief, Risk Analysis Branch, Federal Emergency Management Agency Region IX, *Ricardo Pineta* – Chief, Floodplain Management Branch, DWR, and *Robert Olson* – Consultant, Robert Olson Associates, Inc.

From: WSSPC e-Newsletter, Summer 2012, p. 4

CGS and Cal EMA collaborate on tsunami hazard mitigation and preparedness

Submitted by Rick Wilson, CGS

The California Geological Survey (CGS) and the California Emergency Management Agency (Cal EMA) have been working together on a variety of tsunami hazard mitigation and preparedness activities to further understanding of how tsunamis can affect the coast of California with a goal of improving public safety. These activities are funded by the National Oceanic and Atmospheric Administration through the National Tsunami Hazard Mitigation Program, and by the Federal Emergency Management Agency through a Co-Operative Technical Partnership with FEMA Region IX, and are described as follows:

On June 19, the California Tsunami Steering Committee held a meeting at San Francisco International Airport. Representatives from federal, state, and county governments were on hand to discuss important issues related to tsunamis, including Tsunami Preparedness Week activities, new map tools for emergency managers, new tsunami maritime and local evacuation brochure products, and planning for potential Japan tsunami debris.

CGS has developed a website devoted to the effects of the 2011 Tohoku-Oki tsunami in the state. The website includes a link to a poster analyzing the impacts to the California maritime communities during the 2010 Chile and 2011 Tohoku tsunamis. Overall, the 2011 tsunami led to one fatality in northern California and caused damage to 27 harbors statewide, totaling nearly $100M. Effects of the tsunami in California could have been even worse without recent state efforts to understand and convey the best available scientific knowledge, and warning information and ongoing tsunami education. Visit the website at: http://www.conservation.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/Pages/2011_Tohoku.aspx

CGS, Cal EMA, and NOAA-National Weather Service recently completed tsunami sign placement plans for Marin and Sonoma counties. The plans are being used by both counties to initiate their sign planning and placement processes with their coastal communities.

Tsunami signage is one of the requirements by NOAA to allow communities to qualify as *Tsunami-Ready™,* a program to recognize communities who have met criteria demonstrating enhanced tsunami planning, education, and awareness.

CGS and Humboldt State University (HSU) are close to completing two tsunami related databases:
1) a paleotsunami deposit database that will be used to analyze existing tsunami inundation maps and help in the production of newer probabilistic hazard maps in the future; and
2) a tsunami currents database from video recordings of recent tsunamis that will help evaluate modeling results within harbors and bays. Both CGS and HSU are working with the U.S. Geological Survey exploring several sites statewide for evidence of tsunami deposits.

Cal EMA and CGS participated in a county-wide tsunami scenario-driven exercise in Marin on May 10th. The scenario used was a magnitude 9.0 earthquake in Alaska's Aleutian Islands potentially inundating parts of the Marin coast within 5 hours. Emergency operations functions and communications during an emergency were tested and the cities of Belvedere and Tiburon conducted evacuation drills with a number of their citizens.

From: WSSPC e-Newsletter Summer 2012, p. 6

Study takes paleoseismic inventory of tsunami risk in Northern California

Source: UCSB Public Affairs - 06/27/12

Using studies that span the last three decades, scientists at University of California, Santa Barbara (UCSB), have compiled the first evidence-based comprehensive study of the potential for tsunamis in Northwestern California. The authors studied sedimentation patterns in salt marshes, floodplains, and estuaries in the northwestern corner of California for signs of seismic events that could lead to tsunami activity, and combined this with information gathered from numerous studies conducted over nearly 30 years by researchers at Humboldt State University. "Paleoseismicity of the Southern End of the Cascadia Subduction Zone, Northwestern California", which was published in a recent issue of the Bulletin of the Seismological Society of America, documents the work.

According to the study, the local California section has experienced three major earthquakes over the last 2000 years, and accompanying local sea-level changes at roughly 300- to 400-year intervals, with the last one occurring 500 to 600 years

ago. The researchers also found that the entire Cascadia Subduction Zone erupted, causing local submergence at least three times in roughly 500- to 600-year intervals, the last activity taking place in 1700 AD.

For the full press release, visit: http://www.ia.ucsb.edu/pa/display.aspx?pkey=2767

From: WSSPC e-Newsletter Summer 2012, p. 12-13

Guam a StormReady®/TsunamiReady™ community

Source: GHS/OCD - 06/19/12

It's been nearly six years since Guam was first recognized by the National Oceanic and Atmospheric Administration's National Weather Service as a *StormReady*® and a *TsunamiReady*™ community.

After meeting a list of stringent criteria, Guam again celebrates recognition as a *StormReady*®/ *TsunamiReady*™ community. The effective date of this recognition was June 12, 2012. These preparedness programs are geared at helping communities develop plans to prepare and warn citizens about severe weather, flooding and tsunami threats.

For Guam to become *StormReady*® and *TsunamiReady*™ , it had to meet several criteria focusing on disseminating and receiving critical weather information, methods for alerting the population, community outreach, a comprehensive natural disaster plan, and 24-hour points of contact. "As an island that is prone to the potential wrath of Mother Nature and as an agency that's committed to holding emergency preparedness at the highest level, I am proud Guam has earned National Weather Service's distinctive "*TsunamiReady*™ / *Storm-Ready*®*"* recognition," said Homeland Security Advisor, James T. McDonald. Ms. Genevieve Miller, meteorologist-in-charge of the Guam Na-tional Weather Service Forecast Office, presented the Lt. Governor with recognition letters and *StormReady*® and *TsunamiReady*™ signs at a ceremony held June 19 at Guam Homeland Security/Office of Civil Defense (GHS/OCD).the entire United States there are less than 2000 locations that have been designated as *StormReady*® and less than 110 locations designated as *TsunamiReady*™ , so this recognition speaks volumes for Guam," stated Ms. Miller.

"Since 2006 Guam has continuously maintained this recognition. I work very closely with GHS/OCD and I've been amazed with the growth in capabilities," said Chip Guard, National Weather Service's Warning Coordination Meteorologist at Guam's Weather Forecast Office.

"Although this is a pinnacle for Guam, we don't intend to stop here. We intend to continue to maintain and improve our readiness. We need to focus down the road and maintain this prestigious certification," added McDonald.

The press release can be found at *http://www.guamhs.org/press-room/press-releases*

Public input sought on Guam tsunami evacuation maps

Source: GHS/OCD - 06/29/12

The Guam Homeland Security/Office of Civil Defense, in coordination with Bureau of Statistics and Plans, is seeking suggestions or comments on DRAFT Guam Tsunami Evacuation Maps. Data and information used to develop the maps are based on a comprehensive report entitled "Tsunami Hazard Assessment Special Series: Vol. 1 Tsunami Hazard Assessment of Guam" (2010).

Copies of the report can be obtained from: http://nctr.pmel.noaa.gov/hazard_assessment_reports/index.html

Copies of the draft maps can be viewed online at http://www.guamhs.org

From: WSSPC e-Newsletter Summer 2012, p. 9-10

OREGON

Tillamook tsunami sirens

Tillamook County Commissioners have decided to stop using the tsunami sirens on January 1, 2013, but SOS (Save our Sirens) members want to keep them. To read full articles (from Oct. 9) on the discussion:

http://www.kgw.com/news/Rockaway-Beach-residents-fights-to-save-tsunami-sirens-173216471.html

http://www.bendbulletin.com/article/20121009/NEWS0107/210090392/

James Roddey presentation

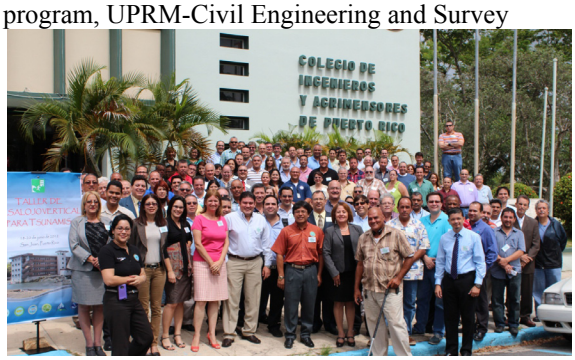
On December 12 at 6:30 PM (Chemeketa Community College and Salem Community Emergency Response Team are hosts), James Roddey, expert on earthquake and tsunami preparedness, will speak. The presentation will be held in Building 6 Auditorium, 4000 Lancaster Drvie NE, Salem, OR. Salem CERT members, Marion County Citizen Corps, and Red Cross volunteers will also be on hand.

PUERTO RICO

The Puerto Rico tsunami resilient planning and construction best practices: Tsunami vertical evacuation workshop

Summary and Recommendations

Victor Huerfano[1], Christa von Hillebrandt[2], Jose Martinez Cruzado[3], Carolina Hincapie[1] and Jeanette Lopez[1] [1] Puerto Rico Seismic Network, UPRM-Geology [2] Caribbean Tsunami Warning Program, NOAA/CTWP [3] Puerto Rico Strong Motion program, UPRM-Civil Engineering and Survey



The Puerto Rico Tsunami Vertical Evacuation Workshop was held June 18-20, 2012 in San Juan, Puerto Rico. The meeting was organized by the Puerto Rico Seismic Network (PRSN) and the Puerto Rico Strong Motion Program (PRSMP) of the University of Puerto Rico (UPR) with the support of the Earthquake Commission of the Colegio de Ingenieros y Agrimensores de Puerto Rico (CIAPR) and the US National Weather Service Caribbean Tsunami Warning Program. The purpose of the workshop was to provide viable alternatives to the coastal communities threatened by tsunamis so that they can save their lives by evacuating quickly.

One hundred and thirty participants, including community leaders, engineers, architects, surveyors, scientists, planners, bankers, technicians, local and state government and public utilities professionals and emergency management officials from mostly Puerto Rico, but also Hawaii, Washington, British Virgin Islands, Venezuela, Colombia and Haiti attended the 3 day workshop.

Twenty four subject matter experts gave lectures on the science of tsunamis, impact of the 2011 Tohoku Japan tsunami, tsunami sources, the tsunami alerting protocol, inundation and evacuation maps, including the identification of evacuation routes, vulnerability of local communities with greatest risk, identification, screening and design of vertical evacuation structures, laws and regulations governing land use in wetlands and coastal maritime areas, design criteria, estimates of costs and funding sources for evacuation routes and vertical evacuation structures.

Community leaders and participants of the meetings met in breakout groups and proposed alternatives for the Barrio Pozuelo (Guayama), Isla Verde (Carolina), Bo. Islote (Arecibo), Bo. Espinar (Aguada), Punta Santiago (Humacao) and San Jose (Mayagüez) presented alternatives for evacuation which included the construction of a hotel, development of evacuation routes thru wetlands and construction of berms, usage of multistory parking lots, observation towers (2), construction of a multistory parking lot and rehabilitate the 2 schools and alternative routes thru wetlands, respectively. Support will be required to follow-up and identify funding for these proposals.

Tsunamis are a series of waves generated in the ocean that cause great devastation as they inundate coastal areas. Over the past 500 years almost 100 tsunamis have been observed in the Caribbean, with at least 3510 people having lost their lives to this hazard in just the past 170 years. Historically, two tsunamis have significantly impacted the western and eastern coasts of Puerto Rico in 1867 and 1918 with at least 140 deaths. Currently, it is estimated that over 62,000 people (1.7% of the total resident population of PR) live in areas that can be impacted by tsunamis in Puerto Rico. The total amount of people that could be impacted is much larger considering the floating community and tourists.

Most of the tsunamis have been caused or are associated with local earthquakes, which generate waves that reach the coastal zones within minutes and affect the shores for hours. Nevertheless, other documented sources of historical and potential tsunamis in Puerto Rico are regional and distant earthquakes and submarine landslides. In 2012 new tsunami inundation mapping was performed for Puerto Rico in which 275 faults were considered. Ongoing work is addressing the tsunami impact in Puerto Rico from distant and regional tsunamis, as well as submarine landslides and other local earthquake scenarios.

The reality is that a tsunami from a local earthquake could reach the shores of Puerto Rico within five minutes to an hour, so the people at risk need to immediately evacuate after the strong ground shaking stops. Nevertheless, activation of evacuations could be delayed for several reasons. Many people will wait to evacuate until they receive an official warning message. Currently the time needed to activate the emergency notification system in Puerto Rico can take up to 16 minutes. Other delays could occur due to vehicular traffic, limited mobility of evacuees, poor visibility if event is not during daylight, delays in the activation of emergency alert

systems, lack of practice, limited signage and fear of robberies. These times could be reduced if the NWS established a Caribbean Tsunami Warning Center in Puerto Rico and continued strengthening of the Puerto Rico Seismic Network. There is also a critical need to continue strengthening public education and preparedness to empower people to respond immediately and appropriately to the natural signs of a tsunami, irrespective of whether or not a tsunami message is officially disseminated.

Given that there are many communities in Puerto Rico for which the time it would take to evacuate is far greater, in some cases 40 minutes more than the tsunami travel time, it is urgent to identify alternatives to decrease the evacuation times. Some of the communities focused upon are located in Mayagüez, Aguada, Arecibo, Humacao, Guayama and Isla Verde. The alternatives to the evacuation dilemma include relocation, identifying new evacuation routes and identification and construction of vertical evacuation structures. This workshop focused on the alternative of vertical evacuation.

Tsunami planning, including vertical evacuation planning, needs to ensure and facilitate through successive and multiple venues the broadest participation of the community, including the young, elderly, those with special needs, media, volunteers, health, industrial, business and tourism sectors and government so that the results reflect its social, economic and political reality.

Since many of the tsunami hazard zones and evacuation areas are located in or near wetlands, the evacuation alternatives require the granting of special permits. For some communities the permitting process has impaired communities from establishing faster evacuation routes. In order to accelerate the permit process, it is highly recommended that local and state agencies support the local communities during the permission process with the US Army Corps of Engineers and other state and federal agencies.

For many other communities the best option to provide a safe haven to residents and visitors could be a vertical evacuation structure. For these the following should be considered in light of recent tsunami experiences in Japan and elsewhere:

The existing (2008) and revised (in preparation) FEMA P646 Guidelines for Design of Structures for Vertical Evacuation from Tsunamis and the accompanying 2009 Guide for Community Officials (FEMA P646A) provide an invaluable resource for the planning and designing of such structures. The Project Safe Haven of Washington in which the type and place for vertical evacuation structures have been identified thru a community participatory process provides best practices for Puerto Rico and other tsunami threatened regions.

Vertical evacuation structures can be buildings, towers, berms or trails. The heights of vertical evacuation structures must use the maximum considered tsunami: It is necessary to determine tsunami inundation heights for events beyond the historical experience and consider the return period of 2500 years to which a safety factor of 30% should be added to account for modeling uncertainty. An additional safety factor includes an additional 3 meters (1 story)

In Japan, tsunami runups of up to 40 meters were recorded, and although in Puerto Rico, such inundation is not expected, only structures equivalent to at least four floors should be considered as safe for vertical evacuation.

Tsunami inundation models that are appropriate to the local conditions need to be implemented in Puerto Rico, most importantly; the models which have been used to date can't resolve for the steep submarine bathymetry around the islands or model the effect of the fringing reef.

In addition to tsunami load, earthquake and wind loads must be considered. Earthquake design must take into consideration site specific conditions like amplification and liquefaction. Compliance with the Puerto Rico Building Code of 2011 is essential. Progressive collapse needs also to be mitigated in case of unforeseen failure of structural members. In reality all these loads will likely be less than those from tsunami, except for tall buildings.

Although mid and high rise buildings have been successfully used for vertical evacuation, these need to have open and free access at all moments. Parking garages are very good alternatives for vertical evacuation

Tsunami loads that need to be considered include hydrostatic, buoyant, hydrodynamic, impulsive, debris impact forces, damming of waterborne debris, and uplift forces. The maximum occupancy of these structures during a tsunami event has to be determined, including the resident and floating population.

The significant flow velocities of tsunamis of up to 8.5 m/sec need to be considered when designing and evaluating vertical evacuation structures. Foundations also need to consider the scouring effects of tsunamis.

Rapid screening techniques for earthquake resistance provided by FEMA can be used to identify existing buildings which could be used for vertical evacuation. These buildings will still need to be evaluated for seismic and tsunami loads, and their resistance to progressive collapse.

Given the infrequency of tsunami events, it is essential that these structures serve multiple purposes so that they are an asset to the community at all times, and not only during a tsunami.

Currently, tsunami vertical evacuation guidelines are only recommendations, not compulsory. Efforts are underway to include tsunami loads in ASCE 7-16 and the IBC in 2018. These national codes should be adopted and enforced locally by 2020/2022 in Puerto Rico and the US Virgin Islands as well as other coastal states and territories. Nevertheless it is important to start leveraging special planning with developers now.

The participants also underscored the importance of tsunami exercises, like LANTEX and CARIBE WAVE to exercise evacuation and an opportunity to discuss vertical evacuation measures and urged the participation of all in the next exercise on March 20, 2013.

As part of the TsunamiReady program, vulnerability studies are available for 22 of the 44 coastal communities of Puerto Rico. Social factors such as population, age, household composition, income and schooling are taken into consideration. It is also noted that economic factors, as well as the total population that can be in the tsunami hazard zone also are very important to consider when determining the tsunami sensitivity. In Puerto Rico the vulnerability to tsunamis has increased due to social, demographic and economic changes. Inadequate planning policies have also contributed to increasing the number of people living in tsunami threatened zones.

Cost estimates are necessary to help determine the viability of a project. To determine the true cost of a tsunami vertical evacuation structure, the costs for a design following the PR Building Code of 2011 can be compared with those implementing the FEMA P646 guidelines. The cost of a structure will depend on the design. The accuracy of the cost estimates depend on the amount of information available. $150-200 p/sq ft ($1500-2000/per person) is the cost estimates for proposed vertical evacuation structures in Washington (Project Haven). Costs need to include also the operational and ongoing costs of the structures. The benefits of these constructions also need to be estimated.

Puerto Rico has the expertise to design and construct vertical evacuation structures. But, the development of public policy and identification of funding are critical for the construction and usage of vertical evacuation structures. Different alternatives exist for federal, state, municipal governments and the private sector, not for profit, public/private partnership and/or community associations, as well as resident populations.

In addition, the participants of the non-US Caribbean recognized that vertical evacuation planning is an important consideration in emergency preparedness measures. The work being performed in Puerto Rico, Haiti, Venezuela, Colombia and in other parts of the world, can serve as a useful model for developing and strengthening tsunami preparedness programs. In support of this effort the following recommendations are also made to the Intergovernmental Coordination Group for the Tsunami and Other Coastal Hazard Warning System for the Caribbean and Adjacent Regions (CARIBE EWS):

*Develop a strategy to expand effective evacuation measures, including vertical evacuation, to all nations. Positive experience with the evacuation efforts in the region should be shared and leveraged to extend these practices to other Caribbean nations.

*The integration of national, regional, local and community agencies and organization for the development of evacuation strategies U.S. NWS Tsunami Program, FEMA and USAID should be approached to support nations in tsunami vertical evacuation strategies.

*Socialize vertical evacuation expertise from Chile, Japan, USA, Puerto Rico and other places.

*Encourage countries to complete tsunami inundation mapping and propose in the meantime the criteria that should be used for evacuation maps and response plans for those which do not have tsunami inundation maps.

*Strengthen tsunami response protocols and explore alternatives for the communication of guidance information during events

*Help identify national and international funding for Caribbean com-munities to promote vertical evacuation strategies.

All participants acknowledged with great appreciation the Puerto Rico Seismic Network and the Puerto Rico Strong Motion Program of the University of Puerto Rico at Mayaguez, the Earthquake Commission of the Colegio de Ingenieros of Puerto Rico and the NWS Caribbean Tsunami Warning Program for the organization and conduct of the Workshop and the UPRM and the National Tsunami Hazard Mitigation Program of NOAA NWS for providing the corresponding funding.

Online tsunami and vertical evacuation resources:
US National Tsunami Hazard Mitigation Program: http://nthmp.gov
US Tsunami Program: http://tsunami.gov
Puerto Rico Seismic Network: http://prsn.uprm.edu
Puerto Rico Disaster Decision Suppor Tools: http://prddst.uprm.edu/apps/ddst/
Tsunami Evacuation Maps for Puerto Rico: http://prsn.uprm.edu and

http://globalmatrixeng.com/tsunamiproject/tsunamimaps/tsunamievacuationmaps/puertoricotsunamievacuationmap
FEMA Guidelines for Design of Structures for Vertical Evacuation from Tsunamis:
http://www.fema.gov
Caribbean Tsunami Warning Program:
http://www.srh.noaa.gov/srh/ctwp
Safe Haven Project:
http://facebook.com/ProjectSafeHaven ♦

How to replace documents lost in a disaster (FEMA) (New York specific)
Release date: December 4, 2012
Release Number: NR-073
http://www.fema.gov/news-release/how-replace-documents-lost-disaster-0

NEW YORK – One of the dire consequences of any disaster for many people is the loss of important documents. Often, such documents are needed by the Federal Emergency Management Agency (FEMA) and state emergency services in order to process assistance applications for those who suffered losses or damage to their homes and belongings.

If papers are gone – like birth certificates, Social Security cards, drivers' licenses, tax records, etc. – New York state and FEMA are advising residents on how to recover them:

BIRTH CERTIFICATES: If you were born within the confines of the five boroughs of New York City, visit or write to the Office of Vital Records, 125 Worth Street, Room 133, New York, N.Y. 10013. (A photo ID is required both by mail and in person.) The office advises the fastest way to get records is online at www.nyc.gov/vitalrecords. The phone number is (212) 788-4520. To download and print an application, log onto http://home2.nyc.gov/html/doh/downloads/pdf/vr/birth1.pdf ; to apply online, log onto www.nyc.gov/vitalrecords.

If you were born in New York state outside of New York City, log onto www.vitalchek.com or phone 877-854-4481. This will connect you to a company called VitalChek, which is contracted with the state to handle credit-card orders. There are modest fees involved.

DRIVERS' LICENSES: Visit any New York Department of Motor Vehicles office. To find an office nearby, log onto www.dmv.ny.gov/index.htm and click on "Replace License or ID."

SOCIAL SECURITY CARDS: Call the U.S. Social Security office at 800-772-1213, Monday through Friday, 7 a.m. to 7 p.m. EST. For TTY users the number is 800-325-0778, or log onto www.ssa.gov/ssnumber for more information.

FEDERAL TAX RECORDS: Call the Internal Revenue Service at 800-829-1040, Monday through Friday, 7 a.m. to 10 p.m. EST, or log onto www.irs.gov.

OTHER RECORDS: For copies of your utility bills, bank records, insurance policies, mortgage payments and the like, call the appropriate firm and speak to a customer-service representative.

To prevent further loss of vital documents, place the originals or copies in a sealable plastic bag or other watertight container and secure that container where it is best protected and can easily be located. It is also a good idea to make copies of vital and important documents and mail them to a friend or relative you can trust to keep them safe and retrievable.

Last Updated: December 4, 2012 - 14:05 ♦

NEWS

Scientists find evidence of ancient tsunami [seiche] in Switzerland

"Ah, Geneva----a place where you can stroll along the lakefront, gaze at Mont Blanc and, according to scientists, be bowled over by a giant tsunami.

Researchers say they've found good evidence that it has happened before. In 563 bishop Gregory of Tours wrote, "a cascade of rocks plunged into the Rhone River, generating a wave of water that "overwhelmed with a sudden and violent flood all that was on the banks as far as the city of Geneva," 40 miles away.

Full article by Sonia van Gilder Cook, Nov. 22, 2012, Time NewsFeed
http://newsfeed.time.com/2012/11/22/scientists-find-evidence-of-ancient-tsunami-in-switzerland/

Freight-container hotel opens in tsunami-devastated area

Natori-Miyagi Prefecture. A two-story hotel consisting of orange and blue freight containers opened in Natori, Miyagi Prefecture, to help alleviate the accommodation shortage in areas affected by last year's natural disasters. The hotel is the first of nine planned by Tokyo-based hotel operator Kachikaihatsu Company in Iwate, Miyagi and Fukushima, the three prefectures hardest hit by the March 11, 2011 earthquake and tsunami

From: The Asahi Shimbun,
http://ajw.asahi.com/article/0311disaster/recovery/AJ201210070016. The full article contains photos.

Wireless carriers implementing the Commercial Mobile Alert System (CMAS)

The Commercial Mobile Alert System (CMAS) is a partnership between the Federal Emergency Management Agency, the Federal Communications Commission and wireless carriers to enhance public safety. The system allows authorized public safety authorities to use FEMA's Integrated Public Alert and Warning System - Open Platform for Emergency Networks (IPAWS-OPEN) to send geographically targeted wireless emergency alerts (WEA) to cell phones.

There are three types of alerts: Presidential, Imminent Threat, and AMBER, and once roll-out is complete, members of the public who have CMAS-capable phones will automatically receive the alerts. Customers can opt-out of Imminent Threat and AMBER alerts, but not Presidential alerts. The system could eventually be used for earthquake and tsunami early warning system alert systems. Four major carriers - Verizon, AT&T, Sprint and T-Mobile -have posted information about CMAS on their websites, although their implementation schedules are in varying stages. For information about the system, visit: http://www.fema.gov/commercial-mobile-alert-system

From: WSSPC e-Newsletter Summer 2012, p. 5

PUBLICATIONS

Sedimentary Geology

Volume 282, pages 1-374 (December 2012) is concerned with the 2011 Tohoku-oki tsunami.

Natural Hazards Science Strategy—Public review release Source: USGS

According to the U.S. Geological Survey executive summary, the Natural Hazards Science Strategy Planning Team (H–SSPT) was charged in October 2010 with developing a long-term (10-year) Science Strategy for the USGS mission in natural hazards. This report fulfills that charge to provide scientific observations, analyses, and research that are critical for the Nation to become more resilient to natural hazards. Public comments are scheduled to be accepted until August 1, 2012. For a copy of the report, visit: http://pubs.usgs.gov/of/2012/1088/

From: WSSPC e-Newsletter Summer 2012, p.15

Guidelines for Design of Structures for Vertical Evacuation from Tsunamis, Second Edition, FEMA P-646, April 2012

Updated by the Applied Technology Council

Technical updates contained in this Second Edition include: (1) observations and lessons learned from the March 11, 2011 Tohoku tsunami; (2) revision of the debris impact expression to remove overconservatism deemed to be present in the prior edition; (3) additional explanation of the definition of tsunami elevation as it relates to run-up elevation used in tsunami force equations; and (4) an update of reference documents to the most current version. For a copy of the report, visit: https://www.atcouncil.org/files/FEMA%20P-646small.pdf

From: WSSPC e-Newsletter Summer 2012, p.17

Disasters Preparedness and Mitigation in the Americas

Issue 118 (November 2012) is now available online at http://new.paho.org/disasters/newsletter/.

WEBSITES

https://www.llis.dhs.gov/about.do

Lessons Learned Information Sharing (LLIS.gov) is the national, online network of Lessons Learned, Best Practices, and innovative ideas for the emergency response and homeland security communities. *LLIS.gov* is a US Department of Homeland Security/Federal Emergency Management Agency program. This information and collaboration resource helps emergency response providers and homeland security officials prevent, protect against, respond to, and recover from terrorist attacks, natural disasters, and other emergencies. LLIS.gov provides Federal, State, and local responders from all disciplines with a wealth of information and front-line expertise on effective planning, training, and operational practices across homeland security functional areas.

CONFERENCES/SYMPOSIUM

January 8-10, 2013
International Disaster Conference and Expo
New Orleans, Louisiana

This conference will discuss emergency management policy and successful mitigation practices. Perspectives from homeland security, emergency response, disaster recovery, business continuity, and global security will be presented. Topics include the differences in responding to natural versus man-made disasters, the Mississippi Alternative Housing Pilot Program, human resilience and logistics in supply chain management, emergency responder decision support tools, societal resilience to terrorism, portable water storage and distribution, and technologies for managing high volumes of insurance claims.

From: DR 595, Sept. 20, 2012 ♦

INDEX *TsuInfo Alert*, volume 14, 2012

Lessons learned at Japan's tsunami catastrophe: Local readiness and international urban search & rescue response--Part Two
By Larry Collins

Introduction

Part 1 discussed the Magnitude 9.0 earthquake (the fifth-strongest quake ever recorded) off the coast of Japan in March 2011, which resulted in some of the deadliest tsunamis since the infamous eruption of Krakatoa. The intent of this series is to examine the emergency response including urban search and rescue operations conducted by the U.S. and UK teams, and especially to describe important lessons that can be applied to save lives through improved tsunami readiness and response in our own nation and in other countries with tsunami-vulnerable coastlines.

The coasts of North America are vulnerable to tsunamis, and in particular the West Coast and the Gulf Coast are more vulnerable than previously recognized. This is a time when many states, counties, and cities are developing (or have already developed) tsunami plans, warning systems, evacuation plans, and response strategies. The Japan calamity is a reminder that even the best-prepared places can be surprised by colossal acts of nature and man, and that a mission of the fire and rescue services is to be prepared for catastrophic-level disasters that damage or destroy entire systems upon which we rely every day.

New findings help explain destructive forces

New information from ongoing research of the March 2011 Japan tsunami catastrophe is helping us better understand the dynamics of tsunamis and how they can impact many other populated coastlines including those of the United States and Canada. Research from the Japan quake is also illuminating some key factors in the tremendous devastation wreaked there in March, and the huge odds faced by the most vulnerable of Japan's coastal residents.

"They were doomed to start with," Costas Synolakis (University of Southern California's Tsunami Center director) recently said about some of those who perished in the catastrophe. A $1.6 billion undersea breakwall outside the town of Kamaishi "didn't protect the town," he said, taking perhaps 6 feet off of a 40-foot tsunami wave. Funneled by narrow sea canyons, waves as high as 130 feet hit some towns, powered by the seafloor's abrupt piston-like bucking during the quake.

Synolakis, a world-renowned researcher who have been instrumental in advising officials in Los Angeles County and elsewhere about "best practices" in tsunami readiness since 1997 (and whose research team prepared the first "tsunami inundation zone" maps for California) has been working in Japan with other scientists trying to determine the geological forces and other factors that contributed to the huge death toll.

Among their findings: The sea floor off the coast of northern Japan was dramatically transformed during the 3-minute long earthquake. The changes include huge cliffs that erupted from a previously flat ocean bottom, and dramatic faulting that in the past would have remained hidden because we didn't have the technology to find it that far beneath the waves. The use of submersible unmanned craft has resulted in video that shows large cracks in the sea bed, huge chasms dropping away, and other evidence of massive earth movement. Viewing the footage, it's obvious even to the untrained eye that this kind of movement would have produced massive displacement of the ocean water column, resulting in equally massive tsunami waves.

"In some places, we cannot see to the bottom of the fissures," says geophysicist Takeshi Tsuji of Japan's Kyoto University. Before-and-after robot submarine visits to three sites about 70 miles off Japan's coasts confirm that the seafloor shifted more than 70 feet eastward and dropped more than 30 feet in some locales, along the fault between the Pacific Ocean and the Japanese crustal plate. Fissures stretch the length of football fields and a cliff several hundred feet tall looks freshly exposed at one spot, more than 2 miles deep.

Merging tsunami waves: A portend of catastrophe

Scientists have discovered another huge and previously unseen factor that increased the lethality of this particular earthquake-tsunami sequence: *Merging tsunamis*.

First hypothesized by scientists concerned that some tsunamis might actually merge in the open ocean to form a sort of "rogue tsunami" train that might double the size and strength of the waves, this quake caused the first "merging tsunamis" that have ever been formally documented.

In the months following the catastrophe, researchers discovered that NASA and European satellites captured evidence of at least two distinct wave fronts emanating from the rupture zone and merging in the open ocean to become a single larger wave front (roughly twice the size of the original waves). This greatly amplified wave train struck Japan's coast at double its original intensity. These "merged tsunamis" retained their lethal strength at far longer distances than would normally be expected, an indication of the insidiousness of this phenomenon.

Scientists have long puzzled over whether it is possible for tsunami waves to merge in the ocean to become "super tsunamis". Some researchers suspected that this kind of dynamic resulted in a huge series of tsunamis that killed people in Chile, Japan, and Hawaii following a large offshore Chilean quake in 1960. Some suspected that such super tsunamis might have been responsible for some of the worst catastrophes in human history. But until the Japan catastrophe they lacked indisputable evidence to support that theory.

Now it has been tragically confirmed. Strangely, the discovery was accidental. It just so happened that three satellites equipped to detect sea level differences and other signatures of tsunamis happened to be passing over that part of the earth when Japan was struck on that fateful day in March. The satellites initially detected two major wave fronts emanating from the offshore epicenter. But they recorded evidence of the two wave fronts merging into a single much larger wave front that was kept intact by effects from the ocean bottom and other factors. The result was devastation on a sublime scale, with iconic scenes that remain etched in peoples' minds.

The towering waves wiped out large sections of many coastal cities in Japan and continued racing across the Pacific Ocean toward the United States. As Japan reeled from the devastating blow that left an estimated 15,000 to 20,000 people dead or missing--and as the world watched the catastrophe get worse with the discovery of major damage to nuclear power facilities in the tsunami impact zone--the United States and other nations prepared for the possibility of disastrous tsunami waves arriving within hours.

Minutes after the quake, a series of devastating tsunamis 30 to 40 feet high (and a whopping 125 feet high in the port city of Ofunato) began destroying Japanese coastal cities as the world watched footage from news helicopters overflying scenes of destruction caused by what could be described as a series of "oceanic flash floods". Motorists tried to outrun the waves as they swept across entire villages, only to be encircled by the surging inland-flowing rivers and swept away in massive debris waves that blasted across canals and seemed to swarm uneven terrain features. Some were extremely lucky, making the right turn and ending up on roads from which they could outrun the oncoming waves. Others were not so fortunate.

For those caught in the path of the waves, the effect was not much different than being downstream of a dam after it fails. Victims were not simply drowned: They were also physically pummeled and battered by debris, their lungs filled with sediment, and carried away to be deposited amid piles of debris or perhaps swept out to sea as the tsunami flood receded. Motorists were carried away inside their automobiles, which ended up being deposited in every conceivable configuration, and at great distances from where they were first struck.

U.S. tsunami warnings, preparations, and response

Simultaneous to this catastrophe, a series of tsunami watches and warnings was quickly issued by the Hawaiian and West Coast/Alaska Tsunami Warning Centers probably impacts on the Hawaiian Islands and the North American mainland as the waves spread across the Pacific at the speed of a jet aircraft. Tsunami watches and warnings were initially issued for at least 20 nations. California was initially placed under a Tsunami *Watch* (possibility of a tsunami; make appropriate preparations), which was shortly thereafter upgraded to a Tsunami *Warning* (indicating that strategically positioned ocean buoys had confirmed a series of tsunami waves heading that way).

In the end, the Hawaiian Islands and the West Coast of North America dodged the proverbial bullet, with serious damage in some coastal zones but only a single fatality recorded. True disaster was averted in the U.S., but Japan was not so lucky.

As the scope of the catastrophe in Japan became evident, the United States government joined other nations offering assistance that included military assets to support search and rescue, road clearing, and other critical needs; nuclear experts; a wide range of advisors; and USAR teams. With the acceptance of assistance, two American USAR teams were deployed.

Both teams landed at Misawa joint air base in northern Japan. The UK's USAR team also landed at Misawa. It was decided that all three teams would travel together to one of the main tsunami impact zones, where they would establish a shared Base of Operations and operate jointly to conduct search and rescue operations as assigned by the Japanese unified command.

USAR teams from all nations in the operational area worked in a well-coordination fashion to accomplish missions assigned by Japan's government through the jurisdictional commands that had been established. It was just the latest example of the effectiveness of the INSARAG (International Search & Rescue Advisory Group) protocols, essentially a series of consensus-based standards that guide the development, training, equipment, typing, deployment, and operations of USAR operations at disasters of the magnitude requiring international USAR team response.

First assignment: Search city largely destroyed by 124 foot high waves

The USAR teams moved into their search areas on the morning of March 15. Each team established a temporary "forward" BoO from which to coordinate the search of its assigned area. They strategically placed their forward BoO's at the uphill edge of the "tsunami interface" (described here, apparently for the first time, as "a wide band of destruction notable for many collapsed buildings that had been pushed uphill by the tsunami waves but which had not necessarily been completely submerged in water altogether", meaning that a higher degree of survivability could expected over places where the buildings and debris piles had been completely submerged).[1]

From the forward BoO's, the team leaders coordinated wide-area search operations from the uphill perimeters of the tsunami impact zone down to the waterline, a challenging task because of the completeness of destruction and the lack of recognizable landmarks.

A "forward" or "provisional" OSOCC (On Scene Operational Control Center)[2], was established adjacent to USA-1's forward BoO in Ofunato. The OSOCC's role is to help coordinate assignments and operations of international USAR teams operating at a disaster, ensuring effective use of these teams while avoiding conflicting search/operational areas, to accomplish priorities and missions established by the local authorities of the nation experiencing the disaster. From the forward/provisional OSOCC, progress of the international USAR teams was tracked as they moved through their assigned search areas looking for survivors and victims. This coordination element also serves as a sort of clearinghouse for information and intelligence and resource requests in support of the overall urban search & rescue operations.

Both U.S. teams and the UK USAR team quickly engaged in wide-area searches in their assigned areas of responsibility that stretched along the heavily industrial and residential southern shores of Ofunato's inland bay. They were joined by USAR teams from China and Taiwan who were searching adjacent areas. The search areas were gridded off by the team leaders and methodically searched for survivors, with deceased victims also being located and documented for removal by local civil authorities. The act of creating grids was complicated because of the terrain features and the "total wipeout" conditions that left few identifiable streets, no addresses at all in many areas, and maps in Japanese matching street signs in Japanese (where they could be found), but with no English translations.

In addition to the invaluable interpreters provided by the Japanese government, several Ofunato firefighters were assigned as guides for the USAR teams, providing local knowledge and helping discern locations, streets, neighborhoods, and associate them with the maps. The level of damage was almost sublime. Anyone who watched the tsunamis via television news coverage saw how towns and cities seems to be getting wiped off the map by the huge waves roaring inland like freight trains. But to stand there on Ground Zero in areas where factories, huge fishing boats, and apartment complexes were swept away or crushed, is another perspective entirely.

Even for veteran USAR team members who've seen major destruction from hurricanes, earthquakes, floods, tornadoes and terrorist attacks, the scale of destruction on Japan's coast was sometimes hard to fully appreciate because it was everywhere they looked. Logs tossed about like toothpicks, automobiles jammed into the second or third floor of multi-story buildings, fishing boats driven far inland and deposited on homes and businesses, tsunami safe refuge areas decimated….the signs of immense destruction went on and on.

And beyond the *scale* of damage, the *thoroughness* of destruction was so complete that it impressed upon us the lethality of tsunamis, and the importance of getting people out of the way of them because to be in the path of one is simply not very survivable. It emphasized the importance of tsunami planning, training, research, and response efforts that are ongoing in the United States and other tsunami-vulnerable nations.

Back on the ground in Ofunato, effective search grids were established by the USAR teams, and other challenges were overcome by use of both "traditional" and "non-traditional" USAR and wide area search methodology. Safety briefings were conducted to review aftershock potential and actions to be taken in case of a major shaker (of if Tsunami Warnings were to be issued by the Japanese government for distant aftershocks that might not be felt where we were working). Also reviewed were the local signals for Tsunami Warnings. The USAR team leaders reviewed Escape Routes, Safe Zones, and other LCES (Lookout, Communications, Escape Route, Safe Zone) and other safety issues before sending personnel into the search areas.

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1 The so-called "Tsunami Interface" is notable as an area with higher potential for live victims to be found in collapsed buildings, vehicles, and debris piles that were not completely submerged. In future tsunami disasters, the Tsunami Interface should be a priority search area.

2 During international disasters requiring the operations of urban search and rescue teams from various countries to assist the nation suffering the disaster, an OSOCC is established under consensus-based international rules established by INSARAG (International Search and Rescue Advisory Group).

Technical and Canine Search resources were shared among the search squads, and heavy snow fell during parts of the operations. Much of the searching was manpower-intensive because of the debris that had to be inspected and sometimes moved. Every time a body was located, it was marked, mapped with GPS coordinates and on a search map, and the location was communicated to the appropriate authorities so that recovery could proceed in an organized and dignified manner based on local protocols and customs.

As darkness fell, USAR team members and the canine search teams were processed through a thorough decontamination process established by the respective team Haz Mat Specialists. And when they returned to the BoO, the vehicles were decontaminated.

Each night the USAR team leaders and the DART and OSOCC reps met with local Japanese commanders at the Ofunato Fire Department's headquarters to report on progress, complications, resource needs, and assignments for the following day. They returned after the teams were largely bedded down, with instructions to be prepared to move out at first light. So the operational pace was thus: Convoy from the BoO to the search area at first light; conduct wide-area search operations until darkness; decontaminate personnel, canines, and equipment; return to the BoO for rehab and rest; nighttime debriefing and planning meetings; and up and out at first light the next day.

Based on the assignments determined by Japanese incident commanders, the U.S. and UK teams started by conducting wide-area search operations, and then transitioned to "targeted de-layering" operations intended to locate any potential survivors; while locating deceased victims in large collapses and in large debris piles requiring heavy equipment and *selective debris removal*. For the targeted delayering operations, the teams selected areas with the highest likelihood to contain trapped survivors and prioritized those places. Priority search areas included the "tsunami interface" zones, where the waves had pushed buildings, autos, and debris to the perimeter of its advance and then retreated to the sea, leaving a wide band of collapse and debris piles and structures that had not been completely submerged.

Japanese commanders arranged for excavators to be made available to the USAR teams, and the plan was for wide area searches to proceed in some areas while rescue (Search) squads operate with the available excavators. Meanwhile, the Technical and Canine Search elements were coordinated to best effect by the respective Search Team Managers.

Heavy equipment movement required specific travel routes through the destruction. In some cases ramps had to be constructed by the USAR team members to allow access to the particular sites. The excavator operators worked closely with the teams, with the operations coordinated by squad leaders and the "Heavy Equipment & Rigging Specialists assigned to the USAR teams, with team Safety Officers observing and other precautions to prevent mishaps and keep the search rhythm going.

Snow fell in increasingly heavy flurries through the mission. The weather was a factor in the pace of operations, but the USAR teams were well equipped for winter conditions. Wide-area search operations proceeded until all the assigned geography had been covered, with delayering operations at the targeted sites in Ofunato.

It was determined that the next assignment for the U.S. and UK teams would be the north, in the devastated port city of Kamaishi, where the world's largest manmade tsunami barrier had been topped by the huge waves that swept away much of the coastal population living on a series of bays separated by high mountains.

Kamaishi

The USAR teams departed for Kamaishi just after sunrise in a 2 hour convoy over winding roads through the steep, high, snow-covered coastal mountains. The roads were covered in a blanket of fresh snow from the night, with some deep drifts. An escort from the Kamaishi Fire Department led the way over the mountains and down to the coast. The convoy included 6 tour buses and five 6X U.S. Air Force trucks from Misawa AFB, whose commander had graciously assigned the drivers to accompany and support the USAR teams throughout the USAR operations.

The convoy arrived at Kamaishi City Hall at 0930 hours and attended a briefing to receive specific search instructions and maps. The assigned search area, a neighborhood known as Unosumai that sits on one of the bays in the Kamaishi city limits, had only received a cursory search thus far. The place had been devastated.

The neighborhood of Unosumai and greater Kamaishi City had been struck by tsunamis estimated to have exceeded 40 feet in height. The previously-mentioned Kamaishi Tsunami Protection Breakwater was seriously damaged. The breakwater (6,400 feet long and 207 feet in depth) was once recognized by the Guinness Book of World Records at the deepest breakwater in on Earth. The tsunamis swept up into three main bays that make up Kamaishi city, carrying homes, automobiles, and debris miles inland. Then the water reversed course and rushed back to the sea, carrying the same debris (now further broken up) and many victims. The tsunami impact in Kamaishi was well documented and resulted in some of the most dramatic scenes caught on film and seen around the world.

The leaders of all three USAR teams had agreed to meet at a bridge that made a natural dividing spot to organize the search of Unosumai. The search area was gridded and target search areas were identified. A unified

communication plan was also established. A unified command post was established with local and regional Japanese fire department officials next to the bridge, and from there the overall search and rescue operations in this part of the city were coordinated.

In cold, windy weather marked by snow flurries and a number of significant aftershocks, the teams moved through the search areas, methodically searching for survivors, but finding only bodies. The operation continued until this part of Kamaishi had been thoroughly searched and more deceased victims had been recovered.

Conclusion of USAR mission

On March 18, 2011 the Japanese government determined that the U.S. and UK USAR teams had completed their assigned search and rescue operations, and there were no further missions for the USAR teams. The school grounds in Setamai, which had become a unified BoO for the USAR teams, were thoroughly cleaned by the rescuers. The director of the school, the school's staff, and other who had supported the teams, were thanked sincerely.

The equipment caches were loaded and prepared for departure to Misawa AFB. The convoy once again traversed the mountains of the northern Japan coastal area and headed back.

At Misawa, the convoy, equipment, canines, and personnel were checked by Air Force personnel for radiological contamination, confirming that there had been no exposure. Once inside the base, the team was then assembled for a briefing with Mr. Okada (Minister of the Embassy of Japan in Afganistan, and leader of the team of Japanese Foreign Ministry interpreters). Mr. Okada thanked both U.S. teams and the UK team for their diligent work, reiterated Japan's dire situation and the need for international USAR teams in this catastrophe.

On March 19, the U.S. USAR teams completed Japan Customs procedures and loaded onto a chartered Delta Airlines 747 aircraft for the non-stop return flight back to the U.S.

Lessons for planning, training, and response to tsunamis

In an age where managing the fire and rescue services are challenged by the consequences of terrorist attacks, earthquakes, hurricanes, floods, wildfires, tornadoes and other disasters that happen more frequently, some may find it difficult to get worked up about the danger of tsunamis, which are clearly a very rare event in most coastal zones. Nevertheless, as demonstrated in Japan, in Chile in 2010, and in the 2004 Sumatra quake/tsunami, the potential life loss (including the loss of many firefighters and rescuers during post-earthquake and post-tsunami emergency operations) can no longer be denied in places recently identified as being vulnerable to "near-source" tsunamis. This is likewise true of locations vulnerable to teletsunamis.

Armed with more knowledge about the hazards of tsunamis that are illustrated so well by the Japan catastrophe, the 2010 Chile quake/tsunami, and the Sumatra event, it's incumbent on local fire department officials and other decision makers to develop a rational response plan that takes into account the need to warn and evacuate the public, provide reasonable guidelines for firefighters and rescuers assigned to tsunami- vulnerable coastal zones, to take advantage of research being done by experts who can help quantify the actual risks, and to heed the lessons from Japan, Sumatra and other places that have experienced deadly tsunamis. Here is a brief synopsis of some lessons learned in the USAR operations at Ofunato and Kamaishi.

Lesson: Emergency services impact

Post-tsunami search and rescue operations are likely to be difficult and dangerous, possibly requiring the use of swiftwater rescue teams and task forces, rescue divers, helicopters, rescue boats, and other special resources. Extensive damage to fire department and other municipal structures, as well as infrastructure like roads and bridges, is probable in some scenarios. The potential for live victims to be trapped, requiring specialized extrication resources, is significant.

Combined with the other land-based effects that typically occur during damaging quakes (i.e. collapsed buildings, freeway overpasses and dams; multiple fires; haz mat releases, etc), large tsunamis striking the coast for period ranging from minutes to hours (24 hours in some estimates) would clearly impede the ability of fire/rescue agencies to cope with the disaster.

Lesson: Planning and preparations

Considering the steady stream of warnings from seismologists about the potential for damaging earthquakes in the coming years, and the increasing body of knowledge that indicates significant local and distant-source threats, it can be argued that this issue is worthy of immediate attention. With preparation, fire departments and other public safety agencies have the means to devise effective Tsunami Warning, Evacuation, and Search and Rescue Plans that will serve the public and safety employees well when the next tsunami event occurs.

One option is to establish multi-discipline working groups to address this issue at the appropriate levels of government. Fire/rescue agencies in potential tsunami impact zones should seek technical advice from recognized experts who can accurately define the hazards that need to be addressed.

There's a need to develop effective public education programs to raise awareness about the danger from near-source tsunamis as well as far-source events. There's a need for realistic warning systems that include not only signs posted in multiple languages, but implementation of audible warning systems (i.e. sirens along endangered coastal zones) that conform to recognized standards. Such systems are now in place along the coasts of Oregon, Washington state, Hawaii, and other vulnerable U.S. coastal zones.

There's a need to develop new strategies for fire departments and other public safety agencies within the affected areas of Southern California, as well as anywhere else that near-source tsunamis are possible.

Lesson: Assess tsunami impact potential

By now, fire/rescue officials along any coast should know if their jurisdiction is potentially vulnerable to tsunamis (near-source or teletsunamis). But that assumption has at times been deadly wrong: It's clear that some tsunami-vulnerable coastal residents and fire/rescue officials alike are not aware of the potential for tsunamis to strike their own home turf. Large stretches of the U.S. coastline have long been identified as being vulnerable to tsunami impact, and in places like Hawaii and the Pacific Northwest, sophisticated tsunami warning systems, evacuation plans, and response plans have been in place for years.

But in some areas of North America, near-source tsunami potential has been recognized by researchers and scientists only in recent years. This includes much of Southern California, long thought to be free from near-source tsunami hazards. It was an assumption that turned out to be wrong, as evidenced by the recent discovery of major offshore "thrust" earthquake faults (whose vertical rupture would cause the sea bed to rise and/or fall, displacing huge columns of water and causing tsunamis that would strike the coast within minutes) and 3,000 foot deep vertical undersea cliffs (whose collapse for any reason including earthquakes or even spontaneously could displace sufficient water to create tsunamis up to 40 feet high) just off the coast. It also includes parts of the Gulf Coast, which could be hit by tsunamis from earthquakes and other events in Mexico, Puerto Rico, Haiti, the Dominican Republic, etc.

In still other coastal areas, earth scientists knew about significant tsunami potential but local fire/rescue officials and responders seem to be relatively unaware of the hazard.

In any event, it remains the responsibility of local fire and rescue officials to develop and maintain an awareness of all significant life hazards, including tsunamis where that's an issue. If that means reaching out to establish partnerships with the scientific community and working closely with seismologists and earth scientists, so be it. There are many benefits for fire/rescue agencies that are forward thinking enough to have these types of relationships with people who study hazards pertinent to their role as public protectors, not the least of which is awareness of the extent and severity of exposure to hazards like tsunamis, and access to expert evaluation of planning, evacuation, and emergency response options.

Lesson: Implement tsunami plans for all tsunami-vulnerable coastal zones

Once it's been established that tsunamis (from any source) are a local threat, a general all-encompassing (i.e. county-wide, city-wide, etc) tsunami plan should be created and implemented, including hazard assessment; tsunami hazard mapping for the purposes of planning and response; public safety agency notification, public notification, evacuation plans (including evacuation of special-needs populations), unified command post(s) on high ground, post-impact emergency response plans, and other critical tasks. This is typically a multi-agency effort to establish the overall plan within which the fire/rescue plan should typically reside or support.

Next, the fire department should establish its own plan within (and/or in support of) the general tsunami plan.

Tsunami plans are simple yet complex. They are simple in the respect that the potential inundation areas are somewhat predictable, and therefore the geographic incident area can be anticipated. Within that geographic area are highways, streets, infrastructure, structures, and population that typically are relatively fixed; in other words, a plan you develop today should still be fairly applicable five years from now.

Tsunami plans are complex because each geographic area can also be complex in terms of endangered population, access, public education and awareness, the level of local firefighters' understanding of tsunamis and related hazards, emergency resources (engines, trucks, rescue companies, USAR teams, helicopters, lifeguard units, rescue boats of various types, etc.), and complications like damaging earthquakes preceding tsunami impact. For example, the plan should direct dispatchers to immediately check with authorities (or, better, to have "in place" earthquake monitoring systems like the online USGS quake notification system) to determine whether the quake's epicenter is *offshore*, and to immediately transmit epicenter information to field units so they can react appropriately. If the epicenter is reported to be offshore and of a certain magnitude or larger, the plan might specify issuance of

standard tsunami warnings and evacuation instructions to the fire department and public. But even if the quake is centered onshore, the potential for tsunamis resulting from underwater landslides should be recognized.

Tsunami plans should include appropriate important information, even including things like cautions against personnel against committing themselves to potential inundation areas --until the danger of multiple waves has passed (a period of hours, according to some tsunami researchers). This will clearly cause a conflict in cases where fires have broken out, people are trapped in collapsed buildings, and mass casualty situations occur within potential tsunami impact zones. The plan should take these and other predictable factors into account and provide reasonable guidelines for personnel faced with such a dilemma.

The plan might begin with the recognition that strong shaking in coastal areas should cause firefighters to immediately abandon fire stations, evacuate to high ground or to an area that is a safe distance from the coast (based, in part, on tsunami impact and inundation maps), and initiate immediate public evacuation until the danger of a tsunami is ruled out.

The tsunami plan should recognize the advantage of using helicopters, inflatable rescue boats, and other special resources to conduct search and rescue in the wake of a tsunami event. It might also include provisions for pre-deploying resources in anticipation of predicted tsunamis from distant sources.

Finally, the plan should address the possible need for (and mechanisms for requesting) regional, state, federal, and potentially even international resources like USAR teams, law enforcement mutual aid, boat and helicopter assets, disaster medical teams, coroners teams, etc.

Lesson: The importance of public tsunami awareness and education

One lesson from the Japan catastrophe is the importance of effective public education programs that continually raises awareness about the danger from near-source tsunamis as well as far-source events. There is also a need for realistic warning systems that include not only signs posted in multiple languages but also implementation of audible warning systems (i.e., sirens along endangered coastal zones) that conform to recognized standards. Such systems are now in place along the coasts of Oregon, Washington state, Hawaii, and other vulnerable U.S. coastal zones. Japan has, for many years, been a leader in this approach, and an example for other nations. And yet, even some of their systems and preparations were overwhelmed by the strength, size, and ferocious quickness of the tsunamis that struck in March.

Sidebar 1:
Surprising Levels of Destruction in Ofunato

The search areas in Ofunato were notable for what could be described as “total wipeout” conditions from the waterline inland to through the “tsunami interface”, to the inland/uphill tsunami boundary lines that ran just below the main road that cut mid-slope across the mountainsides that border Ofunato’s bay.

The destruction along some swaths of land was akin in some ways to that seen in the worst hurricanes or tornadoes: entire blocks leveled, street signs and other landmarks obliterated, no way to determine street names address except through the use of GPS and local knowledge, many large buildings and vehicles deposited far from where they began, and ease of disorientation due to the entirety of destruction for block after block and mile after mile of destruction in some areas was so complete that it appeared many victims had been swept into the sea, along with nearly anything else that would float.

Adding to the sense of “total wipeout” was the sheer proportions of destruction, which easily exceeded that of most disasters. In some places it looked like a monster had tossed buildings, boats, automobiles, and large industrial machinery and cranes haphazardly. And that is essentially what the monster waves had done. The only thing that seemed to be working in the rescuers’ favor was the fact that some communication systems still seemed to be functioning in some areas.

In many places the tsunami waves penetrated far uphill and inland of the main road traversing the hills on both sides of the bay, and they had even deposited large tugboats and fishing vessels far uphill. This was remarkable based on the height (estimated 200 feet or more) above the bay.

The surprisingly deep inland/uphill reach of the tsunamis affected the assignment of “High Ground/Safe Zones” by the USAR teams planning for the inevitable aftershocks and Tsunami Warnings that would occur in the following days. This concern was heightened by our observation of tsunami evacuation and safe refuge zone signs in USA-1’s

search area, where even the areas that had been considered safe because of their inland/uphill locations had been wiped out.

The concern was heighted by the sight of total wipeout conditions and the presence of large vessels in areas that had been expected to be safe from tsunamis. In safety briefings for search squads and other personnel about to engage in operations, this author (assigned as deputy task force leader for the Japan tsunami mission) instructed personnel to constantly be aware of Escape Routes and how to reach them, and to move far above the existing tsunami inundation boundaries in the event of another large earthquake or tsunami warnings, just to add a margin of error in case incoming tsunamis might be higher than one would normally anticipate.

Having studied tsunamis for many years and having been involved with the development and implementation of the Los Angeles County Tsunami Plan for a decade, I was left wondering, Why did the destruction here extend so far inland and uphill, far beyond what might be expected from a 30-foot or 40-foot tsunami? What funneling force had been at work to push the waves so far inland and so high up the hillsides? And what had caused these tsunamis to wipe out areas that had been designated as public tsunami refuge areas, places so far uphill and/or inland that it would be reasonable to assume safety could be found there?

We would learn that answers later from scientists and by examining the history of Ofunato, which had been leveled several times by huge tsunamis in the last century and a half.

Just as physical trauma to a human body has a direct correlation to "mechanism of injury" in our studies and experience of EMS, the damage observed by the USAR teams (and, consequently, the challenges posed by USAR team conducting wide area searches there) were dictated largely by the "mechanism of catastrophe" that had struck Japan. The quake itself and the resulting tsunami waves had a direct effect on the conditions encountered by the first responders and the assisting national and international USAR teams.

From scientists and others, we have learned this about the cause of the Japan tsunami catastrophe. The magnitude 9.0 "main shock" earthquake resulted from the rupture an offshore fault that caused by 5-8 meters of up-thrust on a seabed measuring 180-kilometers wide. The upraised seabed as about 60 kilometers offshore of Honshu, Japan. The displacement of water generated a series of tsunami waves exceeding 10 meters (30 feet) in height along much of the northeastern coast of Japan, which penetrated up to 10 km (6 miles) inland in some places.

But Ofunato's residents experienced an even more dire set of circumstances, which were responsible for the massive scale of destruction we witnessed there.

The port of Ofunato opens to the sea by a narrow entrance sandwiched by two high headlands, creating a sort of venturi effect that compresses and raises the waves when large tsunamis approach the coast. As the tsunamis moved inland past the coastal headlands, they encountered a widening of the bay, which eventually transitions to a long river valley leading into the coastal mountains. Prior to the tsunami, factories, heavy industry and commercial zones had been located along the bottomlands nearly level with the sea. The hillsides rising away from the water had been covered densely by homes and light commercial zones reaching high into the hills on both sides of the bay.

Based on direct physical evidence (including fishing gear and other flotsam scattered high above the bay) found in Ofunato, a joint research team from Yokohama National University and the University of Tokyo has determined that at least one tsunami wave that swept up Ofunato's bay exceeded 30 meters (90 feet) in height.

A University of Tokyo researcher named Taro Iwate more recently estimated the tsunami height in Ofunato at 37.9 m (124 feet). Iwate's estimates are based on scour lines and other evidence he found on the slope of a mountain some 200 m (660 feet) from the coastline. Iwate's findings seem to match the eyewitness accounts of some local residents we encountered during our search operations there. These residents described huge waves "the size of a 10 story building" arriving just 13 minutes after the earthquake.

And there is additional evidence of the veracity of those eyewitness reports. Long before the March 2011 catastrophe, scientists had determined that Ofunato's bay was struck by a tsunami 125 feet high in 1896, generated by the disastrous "Meiji-Sanriku" earthquake. The city was also struck by a 96-foot high tsunami in 1933. So Ofunato

was a known hot spot for devastating tsunamis long before 2011, and that helps answer the question of we encountered such total destruction there.
End—Sidebar 1

Sidebar 2:
A Tsunami Hazard Refresher

Despite their potential for huge life losses and the destruction of coastal cities, tsunamis remain a little-understood phenomenon to many emergency responders. Contrary to some common perceptions, seismic sea waves aren't simply "large waves" of the sort generated by wind, the turbulence of large storms, and other typical oceanographic and weather phenomena. In fact, tsunamis are very different (and hence far more dangerous) than wind-driven waves with respect to their inertia and their ability to sweep ashore for great distances. Whereas it's true that tsunamis may be quite large in height, the true danger is related to the mass of energy that propels them through the ocean at great speeds.

The true nature of the deadly force behind tsunamis is multi-faceted. First, tsunamis are generally caused by significant vertical movement of large blocks of the earth's crust during earthquakes, or by the occurrence of large underwater landslides--or both. Unlike wind-driven waves, which generally affect just the top 20 to 30 feet of water, the energy of a tsunami is traveling at jet engine speeds through the entire column of water from the surface all the way to the ocean floor. When such a large mass of waterborne energy strikes the coast, it may suddenly raise the level of the sea and drive walls of water far inland, creating a sort of flash flood that can pick up ships and large buildings and carry them inland. Topographic features of coastal zones such as bays, inlets, and river mouths can multiply the force and reach of tsunamis…and in Japan this proved extremely deadly, as we shall see.

Even with the potential lethality of tsunamis (sometimes called seismic sea waves), these natural hazards are usually low on the priority list of public safety agencies along both coasts, even in some zones long identified as vulnerable. Many officials mistakenly assume they will always have several hours after a Tsunami Warning is issued to evacuate threatened populations to high ground. This, unfortunately, is not always true, as demonstrated in Japan, where waves began striking the coast just 15 minutes after the 9.0 offshore quake.

So officials need to understand that tsunamis caused by local earthquakes and underwater landslides can strike some coastlines within minutes, and the closer you are to the epicenter, the higher the chances that the largest and most damaging tsunamis will strike your location. This is not always as well understood as it might be.

"The stated goals for getting warnings out in the Pacific are 30 minutes or more for a basin-wide event, 10 to 15 minutes for a regional event, and five minutes for a local event (near-source earthquake)," according to Laura Kong, director of the United Nations' International Tsunami Information Center in Hawaii, speaking at a tsunami preparedness seminar on February 8, 2005.

But back in 1993, five minutes' warning proved insufficient to save nearly 200 people killed on the northern Japanese island of Okushiri, which was swamped by 93-foot tsunamis just three minutes after a major quake there. As residents evacuated the coastline for high ground in the dark of night, structure fires lit up the city below. And, with news cameras rolling, a black wave could be seen sweeping into the city and overtaking burning buildings and fire engines alike. Several more tsunamis followed, destroying large sections of the city and killing more than 200 people, including many firefighters. This disaster illustrated the short timeline that coastal residents and first responders may have in the aftermath of a major quake.

"In many areas where the (2004) Asian tsunamis hit, such local communications systems need to be improved," said David Prior, an expert on geological hazards at Texas A&M University, in 2005. "How can the warning system effectively alert people along the coast, especially if the earthquake and tsunami occur at night?"

Harry Woodworth, a meteorologist and tsunami researcher working out of the National Weather Services' Mt. Holly (NJ) station, puts it this way on an educational Web site: "If you are in a coastal region and experience a large or lengthy earthquake, immediately head for higher ground. This IS your warning."

Fortunately, awareness levels and corresponding plans are improving as emerging research and experience indicates that many cities on the West Coast and even the Gulf may be vulnerable to "near-source" tsunamis that can wipe out large coastal tracts and kill tens of thousands of people within minutes of precipitating events such as offshore (and even on-shore) earthquakes and underwater landslides.

For firefighters, lifeguards, law enforcement, EMS, and other first responders, there is an increasing awareness of the risk-vs-gain decisions required when assessing post-earthquake damage along the coastlines, attempting to suppress fire, trying to rescue trapped victims in collapsed structures, treating the injured, and conducting other post-earthquake emergency operations.
End-Sidebar 2

Sidebar 3: A Historic Perspective on Tsunamis

Earthquake, floods, hurricanes, tornadoes, landslides, volcanoes, tsunamis…throughout history natural disasters have altered the way we live and even where we live. Tsunamis in particular have played a huge role in the settlement of people and their various cultures. The majority of America's population is concentrated along the coastlines, and the same is true of most other nations that have border the oceans of the world.

As just one example, it's recently become evident that Los Angeles County itself has a potential "near source tsunami" hazard that was previously unrecognized by scientists. Only after the Northridge quake (which occurred on a previously unknown "hidden thrust fault" that set off alarm bells in the seismology world), and after studies were conducted to determine how many other "thrust faults" underlie our coastal zones, was it determined that there are several large thrust faults off the coast of Southern California, which translates to the potential of tsunamis up to 42 feet high striking our beaches just minutes after a local offshore quake, with hundreds of thousands of people (and on a summer day perhaps a million or more) at risk.

Not only that, but scientists further determined that a line of huge offshore (underwater) cliffs up to 2,600 feet deep and nearly vertical, can collapse either spontaneously or during an earthquake, resulting in huge tsunami waves striking the mainland and Catalina within minutes. The County of Los Angeles has developed a multi-agency task force to address this hazard, and a County Tsunami Plan is already in place. Our Department is in the final stages of developing its own Tsunami Emergency Procedures to ensure our ability to respond to the threat of near-source (as well as distance-source) tsunamis.

And although some readers may not consider tsunami readiness as a priority, history itself is full of examples of just how fast tsunamis can change the way we see and live in the world.

Sometimes it helps to look back in time, to better understand what can happen in our future. Recent researchers announced that a long-held belief in classic history has been wrong all along, and that an icon of the world—the birthplace of the original Olympic Games--was destroyed not by earthquakes, *but by tsunamis resulting from earthquakes.*

Here is a case in point: For many years it was assumed that Olympia was destroyed by huge earthquake in (or around) 551 AD. Scientists assumed that the city was later buried in flood deposits emanating from the nearby Kladeos river in the western Peloponnese area of Greece. This theory was bolstered by nearly 30 feet of mud, sand and debris that they had to dig through to uncover Olympia in the late 1800's. But even though Olympia was sited at the junction of the Kladeos and Alpheios rivers, there has no evidence that either river carried enough water or sediment to bury Olympia ten meters deep in debris even during flood stages.

The clue that solved the riddle was the deposits themselves: Scientists have found them full of molluscs, snail shells and remnants of marine protozoa, and they are broken up and laid down in ways that indicate they were transported inland at high speed and energy. Not only that, but researchers excavating Olympic found that fallen sections of the columns of the Temple of Zeus did not fall on top of each other in a pattern that would be found if they disintegrated during an earthquake. Instead, they were found in the kind of haphazard patter in the sediment that indicates they

came apart during a huge flooding event, in the same time period in which a major earthquake is known to have occurred there.

The conclusion: A series of tsunamis roared nearly 20 miles up a narrow coastal valley and wiped out Olympia, devastated its population and its buildings, and buried the place in detritus from the ocean (something that might have been hard for most people to imagine until the saw footage of tsunamis roaring miles across coastal plains and up river valleys in Japan). Not only that, but the tsunamis that wiped out Olympia were so large--and their momentum of the inrushing ocean behind them was so great--that they gushed over a line of hills separating Olympia from the sea, something that might seem inconceivable until you stand along Japan's eastern coast and see with your own eyes the immense scale of destruction that tsunamis are capable of wreaking.

It's well understood that tsunamis helped shape human history, especially in places like the Mediterranean and parts of Asia. Tsunamis of various sizes strike Greece about every 11 years on average, including huge tsunami that swept across the Mediterranean in 1908 following an earthquake that killed 100,000 people in Italy. As recently as 1956 a 90-foot tsunami struck the southern Aegean Sea. And formal history is full of tsunami catastrophes dating back at least 3,500 years when the volcanic island of Thera (home to the once-blossoming and highly advanced Minoan civilization whose artifacts are still being discovered on Santorini, which used to be *part* of Thera) blew itself off the face of the Earth, an event that many researchers link to the myth of Atlantis and which certainly led to the enrichment of Western civilization as the Minoans streamed into Greece prior to the main eruption.

So in this sense Greece shares something in common with Japan: Both nations are prone to tsunamis, and the history and culture of both nations has been influenced by tsunamis. And while the U.S. has not suffered a huge tsunami since the 1964 Good Friday earthquake struck Alaska, the potential is always there for *us* to be struck. The history of the U.S. coastlines (including the coast of Hawaii and Puerto Rico) tells us that we must be ever-vigilant for both near-source and tele-tsunamis to strike across a vast stretch of the U.S. coastal zones.

End-Sidebar 3

Sidebar 4: The Importance of Logistical and Other Support Operations

By Day 2 of the post-tsunami search and rescue operations in Japan, the unified BoO for the USAR teams from the U.S. and the UK had grown to a sprawling camp. It included a number of shelters set up outside the buildings for various support operations, like Logistics, meeting rooms, equipment and PPE drying (sheltered from the snow and cold), decon support for vehicles (to prevent contamination of the BoO, vehicle support, and others.

The importance of effective logistics elements can never be overemphasized in the deployment of USAR teams to domestic OR foreign disasters, but it's even more critical when operating in other nations.

Another element of international disaster response by the U.S. which cannot be overemphasized is the USAID DART. While the USAR teams were out searching devastated area, Dewey Perks and the rest of the USAID DART were extremely busy coordinating overall U.S. support operations in the field, making sure that the U.S. resources were meeting the Japanese government's needs and maintaining a solid stream of intelligence back and forth to Washington D.C. This element of USAID's response system is a strongpoint in American support to other nations experiencing major disasters.

As is typical in many disasters, there was no running water in the area, so hand washing facilities, areas for food preparation and consumption, and other support was being coordinated by the Logistics elements of all three USAR teams working together, with support from the Japanese government and Misawa Air Force Base. Other issues included fuel, electricity, and heating for areas where personnel ate and slept and worked. The USAR teams are equipped to live and work in a wide range of environments, and this wasn't even close to the most extreme winter weather they had encountered during disasters. But the logistics specialists were kept busy throughout the entire deployment. So were the communications specialists, who were challenged with maintaining communications between distant sites in mountainous country in the middle of a catastrophe…and maintaining contact with the U.S. government in Washington D.C., and the Fairfax County and L.A. County fire departments.

Likewise, the Medical Team personnel were on constant watch for injury-producing situations, and with the responsibility for ensuring timely treatment, it was a challenge in the middle of a catastrophe. Once again, the three teams pooled their resources and collaborated on the medical piece of the response.

The proverbial "gorilla in the room" was the damaged nuclear facilities to the south of the areas in which the two U.S. teams and the UK team operated. The Haz Mat specialists were constantly monitoring the environment of the teams at the BoO and in the field, and the DART and team leaders stayed abreast of the latest information on the nuclear contamination threat. The U.S. and Japanese governments had a plan to move or demobilize the USAR teams if something unexpected occurred, but in the meantime, the teams operated with no readings of elevated radiation detected during the entire mission.

Sidebar 4: End

Sidebar 5:
Tsunami Notification Levels issued by the United States' Two Tsunami Warning Centers

Regional Tsunami Warning: A bulletin, usually based only on seismic information, initially issued as a means of providing the earliest possible alert to the population near the epicentral area of an earthquake. It places a restricted area (2- to 3-hour tsunami travel time) in a condition that requires all coastal areas in the region to be prepared for imminent flooding from a tsunami and is usually based only on seismic information without tsunami confirmation. Subsequent warning bulletins, which incrementally expand the warning area, shall be issued at least hourly, or when conditions warrant, until upgraded to a Pacific-wide Warning or canceled.

Pacific-wide Tsunami Warning: A bulletin issued by the PTWC or the WC/ATWC after confirmation has been received that a tsunami has been generated which has caused damage at distances greater than 1000 kilometers from the epicenter and thus poses a threat to any populated area within the Pacific Basin.

Regional Tsunami Watch: A bulletin issued initially using only seismic information to alert all participants within 1 to 3 hours travel time beyond the tsunami warning area. The tsunami watch area will be expanded hourly until it is either canceled or upgraded by issuing a Pacific-wide warning. A Regional Tsunami Watch may be included in the text of the message that disseminates a Regional Tsunami Warning.

Tsunami Information Bulletin: A bulletin issued to advise participants of the occurrence of an earthquake in the Pacific or near-Pacific area with the evaluation that a potentially destructive tsunami was not generated. If the evaluation indicates the possible generation of a non-destructive tsunami, an investigation will be initiated and additional tsunami information bulletins will be issued until the investigation is concluded.

Appropriate Bulletins will generally be issued within 15 minutes of earthquake origin time for earthquakes occurring within a Center's regional Area of Responsibility (AOR) and within 10 minutes of receipt of data necessary to characterize the earthquake for earthquakes occurring outside of a Center's regional AOR. As initial warnings may be issued when tsunamis have not been generated, warnings are limited in geographical extent until rapid confirmation of the existence or nonexistence of a tsunami is obtained.

Pacific-wide Tsunami Warning Bulletin: A message issued to all participants on a Pacific-wide basis after confirmation has been received that a tsunami capable of causing destruction beyond the local area has been generated and poses a threat to the coastal population for the entire Pacific Basin. Each hour updated information will be sent until the Pacific-wide Tsunami Warning is canceled.

Regional Tsunami Warning/Watch Bulletin: A message issued initially using only seismic information to alert all participants of the probability of a tsunami and advise that a tsunami investigation is underway. The area placed in Tsunami Warning status will encompass a 3-hour tsunami travel-time relative to the time of message issuance. Those areas within a 3 to 6-hour tsunami travel-time will be placed in a Watch status. A Tsunami Warning/Watch will be followed hourly by additional bulletins until it is either upgraded to a Pacific-wide Tsunami Warning or is canceled.

Tsunami Message Bulletin: A message issued to advise participants of the occurrence of a major earthquake in the Pacific or near-Pacific area. The message evaluates whether (a) A Pacific-wide tsunami was not generated based on earthquake and historical tsunamis data. This will be the only bulletin issued. No Pacific-wide tsunami warning is in effect; (b) An investigation is underway to determine if a Pacific-wide tsunami has been generated. Additional bulletins will be issued hourly, or sooner, as information becomes available. No Pacific-wide tsunami warning is in effect; or (c) No destructive Pacific-wide tsunami threat exists. However, some areas may experience small sea level changes. This will be the final bulletin issued unless additional information becomes available. No Pacific-wide tsunami warning is in effect.

If the event occurs in the WC/ATWC area of responsibility and exceeds the WC/ATWC Regional Warning threshold, but is less than the PTWC Warning/Watch threshold, an investigation will be initiated by PTWC and additional Tsunami Information Bulletins will be issued until the investigation is concluded.

Tsunami Communication Test Test messages are issued by PTWC at unannounced times on a monthly basis to determine writer-to-reader delays in disseminating tsunami information, to test the operation of the warning system by the evaluation of two-way communications with interactive personnel response, and to keep communication operating personnel familiar with the procedures for handling message traffic pertaining to the TWS.

The Author

Larry Collins is a Battalion Chief and a Task Force Leader of the Los Angeles County Fire Department (LACoFD) Urban Search and Rescue Team, identified for international response as "USA-2" and for domestic response as California USAR Task Force 2. ♦

INFREQUENTLY ASKED QUESTIONS

What percent of Americans aren't sure if their area has a personal alerting system?

Answer: 71%
Source: Emergency Management magazine, Sept/Oct 2012, p. 14.

What traveled with the drifting debris from the March Japan Tsunami?

Debris washed out to sea by the waves that swept the Japanese coast is beginning to be washed ashore in America, carrying with it large numbers of hitchhikers that could pose a threat to the local sea life. Scientists fear the exotic sea creatures will establish themselves, killing native species or competing against them for food. Researchers have identified almost 60 species of sea creature normally found only in the shallow water around Japan that have made their way on floating debris to the western shores of America and Canada. To read more go to: http://www.businessinsider.com/tsunami-riding-japanese-sea-creatures-are-attacking-american-coastal-waters-2012-10

What is *Tsunami: Caught on Camera*?

Tsunami: Caught On Camera, Part One http://www.youtube.com/watch?v=RVWqOJtaYJc&feature=related

Christmas Day 2004, and across the Indian Ocean, tourists from around the globe are enjoying dream holidays in the sun. But none of them know that the very next day their video cameras will capture one of the most devastating natural disasters in recorded history, which will leave nearly 300,000 dead in eleven countries.

Five years on, and told almost entirely using amateur footage, much of it never broadcast before, *Tsunami: Caught on Camera (*9 minutes*)* is the moving true story of the 2004 Boxing Day Tsunami told through the eyes of those who were actually there. Shot by ordinary people across the tsunami's huge impact area, the remarkable amateur footage reveals what happened when the waves, caused by a massive underwater earthquake, hit land. This powerful, bold and intimate film reveals what it was like to be caught up in the events of that day and tells stories of panic and heart-breaking loss, as well as courage and miraculous survival. ♦

Material added to the NTHMP Library

November – December 2012

Note: These, and all our tsunami materials, are included in the online (searchable) catalog at http://www.dnr.wa.gov/ResearchScience/Topics/GeologyPublicationsLibrary/Pages/washbib.aspx. Click on SEARCH DATABASE, then type 'tsunamis' in the Subject field to get a full listing of all the tsunami reports and maps in the collection.

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By what phrase is 'emergency management' known outside of North America?

Civil protection, according to an article by Brett Hansard in the Oct. issue of *TsuInfo Alert*, p. 6

VIDEO-CD-DVD RESERVATIONS

To reserve tsunami videos, CDs or DVDs, contact Lee Walkling, Division of Geology and Earth Resources Library, 1111 Washington St. SE, MS 47007, Olympia, WA 98504-7007; or e-mail lee.walkling@dnr.wa.gov.

These programs are available to all NTHMP participants, with a 3-week loan period.

Adventures of Disaster Dudes (14 min.). Preparedness for preteens. American Red Cross.

The Alaska Earthquake, 1964 (20 min.) Includes data on the tsunamis generated by that event.

Business Survival Kit for Earthquakes & Other Disasters; What every business should know before disaster strikes (27 min.). Global Net Productions for the Cascadia Regional Earthquake Workgroup, 2003. With CD disaster planning toolkit & other data.

Cannon Beach Fire District Community Warning System (COWS) (21 min.) Explains why Cannon Beach chose their particular warning system.

Cascadia: The Hidden Fire–An Earthquake Survival Guide (10 min.). Global Net Productions, 2001. A promo for a documentary about the Cascadia subduction zone and the preparedness its existence demands of Alaska, Oregon and Washington states. Includes mention of tsunamis.

Disasters are Preventable (22 min.) Ways to reduce losses from various kinds of disasters through preparedness and prevention.

Disaster Mitigation Campaign (15 min.). American Red Cross; 2000 TV spots. Hurricanes, high winds, floods, earthquakes.

Earthquake…Drop, Cover & Hold (5 min.). Washington Emergency Management Division. 1998.

Forum: Earthquakes & Tsunamis (2 hrs.). CVTV-23, Vancouver, WA (January 24, 2000). 2 lectures: Brian Atwater describes the detective work and sources of information about the Jan. 1700 Cascadia earthquake and tsunami; Walter C. Dudley talks about Hawaiian tsunamis and warning systems.

International Tsunami Information Centre, 2004, Tsunami warning evacuation news clips and video footage, UNESCO /IOC International Tsunami Information Centre, 1 DVD, 12 min.

Killer Wave: Power of the Tsunami (60 min.).National Geographic video.

Mitigation: Making Families and Communities Safer (13 min.) American Red Cross.

Not Business as Usual: Emergency Planning for Small Businesses, sponsored by CREW (Cascadia Regional Earthquake Workgroup) (10 min.), 2001. Discusses disaster preparedness and business continuity. Although it was made for Utah, the multi- hazard issues remain valid for everyone. Websites are included at the end of the video for further information and for the source of a manual for emergency preparedness for businesses.

Numerical Model Aonae Tsunami–7-12-93 (animation by Dr. Vasily Titov) and Tsunami Early Warning by Glenn Farley, KING 5 News (The Glenn Farley portion cannot be rebroadcast.)

Ocean Fury--Tsunamis in Alaska (25 min.) VHS and DVD. Produced by Moving Images for NOAA Sea Grant College Program, 2004.

The Prediction Problem (58 min.) Episode 3 of the PBS series "Fire on the Rim." Explores earthquakes and tsunamis around the Pacific Rim

Protecting Our Kids from Disasters (15 min.) Gives good instructions to help parents and volunteers make effective but low-cost, non-structural changes to child care facilities, in preparation for natural disasters. Accompanying booklet. Does NOT address problems specifically caused by tsunamis.

The Quake Hunters (45 min.) A good mystery story, explaining how a 300-year old Cascadia earthquake was finally dated by finding records in Japan about a rogue tsunami in January 1700

Raging Planet; Tidal Wave (50 min.) Produced for the Discovery Channel in 1997, this video shows a Japanese city that builds walls against tsunamis, talks with scientists about tsunami prediction, and has incredible survival stories.

Raging Sea: KGMB-TV Tsunami Special. (23.5 min.) Aired 4-17-99, tsunami preparedness in Hawaii.

The Restless Planet (60 min.) An episode of "Savage Earth" series. About earthquakes, with examples from Japan, Mexico, and the 1989 Loma Prieta earthquake.

Run to High Ground (14 min.). Produced by Global Net Productions for Washington Emergency Management Division and Provincial Emergency Program of British Columbia, 2004. Features storyteller Viola Riebe, Hoh Tribe. For K-6 grade levels. Have video and DVD versions.

Tsunami and Earthquake Video (60 min.). "Tsunami: How Occur, How Protect," "Learning from Earthquakes," "Computer modeling of alternative source scenarios."

Tsunami: Killer Wave, Born of Fire (10 min.). NOAA/ PMEL. Features tsunami destruction and fires on Okushiri Island, Japan; good graphics, explanations, and safety in-formation. Narrated by Dr. Eddie Bernard, (with Japanese subtitles).

Tsunami: Surviving the Killer Waves (13 min.). 2 versions, one with breaks inserted for discussion time.

Tsunami Chasers (52 min.). Costas Synolakis leads a research team to Papua New Guinea to study submarine landslide-induced tsunamis. Beyond Productions for the Discovery Channel.

Tsunami Evacuation PSA (30 sec.). DIS Interactive Technologies for WA Emergency Management Division. 2000.

TsunamiReady Education CD, 2005, American Geological Institute Earth Science Week kit.

Tsunamis: Know What to Do! (8 min. DVD)

Understanding Volcanic Hazards (25 min.). Includes information about volcano-induced tsunamis and landslides.

UNESCO/IOC International Tsunami Information Centre, 2005, U.S. National Tsunami Hazard Mitigation Program public information products—B-roll footage, tsunami science, warnings, and preparedness: UNESCO/IOC International Tsunami Information Centre, 1 DVD**,** 57 min.

The Wave: a Japanese Folktale (9 min.) Animated film to start discussions of tsunami preparedness for children.

Waves of Destruction (60 min.) An episode of the "Savage Earth" series. Tsunamis around the Pacific Rim.

Who Wants to be Disaster Smart? (9 min.). Washington Military Department/Emergency Management Division. 2000. A game show format, along the lines of *Who Wants to be a Millionaire*?, for teens. Questions cover a range of different hazards.

The Wild Sea: Enjoy It...Safely (7 min.) Produced by the Ocean Shores Wash. Interpretive Center, this video deals with beach safety, including tsunamis. ♦