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**A Fire and Rescue Service Primer on Tsunamis—Part II
New Theories About Tsunami Threat**

By Larry Collins

New theories hold that populated coastal areas of Los Angeles County and other parts of Southern California are at moderate to high risk from large tsunamis generated by local earthquakes, as well as from local underwater landslides. According to Doctor Synolakis’ team and other researchers, the potential for heavy damage and loss of life from these events is significant. Perhaps most disturbing are new findings that local offshore faults are capable of generating large tsunamis that can strike the coast of Los Angeles County within as little as a few minutes, leaving little time for warnings or evacuation.

The OES/U.S.C. studies indicate that critical places like Marina Del Rey, Malibu, Long Beach, and other densely populated coastal zones are at extreme risk for heavy damage and life loss in the event of tsunamis. Professor Synolakis and his associates have determined that even moderate-sized tsunamis can propagate far into Marina Del Rey, up Ballona Creek, and up Malibu Creek (via Malibu Lagoon and directly through parts of Malibu Colony). They have uncovered evidence that these and other vulnerable coastal sites can suffer huge loss of life and damage to property. The message for fire/rescue personnel is clear: If tsunamis are preceded by earthquakes that cause fires, structural collapses, hazmat releases, and injuries along the coast, emergency responders will be exposed to significant hazards that they may not anticipate.

This is surprising information in Southern California, where scientists have for decades assured emergency planners that locally-generated tsunamis are not a credible threat. As a result of years of assurances that tsunamis were low-level risks, few Southern California municipalities have developed warning systems or emergency response plans for locally-generated tsunamis.¹

Consider the example of Marina Del Rey, one of the largest private yacht basins on the West Coast, nestled between Santa Monica and Los Angeles International Airport. Professor Synolakis’s current studies demonstrate that a large portion of this coastal community may be inundated by even a “moderate” six-foot tsunami and sea rise. While the study is not yet complete, it is evident that such an event would almost certainly cause a large loss of life. *(Continued on page 3)*

¹ The Ventura County (California) Fire Department has for two decades kept a tsunami response plan in effect, and the Lifeguard Division of the County of Los Angeles Fire Department has a plan for distant-source tsunamis, which are generally preceded by hours with warnings from the Pacific Tsunami Warning Center.

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(Continued from page 1)

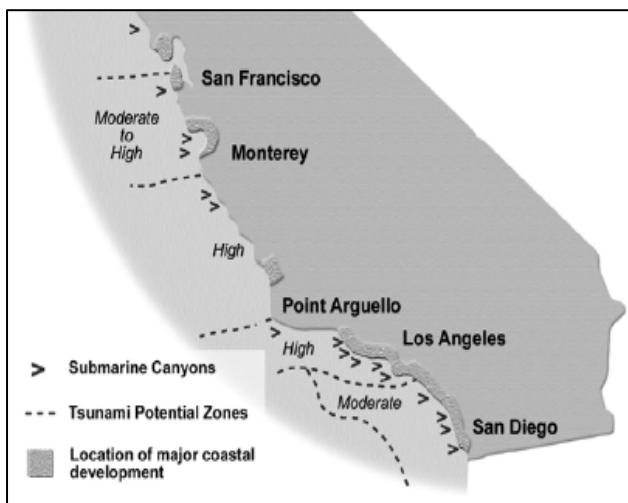
A 6-foot tsunami striking Marina Del Rey would carry with it boats, yachts, and floating docks as it moved across the water. Upon striking the inland edge of the Marina, the wave would come ashore, adding automobiles and buildings to its debris load as it moved onto land. Part of the wave would run nearly one mile up Ballona Creek, causing further damage in adjacent neighborhoods.

Although smaller in size and power, such an event would not be entirely unlike the tsunami that struck Papua New Guinea recently. As in the New Guinea event, Marina Del Rey could be the target of multiple waves, some larger than the first, that could endanger rescuers for fifteen to twenty minutes. Aftershocks could result in repeated tsunamis for hours after the main shock.

According to several researchers, similar effects could occur at coastal inlets and tributaries like Malibu Creek and other populated coastal zones. River inlets, creek drainages, swamps, marinas, and manmade waterways are particularly vulnerable to tsunami action because they tend to propagate large waves further inland. Low, flat areas are also a natural target. For this reason, some of the most valuable property on the West Coast may be *ground zero* for deadly tsunamis.

Consider a large tsunami striking land, picking up all manner of debris (including boats, automobiles, trees, floating docks, and people) as it moves inland. The first wave is likely to be followed by others, some of which may be much larger than the pilot wave. As the waves subside, equally destructive events can occur when the water rushes back toward the ocean, carrying homes, cars, boats, and other debris. For victims caught in the inundation zone, the overall effect of the incoming and outgoing waves is not dissimilar to that of multiple flash floods that completely (and repeatedly) reverse course. In the aftermath of a catastrophic earthquake, such an event may severely magnify the search, firefighting, and rescue problems.

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.

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

Such a plan should direct the local dispatch center to immediately check with authorities 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, there might be standard tsunami warnings and evacuation instructions to be issued by the dispatch center. But even if the quake is centered onshore, the potential for tsunamis resulting from underwater landslides should be recognized.

Tsunami plans should include appropriate cautions against personnel 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 factors into account and provide reasonable guidelines for personnel faced with such a dilemma.

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.

L.A. County Operational Area Tsunami Response Plan

The County of Los Angeles Emergency Management Council, created by Section 2.68.160 of the Emergency Ordinance, and comprised of key County departments, is responsible for overseeing the preparedness activities of County departments. This includes preparation of plans, emergency and disaster-related training of County employees, and related emergency preparedness activities.

The EMC has reviewed and approved the Operational Area Emergency Response Plan – Tsunami Annex. Revisions to the Tsunami Annex will be submitted to the EMC for approval.

The policies, procedures, and concepts identified in this annex follow the guidelines established by the following:

- United States Department of Homeland Security's National Incident Management System (NIMS)
- California Standardized Emergency Management System (SEMS)
- National Fire Protection Association's Standard on Disaster and Emergency Management and Business Continuity Programs (NFPA 1600, 2004 Edition)
- National Oceanic and Atmospheric Administration's (NOAA) National Tsunami Hazard Mitigation Program (NTHMP)
- California Governor's Office of Emergency Services (OES) Local Planning Guidance on Tsunami Response (second edition).

The Los Angeles County's Office of Emergency Management (OEM) convened and chaired the OA Tsunami Taskforce to coordinate tsunami planning and response protocols, including the identification and coordination of evacuation routes. This taskforce consisted of representatives from the OA, Disaster Management Areas (A, B, F, G, and H), coastal cities, special districts, major public safety agencies, seismologists, geologists, and tsunami researchers.

This annex is based on the following assumptions:

-The most likely causes of the tsunami hazard in Los Angeles County are a seismic event off the California coast or in the Pacific Rim, and from a landslide in the coastal shelf off the Southern California coast caused by onshore or offshore quakes, or even spontaneously from the collapse of undersea cliffs. Some earthquake faults off the coast of Los Angeles County and adjacent counties have been identified as potential tsunami generators.

-Time to warn the public, evacuate sensitive facilities, establish temporary shelters, and secure coastal areas will vary from minutes to hours.

-The worst-case scenario for the OA may be a damaging coastal quake that causes structure collapses, fires, ruptured utilities, and mass casualties, followed immediately by one or more damaging tsunamis that strike during critical life-saving operations. The OA participants have reached a consensus that it may be necessary to commit significant emergency resources to life-saving operations in potential tsunami inundation zones, and that appropriate precautions (including the use of L.C.E.S., Lookout, Communications, Escape Route, Safe Zone) should be built into each agency's tsunami response plan and policies.

-If damaging tsunami waves are generated, they may continue to arrive at intervals for several hours, lasting for up to 24 hours.

-Based on State of California (Office of Emergency Services) protocol, and based on the judgement of local authorities, an "All Clear" may be issued and potential tsunami inundation zones may be reopened for reentry by responders and the public two hours after the last observed wave, two hours after the Estimated Time of Arrival (ETA) has passed without a wave coming ashore, or after the West Coast Alaska Tsunami Warning Center determines that no more tsunamis are likely and cancels the Tsunami Warning or Watch.

-Maximum wave height will vary considerably from one location to another, based on local underwater topography, the presence of waterways and other landmarks, and the direction of attack by tsunami waves.

-Withdrawal of the sea may be a precursor to arrival of the wave, however, this does not occur in approximately 20% of cases. Therefore, establishing Lookouts with effective communication is paramount to the safety of the public and of public safety personnel, whenever a Tsunami Warning is issued and immediately after coastal

quakes 6.5 or greater in magnitude, until the All Clear is issued.

-Outflow of water to the sea between crests may be rapid and destructive.

-Elapsed time between successive wave crests at a given point is usually 10 to 45 minutes. Intervals between successive major waves may be similar. If the second wave arrives 20 minutes after the first, it is likely that a third wave (if there is one) would arrive 20 minutes after the second.

-The first wave may not be the largest. If the water from preceding tsunami waves does not have sufficient time to drain back to the ocean, then succeeding waves may attain higher mean heights and may penetrate further inland because they will be "riding" atop bodies of water deposited by previous waves. This means that the first tsunami wave may not be the most damaging; and that additional waves may threaten citizens and responders further inland. The largest wave usually occurs within the first ten waves, with the second or third typically being the most destructive. This must be taken into consideration by emergency responders and by law enforcement establishing evacuation zones.

-Maximum wave activity in bays and harbors is often observed much later than the arrival of the first wave.

Risk Areas

Depending on the magnitude of the tsunami, County coastal communities and special districts could be inundated, most notably along Santa Monica Bay and in the Ports of Los Angeles and Long Beach, southward to Orange County. Field surveys and modeling (1992-1996) project a four meter (13 foot) tsunami would cause extensive damage and flooding along the Santa Monica Bay and similar flat coastlines. The maximum tsunami wave heights generated in computer modeling of the Los Angeles County coastline are 42 feet. Although this is an unlikely scenario, the inundation zone would be extensive, especially in the Marina Del Rey/Venice areas and in the Ports of L.A. and Long Beach and the coast of Long Beach. Other areas at risk include: Palos Verdes, Redondo Beach, Hermosa Beach, Manhattan Beach, Catalina Island/Avalon, and El Segundo's coastal zone.

According to the L.A. County OA Tsunami Annex, "The Working Group on California Earthquake Probabilities of the Southern California Earthquake Center (SCEC) has identified the Palos Verdes, Santa Cruz Island, and Santa Rosa Island faults as active and potentially tsunamigenic. The impacts of an earthquake on the Palos Verdes fault and the resulting tsunami, could especially affect the Ports of Los Angeles and Long Beach. Communities sandwiched between the ocean and other bodies of water, such as wetlands and river inlets, are at very high risk due to the possible overland flow and simultaneous tsunami attacks from multiple directions."

The densification of land use in Southern California and the continued development in areas exposed to coastal and riverine inundations have increased the risk of property damage and loss of life from future tsunamis. Even in regions where the tsunami hazard may be small, the development in areas subject to inundation and downward ground motion (subsidence) increases the overall risk. Future tsunamis may cause economic losses in coastal communities dependent on marine and harbor commerce. Losses to the tourist industry and harbor facilities in the Ports of Los Angeles and Long Beach could be very high, even for small events. Additional risk is posed by the potential release of toxic pollutants due to the failure of marine oil-transfer facilities and terminals.

Concept of Operations

In order to successfully accomplish the mission statement of this annex, County departments, agencies, coastal cities, special districts, and other jurisdictions will use a multi-agency, multi-disciplinary coordinated approach in response to a tsunami threat or event. The County will use the Incident Command System (ICS) component of the SEMS and the NIMS to manage tsunami events.

By consensus of the OA, Unified Area Command shall be established for overall control of emergency resources during tsunami events, with multiple Unified Commands (Malibu, Santa Monica, Venice/Marina Del Rey, South Bay, L.A. Harbor, Long Beach, and Catalina) established to coordinate operations in the coastal zones.

According to the Annex:

"In the event of a Tsunami Watch/Warning and following alert confirmation and threat assessment, local authorities will warn the population in designated risk areas and advise them to move to temporary mass care facilities, if appropriate. Local authorities and emergency managers are responsible for executing evacuation and traffic control plans and implementing area security for areas under a tsunami warning. After local authorities provide a general warning to the public, the highest priority is alerting and moving institutional populations such as schools, hospitals, and convalescent care facilities. The local agency with incident command authority will arrange special procedures for warning, evacuation, and care of institutional occupants."

"Each agency assigned Incident Command responsibilities will control operations within its area of responsibility. Local governments and agencies in the predicted impact areas will prepare for flooding and implement their tsunami and evacuation plans, as well as implement earthquake plans, as appropriate."

"NOAA's NWS operates the West Coast/Alaska Tsunami Warning Center (WC/ATWC) in Alaska to monitor potential tsunamis and provide early warning of such waves. The WC/ATWC is responsible for: (1)

reporting seismic movement along the North American Coast from the Aleutian Islands south through Baja California; and (2) providing technical advice to emergency managers within its area of responsibility.”

“Since California is vulnerable to local-source tsunamis, the current tsunami warning system does not fully meet California’s needs. There are areas along the California Coast considered to be tsunami generation regions. The WC/ATWC may not detect a locally generated tsunami in sufficient time to warn local authorities to evacuate potential tsunami-impact areas. At present, detection of such local-source tsunamis is possible only where the shore can be observed. The first visible indication of an approaching tsunami is often a recession of water. Any withdrawal of the sea, therefore, should be considered a warning of an approaching wave. On the other hand, a rise in water level may be the first event.”

Conclusion

In an age where managing the consequences of terrorist attacks (some involving weapons of mass destruction) have rightly become the national priority, and where hurricanes, floods, and damaging earthquakes are a constant concern, it may be difficult to get worked up about the danger presented by tsunamis, which are clearly a rare event in most coastal zones. Nevertheless, 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.

Armed with this knowledge about the potential to lose firefighters, rescuers, and citizens during a “near-source” tsunami 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, to provide reasonable guidelines for firefighters and rescuers assigned to tsunami-vulnerable coastal zones, and to take advantage of the research being done by experts who can help quantify the actual risks.

End

The Author:

Larry Collins is a 27-year member of the County of Los Angeles Fire Department (LACoFD); a captain, USAR Specialist and paramedic assigned to USAR Task Force 103, which responds to technical rescues and multi-alarm fires across Los Angeles County. He is a Search Team Manager for the LACoFD’s FEMA/OFDA US&R Task Force for domestic and international response, and he serves as an US&R Specialist on the “Red” FEMA US&R Incident Support Team, with deployments to the Oklahoma City bombing, the 9-11 Pentagon collapse, Hurricanes Frances, Ivan, Dennis, Katrina, Rita, and Wilma, and several National Security Events. He authored the text-

book series titled *Technical Rescue Operations* and the Rescue chapter of *The Fire Chiefs Handbook*.♦

Tsunami Deb finds Seaside [Oregon] position the perfect wave to ride—Preparedness is top priority for Seaside Tsunami PREP program

By Pamela Robel, *The Daily Astorian*, January 25, 2008
Reprinted with permission from *The Daily Astorian* of Astoria, Oregon

SEASIDE - Tsunami Deb cuts a striking figure in Seaside, and elsewhere, these days as the coordinator of the Seaside Tsunami PREP program. Outside of emergency preparedness, Tsunami Deb is better known as Deb Treusdell.

Treusdell said she has to thank Seaside Chamber of Commerce Director Al Smiles for bringing the position to her attention a year ago.

"He mentioned he was going after this project and the more I heard about it, the more I thought it was just made for me," said Treusdell. She said that when she asked Smiles whether he would mind if she "put her hat in the ring," Smiles told Treusdell he had expected her to.

According to Treusdell, the city of Seaside was looking for someone with a public relations background rather than a tsunami expert because experts cannot always bring the subject matter down to a level the public can understand and appreciate.

"I guess I'd been around the block enough to know it wasn't going to be simple," said Treusdell. "The challenge is that the information is ever-changing and not all experts agree on the nuances."

From Treusdell's point of the view, the important thing, whether a 40-foot wave or a 60-foot wave hits Seaside, is to get people prepared on an individual need level. Treusdell said helping prepare themselves is in essence what her job has been over the last year.

"She has done a lot of outreach," said Seaside City Planner Kevin Cupples, who helped with the contracting process that brought Treusdell on board. "Especially when you consider that we were having meetings every other week." Those bi-monthly meetings were informational and educational meetings that touched on topics ranging from how to operate a National Oceanic and Atmospheric Administration weather radio to the history of tsunamis on the North Coast. Cupples said he believed Treusdell has done a phenomenal job in fulfilling her responsibilities as an out-reach and education coordinator.

"The point of hiring Deb was to get a core group of people together who would act as a continuing education group after Deb's funding ends," said Cupples. That core group Treusdell has rounded up has been fed by the local Ham radio club, Seaside Tsunami Amateur Radio Society or STARS, which is headed by Jeff Holwege.

"As far as I'm concerned, we got the cream of the crop," said Treusdell. "I'm kind of the Pied Piper of the

tsunami preparedness." Holwege said volunteering with the Tsunami PREP program has been an enjoyable experience.

"I think she's done a fantastic job," said Holwege. "A lot of people have been volunteering and getting involved."

Treusdell will be the first to alert people to the continuance of her contract through the end of March and said the city of Seaside is "really to be commended" for allowing her to do her part and supporting her suggestions. Treusdell's example of the city's support comes in the NOAA weather radio workshops that were held in Seaside.

"I said, 'Those radios are really complicated,'" said Treusdell. The city responded by supporting the workshop classes to teach people how to use the radios. "I had some people who didn't even know how to put the batteries in."

Over the past year, Treusdell has compiled a list of people she has had contact with while dealing in tsunami preparedness; the list is nearing the 500 mark.

"People have asked if it's made a difference and I say it has," said Treusdell. "During the storm, there are 400 people I had personally trained, who got radios and know how they work. That's 400 people who didn't have to go to a shelter."

Of those people, Treusdell said, the most rewarding part of the process has been seeing the steps people have made with her suggestions. She said what is most important is that people tailor their emergency plans to their individual needs, that a 70-year-old couple, with one of them using a walker, is going to have to have a completely different plan from a 30-year-old couple.

"The most rewarding thing, really, is sitting across the table or the living room from a 70-year-old couple, hearing their concerns and then hearing from them two weeks later and hearing they have done their whole emergency plan," said Treusdell. "Seeing people get really involved has been the most gratifying part."

Outside of her work with the Seaside Tsunami PREP program, Treusdell runs a marketing and public relations consulting business. She began the business five years ago after quitting a career in newspaper marketing that had spanned 15 years.

"I was getting further and further away from people and less and less happy with my job," said Treusdell. "I say my business is marketing and public relations, but it's really much more about helping people reach their potential."

As for her continued work with Tsunami PREP, Treusdell said she is hoping funding can be found for some "ongoing, part-time thing."

"I love being 'Tsunami Deb,'" said Treusdell.

From:

<http://www.dailyastorian.com/Main.asp?SectionID=2&ArticleID=48564> ♦

Early warning systems—Reframing the discussion

By Philip Hall

From: *The Australian Journal of Emergency Management*, v. 22, no. 2, p. 32-36.

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Abstract—In recent years, the focus of the international community in relation to risk, disaster or emergency management has shifted from the development of disaster response capabilities to the need to strengthen risk reduction and control mechanisms and policies, with a particular interest in the design and implementation of better early warning systems as a major mitigator of disasters. The emphasis on early warning systems has turned attention and funding to the current capabilities and developments in science and technology, and unfortunately, distracted us from the central issue of addressing the real needs of the communities and people at risk. This paper argues from a background in mission critical systems, project management and business performance, that we cannot achieve the risk reduction and mitigation we seek until the emphasis is placed on the leadership role of emergency management in providing an effective early warning capability through the integration of the improvements in science and technology with traditional methods and an expanded commitment and involvement by all those at risk.

Introduction

For decades, the international community has discussed and debated how coordinated, collaborative international action can reduce the loss of life, property damage, and social and economic disruption caused by natural disasters. The early emphasis on the development of disaster response capabilities has shifted to the need to strengthen risk reduction and control mechanisms and policies, and most recently, to the design and implementation of better early warning systems. As a result of the International Decade for Natural Disaster Reduction (IDNDR), a rich body of literature now exists on the topic of Early Warning and a variety of successful local initiatives are in place. What has not resulted is coordinated, collaborative international action.

The lack of action is keenly felt within the international community, as is evidenced by the papers presented and workshops held at recent conferences organised around themes such as "Research to Action" (Programme, World Conference on Disaster Reduction, Kobe 2005) and "Concept to Action" (Programme EWCH, Bonn, 2006). While the "Hyogo Framework for Action", agreed by 168 nations at Kobe, Japan in January 2005, documents international agreement of the need to move from discussion and debate to tangible results, it lacks clear cut and precise goals which would constitute commitments and provide baseline points of reference for participating governments and any subsequent evaluation of achievements. The Framework, however, does specifically em-

phasise the importance of implementing early warning systems “that are people centered [sic]...and that support effective operations by disaster managers and other decision makers.” (Hyogo Framework, 17 (ii) (d), p. 9).

Many of us agree on the vision and the importance of translating that vision into a global reality. Why is it, then, that we have not been able to generate a sustainable effort to make Early Warning an international achievement? I believe the answer is that the international community has lost sight of the fact that early warning is the integration and extension of existing emergency management capabilities, and therefore, efforts to establish any local, national, regional and international early warning capability must be led by emergency managers, not by scientists and technologists.

Emergency management is a range of measures that bring together the everyday endeavours of private, voluntary, and government agencies in a comprehensive and coordinated way to deal with the whole spectrum of emergency needs. Through this coordinated effort, emergency managers make use of existing tools and processes, such as weather forecasting, law enforcement, transport infrastructure, health services, scientific modelling, telephony, television and radio broadcasts, and legislation, all of which are used to provide specialised services to the community on a day-to-day basis. In the broadest sense, emergency managers are those who carry out any tasks before, during or after a disaster or emergency, which contribute to enhancing or maintaining the safety of communities from disasters by using whatever tools and processes that are available. The plans, structures and arrangements coordinated by emergency managers are people-centric, recognising that the community owns the risk and must be given all possible assistance in identifying and dealing with it. (EMA Web Site).

Putting early warning systems into perspective

In 1997, the UN’s Guiding Principles for Effective Early Warning stated that the objective of early warning “is to empower individuals and communities, threatened by natural or similar hazards, to act in sufficient time and in an appropriate manner so as to reduce the possibility of personal injury, loss of life, and damage to property or nearby and fragile environments.” (Guiding Principles, p. ii) Later that year, the IDNDR Working Group on Early Warning Capabilities summarised years of international debate and expert advice in a report on global experience and current practice on the subject, as well as making recommendations for improvements with particular emphasis on how to ensure that hazard warnings contribute to risk reduction. The result was a thoughtful and detailed discussion of early warning, framed unfortunately in terms of specific systems and sub-systems rather than capabilities (Maskrey et al, 1997).

‘Unfortunately’ because, despite the fact that few have disputed the validity and importance of the concepts

presented in the IDNDR Working Group’s report, the international community continues to debate whether early warning systems should involve the creation of effective preparedness and response mechanisms. (EWS Workshop Viewbook, p. 11). I believe that the terminology we are using is causing much of this confusion. A ‘system’ is generally described as organised or structured, with specific functionality. This description encourages us to think about systems as particular ways of doing specific things, implies scientific and technical leadership, and leads to the kind of questions discussed at the EWS Workshop in Shanghai in 2003. I believe that we would be better able to envision and discuss early warning strategically if it were considered as a capability rather than as a system.

From a strategic viewpoint, an early warning capability is the management integration of expert local knowledge with existing specialised systems and processes, each of which are separately owned and operated by a variety of service providers. Emergency management and its stakeholders assess the functionality and integration of these systems and processes for fitness of purpose relative to a specific hazard, and work with the service providers to extend the functionality or improve the integration of their systems and processes as required toward achieving a more effective and sustainable capability. Without question, an early warning capability provides for preparedness, response, and mitigation mechanisms needed to deal with emergency needs.

‘Early warning system’ is an accurate descriptor for the functionality provided by specialised science and technology-based systems and processes, such as those focused on the detection and interpretation of hazard events, or issuing alerts and warnings for those events. The science and technology-based early warning system, however, is not the primary driver for emergency management processes, although many current discussions of early warning requirements and functionality incorrectly position it in that way.

We can only succeed in meeting the UN’s objective for effective early warning if we recognise that emergency management agencies must lead the development and govern the operation of early warning capabilities as an integration of the extensive hierarchy of emergency management services and processes. An effective early warning capability uses the best available science and technology within the all-hazards emergency management approach. To achieve effective risk reduction functionality, emergency management agencies must fully integrate science and technology into, but not allow them to drive, emergency management.

What is early warning?

The word “early” in Early Warning emphasises the need to improve and optimise not only the science and technology, but also the human capability throughout the entire range of interactions that support emergency

management. Science and technology must continually improve their ability to accurately detect, interpret, and report a hazard event at the earliest possible moment. The community must, through its vigilance and participation, augment and confirm the information from the scientific or technical systems with local knowledge and observations. Emergency managers also need communication technology infrastructure that integrates with traditional methods of communication, so that they can send emergency information out to every community and person at risk.

By reframing the discussion on early warning in terms of the physical issue (i.e. the hazard event), the place of early warning within the context of effective emergency management can be more easily understood. The hazard event is real; everyone, from the international community of experts and specialists to the individuals living in areas that experience the hazard event, can talk about it in tangible terms. Most simply, these tangible terms relate to two operational or functional modes with respect to the hazard event; either:

- Preparing for the hazard event should it occur (i.e. the Prepare State), or
- Dealing with the hazard event when it does occur (including where appropriate as it approaches) (i.e. the Action State).

The hazard event itself triggers our transition from one state to the other; when it occurs, we deal with it and when we have dealt with it, we prepare in case it should occur again.

This proposition, simple and tangible, can be communicated clearly and understood across all possible demographic, gender, cultural, education and livelihood characteristics of the target audiences. It provides a realistic structure within which we can manage the myriad of community awareness, education, scientific, technical, political and logistical details required to prepare for and deal with hazard events. It provides a basic point of reference for emergency managers, planners, politicians, scientists, technologists, and the media; if their actions are not helping prepare for the hazard event should it occur, or helping deal with the hazard event when it does occur, then they are not helping.

Governance of the early warning capability

Reframing the discussion on early warning relative to the hazard event also provides a practical framework for the governance of the early warning capability by emergency managers. Emergency managers govern the early warning capability in accordance with the overall emergency management communications strategy, through which emergency managers agree the terms of and manage relationships with their stakeholders. This strategy identifies appropriate interfaces with the community and with the strategic service providers whose support is crucial if the early warning capability is to be effective—

strategic service providers such as scientists, engineers, infrastructure providers, public officials, community emergency services, and the media. Emergency managers must actively lead, engaging their stakeholders in the development of the early warning capability, and strengthen and sustain that capability through a continuous cycle of review, assessment and improvement activities with the community and the strategic service providers.

Effective governance always depends on the unambiguous articulation of roles and responsibilities, and provides for clear prioritisation and delegation. With respect to the early warning capability, I believe it is essential that we clarify and understand the roles and responsibilities of five primary participants: emergency managers, scientists, the media, public officials, and the community.

In the Prepare State, emergency managers function as Project Managers. They are responsible for coordinating the design, development, implementation, and testing of the plans, systems and processes that facilitate the community's capability to deal with specific hazard events.

Science must provide risk information on hazards that may impact the community, and with assistance from the media, communicate that information to the community in meaningful ways. The community has both the right and the responsibility to be informed about risks on which it is expected to have an opinion or to take action. Therefore, the community must actively participate with emergency managers in the development and presentation of hazard preparedness and community education and awareness programs, ensuring that local knowledge and history are included to augment and contextualise the scientific information available.

Emergency managers must collaborate with the community and strategic service providers on the development of hazard preparedness and response plans that take into account such things as what can be done to reduce the potential risks the community faces with respect to a particular hazard; whether and how an early warning can be realistically provided to the community for optimal effectiveness; and how both the strengths and weaknesses of traditional knowledge and local resources can be managed to ensure the most effective response.

Science and the community are responsible for maintaining diligent observations and monitoring with respect to hazards. Scientific monitoring systems operate continuously, and science is responsible for maintaining and managing these systems as well as reporting to emergency managers when pre-agreed thresholds have been reached or exceeded. Local observations reported by the community not only assist emergency managers to ground truth the data and interpretations derived from the technology-based systems but in situations such as lahars and local tsunami, local observations by the community may be the primary or only source of detecting the hazard and raising the alarm.

Responding to alerts and warnings is the responsibility of all stakeholders, led by emergency management. In the Action State, emergency managers act as Operations Managers; they have the immediate relationship with those at risk and the responsibility for activating and managing the response systems established to deal with the hazard event. They are assisted in their decision making by the continual feed of information from science and the community (monitoring and interpretation), and from all stakeholders on the effectiveness of, and their on-going capability to carry out, planned actions.

Under many hazard response plans, science is responsible in the Action State for issuing alerts and warnings to the community through its normal communications channels. In these situations, the governance model must require that science maintain a close collaborative relationship with emergency managers on the issue of alerts and warnings to facilitate the appropriate community response. Science must also maintain a continuous dialogue with emergency managers about the on-going status of the hazard event and, supported by the media, adhere to the agreed communication strategy for the specific hazard by providing the expected information to target audiences to re-enforce the established hazard response measures. The media, in accordance with the agreed communications strategy, must support emergency managers in the on-going communication with the community, reminding the community of the actions set out in the hazard preparedness plans and informing them of the changing events that guide emergency management decisions on whether to expand or decrease the community's response level. Public officials must activate designated resources and engage with infrastructure providers in accordance with the hazard response plan to support the emergency management measures being initiated.

In governing the early warning capability, emergency managers must take the lead in dealing with two recurring areas of conflict. Scientists often fear that false or inaccurate warnings might result in lack of faith in subsequent warnings and loss of credibility for the scientists. However, even when unable to confirm detection or interpretation, science must provide emergency managers with early notification of a suspected event that may impact the community so that the appropriate levels of response can be initiated. Emergency managers must collaborate with science and the media to inform the community and to establish realistic expectations of the extent and limits of scientific knowledge with respect to the hazards that threaten the community. An informed community, with realistic expectations, can accept false alarms without becoming apathetic or devaluing the professional capabilities of the scientists.

A second area involves public officials who often resist initiating or escalating within the hazard response plan because they are concerned that information and warnings about hazard events will create panic within the

community. Rational fear—fear of situations that are liable to occur—generally motivates people to engage in constructive actions to deal with the situation they fear. Emergency managers must collaborate with public officials and the media to provide factual information about the risks the community faces and the options the community has to mitigate and manage those risks. An informed community is unlikely to panic, and adverse economic reactions will be directly related to the hazard event itself.

Conclusion

The international emphasis on early warning systems has shifted the focus, and the funding, from emergency management to science and technology. As a result, scientists and technologists are more and more considered to be leading the development of a global early warning capability. While there are important benefits to be gained from improving our detection and interpretation systems for natural hazards, these benefits will not be realised unless these systems are fully integrated into the all-hazards emergency management capability. Adopting an all-hazards approach, in which local needs are clearly identified and provided for in national and regional policies, generates synergies and efficiencies that can—and must—be leveraged in international strategic planning for early warning capabilities.

To do this, emergency managers need to establish additional, and strengthen existing, international collaboration and exchange of information mechanisms on early warning capabilities just as science has done with early warning system technology. Emergency management must assume the role of 'Champion' and actively lead the dialogue at all levels, working with the community and strategic providers—in particular science, public officials and the media—to develop effective local, national, regional and international early warning capabilities.

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Viewbook, *Early Warning System Workshop*, Early Warning Systems Do's and Don'ts, 20-23 October, 2003, Shanghai China: Six years after the IDNDR paper was published, the discussions at the Early Warning Systems Workshop in 2003 illustrate the continuing lack of clarity on what early warning systems actually are or should be. International experts in disaster management and the science that informs it exchanged views on "What is encompassed in a EWS?" and whether a EWS "must involve creating effective preparedness and response mechanisms?" Other questions dealt with at the Workshop demonstrate the participants' awareness that confusion about the realities of an early warning system extended beyond the experts. The session on Expectations of Early Warning Systems debated "Do we expect too much of an EWS?", discussed "Hype v. Hope in the use of EWS?" and concluded with an inquiry into whether we should "consider lowering expectations of what EWS can do for society." (Viewbook, p. 11).

About the author

Philip Hall is a Founding Partner of Faerber Hall, a registered consultancy in Australia and the United States. He has extensive experience in delivering operational facilities and mission critical systems in Australia and internationally across a diverse range of application including scientific facilities and networks. Philip recently coordinated experts across five Australian Government departments to produce the project implementation strategy and plan for the Australian Tsunami Warning System, which was accepted by Prime Minister and Cabinet in July 2005. Philip was recently appointed as a Member of the inaugural Board of the newly established International Association of Emergency Managers (IAEM) Oceania. ♦

'Ultrasound' of Earth's crust reveals inner workings of a tsunami factory

May explain why seafloor near SW Japan generates devastating tsunamis, will help assess risk of giant tsunamis in other regions

By Nathan Bangs, Gregory Moore, Emily Pangborn, Asahiko Taira, Shin'ichi Kuramoto, and Harold Tobin

AUSTIN, Texas—Research announced this week by a team of U.S. and Japanese geoscientists may help explain why part of the seafloor near the southwest coast of

Japan is particularly good at generating devastating tsunamis, such as the 1944 Tonankai event, which killed at least 1,200 people. The findings will help scientists assess the risk of giant tsunamis in other regions of the world.

Geoscientists from The University of Texas at Austin and colleagues used a commercial ship to collect three-dimensional seismic data that reveals the structure of Earth's crust below a region of the Pacific seafloor known as the Nankai Trough. The resulting images are akin to ultrasounds of the human body.

The results, published this week in the journal *Science*, address a long standing mystery as to why earthquakes below some parts of the seafloor trigger large tsunamis while earthquakes in other regions do not.

The 3D seismic images allowed the researchers to reconstruct how layers of rock and sediment have cracked and shifted over time. They found two things that contribute to big tsunamis. First, they confirmed the existence of a major fault that runs from a region known to unleash earthquakes about 10 kilometers (6 miles) deep right up to the seafloor. When an earthquake happens, the fault allows it to reach up and move the seafloor up or down, carrying a column of water with it and setting up a series of tsunami waves that spread outward.

Second, and most surprising, the team discovered that the recent fault activity, probably including the slip that caused the 1944 event, has shifted to landward branches of the fault, becoming shallower and steeper than it was in the past.

"That leads to more direct displacement of the seafloor and a larger vertical component of seafloor displacement that is more effective in generating tsunamis," said Nathan Bangs, senior research scientist at the Institute for Geophysics at The University of Texas at Austin who was co-principal investigator on the research project and co-author on the *Science* article.

The Nankai Trough is in a subduction zone, an area where two tectonic plates are colliding, pushing one plate down below the other. The grinding of one plate over the other in subduction zones leads to some of the world's largest earthquakes.

In 2002, a team of researchers led by Jin-Oh Park at Japan Marine Science and Technology Center (JAMSTEC) had identified the fault, known as a megathrust or megasplay fault, using less detailed two-dimensional geophysical methods. Based on its location, they suggested a possible link to the 1944 event, but they were unable to determine where faulting has been recently active.

"What we can now say is that slip has very recently propagated up to or near to the seafloor, and slip along these thrusts most likely caused the large tsunami during the 1944 Tonankai 8.1 magnitude event," said Bangs.

The images produced in this project will be used by scientists in the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE), an international effort designed to, for the first time, "drill, sample and instrument the earth-

quake-causing, or seismogenic portion of Earth's crust, where violent, large-scale earthquakes have occurred repeatedly throughout history."

"The ultimate goal is to understand what's happening at different margins," said Bangs. "The 2004 Indonesian tsunami was a big surprise. It's still not clear why that earthquake created such a large tsunami. By understanding places like Nankai, we'll have more information and a better approach to looking at other places to determine whether they have potential. And we'll be less surprised in the future."

Bangs' co-principal investigator was Gregory Moore at JAMSTEC in Yokohama and the University of Hawaii, Honolulu. The other co-authors are Emily Pangborn at the Institute for Geophysics at The University of Texas at Austin, Asahiko Taira and Shin'ichi Kuramoto at JAMSTEC and Harold Tobin at the University of Wisconsin, Madison. Funding for the project was provided by the National Science Foundation, Ocean Drilling Program and Japanese Ministry of Education, Culture, Sports and Technology.

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Historical natural hazards data in Google Earth

By Jesse D. Varner and Paula K. Dunbar
Eos (American Geophysical Union Transactions) v. 88, no. 52, Supplement, p. F753 [abstract]
2007

The NOAA National Geophysical Data Center (NGDC), with assistance from the University of Colorado's Cooperative Institute for research in Environmental Sciences (CIRES), maintains a database of information about historical natural hazards such as earthquakes, tsunamis, and volcanic eruptions. Long term data from these events can be used to establish the past record of natural hazard event occurrences. These data are also important in disaster recovery, mitigation and response planning for future events. The database includes socioeconomic information (i.e. number of fatalities, injuries, and damage) and scientific data (i.e. earthquake magnitudes, tsunami intensity) for hazard events from ancient times (2000 BC and earlier) to the present.

To supplement existing tools for extracting and visualizing the data (web-based forms and ArcIMS interactive maps), the data is now viewable in Google Earth via Keyhole Markup Language (KML). The historical datasets: significant earthquakes, tsunami source events, tsunami run-ups (locations where tsunami effects occurred), and significant volcanic eruptions. The related datasets are linked together: for example, the user can display information about a tsunami event that was triggered by a specific earthquake or volcanic eruption. The date range of displayed historical events can be controlled using Google Earth's time slider feature. Tsunami runup locations can be displayed for individual tsunami events or for all events collectively. The tsunami runup placemarks are extruded above the surface of the earth at a height proportional to the maximum wave height recorded at that location, allowing visual comparison of recorded tsunami heights. Using Google Earth as a tool for displaying historical natural hazards data enables a broader audience to discover and use the data, with an improved understanding of the geographic and temporal distribution of historical hazard events.

<http://www.ngdc.noaa.gov/seg/hazard/hazards.shtml>

NEWS

Caribbean tsunami warning system

Recently the UN Intergovernmental Commission created Resolution XXIII-13 to establish an intergovernmental coordination group for tsunami and other coastal hazards warning system for the Caribbean and adjacent regions. The resolution is online:

<http://ioc3.unesco.org/indotsunami/IOC23/resolution13.htm>

Network of tsunami detection buoys developed by NOAA researchers now in place

March 12, 2008

[NOAA recently deployed the final two tsunami detection buoys](#) developed by NOAA's Pacific Marine Environmental Laboratory (PMEL) in Seattle, WA, to complete a network aimed at bolstering the U.S. tsunami warning system. This vast [network of 39 stations](#) provides coastal communities in the Pacific, Atlantic, Caribbean and the Gulf of Mexico with faster and more accurate tsunami warnings. NOAA is a world leader in [tsunami research](#).

These final two deep-ocean assessment and reporting of tsunami ([DART](#)) stations, deployed off the Solomon Islands, give NOAA forecasters real-time data about tsunamis that could potentially impact the U.S. Pacific coast, Hawaii and U.S. Pacific territories. Tsunami sensors are now positioned between Hawaii and every seismic zone that could generate a tsunami that would impact the state and beyond, including the U.S. West Coast. Buoys already in the western Atlantic, Gulf of Mexico and Caribbean have been keeping watch over the U.S. East and Gulf coasts.

As of February 6, 2008, there are 52 [TsunamiReady](#)TM sites in 10 states, Puerto Rico and Guam. The Tsunami-Ready program sets minimum guidelines for communities to follow for adequate tsunami readiness.

The [next generation forecast tools for tsunami warning and mitigation](#) are being developed in close collaboration with Tsunami Warning Centers and academia. The SIFT (Short-term Inundation Forecasting for Tsunamis) system is under development for operational use in National Weather Service Tsunami Warning Centers. Forecast products include estimates of tsunami amplitudes, flow velocities and arrival times for offshore, coastal and inundation areas.

From: <http://www.oar.noaa.gov/news/2008/dart.html>

Fiji needs to prepare for tsunami

According to the Director of Fiji Meteorological Services, Rajendra Prasad, Fiji needs to prepare for the threat of tsunamis, although their island has not experienced a tsunami in recent memory. Prasad chairs the Tsunami Working Group within the National Disaster Management Council. He is eager to complete the Fiji tsunami response plan.

From:

<http://www.pacificmagazine.net/news/2008/03/12/fiji-needs-to-prepare-for-tsunami-meteorology-director->

NOAA helps prepare East Coast communities for tsunami, storm-driven flood threats

December 3, 2007 press release

A team of scientists took a crucial step forward in NOAA's effort to prepare U.S. coastal communities, including Long Island, Atlantic City, and Daytona Beach for potentially deadly tsunami and storm-driven flooding.

Scientists with [NOAA's National Geophysical Data Center](#) and the Cooperative Institute for Research in Environmental Sciences, both based in Boulder, Colo., recently created high-resolution digital elevation models, or DEMs, for the three cities.

"Tsunamis are a real threat to coastal communities across the world, including the United States," said Lisa Taylor, NOAA NGDC project manager. "Developing coastal digital elevation models is one of a series of important collaborative efforts within NOAA to create the best possible Tsunami Warning System for the country."

The DEMs are constructed from near-shore seafloor depth and land elevation data to create a detailed representation of coastal relief. They provide the underlying framework necessary to accurately forecast the magnitude and extent of coastal flooding during a tsunami or storm surge event. Since 2006, scientists have created DEMs for 20 U.S. coastal communities. The team expects to build more than 50 additional DEMs for U.S. coastal communities in the coming years.

Once a DEM is developed, it is sent to the NOAA Pacific Marine Environmental Laboratory in Seattle, Wash., where it is incorporated into tsunami model scenarios. These scenarios simulate offshore earthquakes, the resulting tsunami movement across the ocean, and the magnitude and location of coastal flooding caused when the tsunami reaches the shore. With these results, the [NOAA Tsunami Warning Centers](#) can issue more accurate flooding forecasts if an earthquake triggers an actual tsunami.

"Near the shoreline, all tsunamis are sensitive to minor variations in seafloor and land topography, increasing in height as they approach the coast," said Barry Eakins, CIRES research scientist. "A better understanding of these variables is critical to predicting how a tsunami will flood coastal communities."

NOAA, along with its federal and state partners in the [National Tsunami Hazard Mitigation Program](#), is implementing the [Tsunami Risk Reduction for the United States: A Framework for Action](#), a joint report of the Subcommittee on Disaster Reduction and the United States Group on Earth Observation, December 2005. This action plan addresses the tsunami improvement initiative in the near-term and plans for a coordinated tsunami risk reduction effort over the long term.

The National Oceanic and Atmospheric Administration, an agency of the U.S. Commerce Department, is celebrating 200 years of science and service to the nation. From the establishment of the Survey of the Coast in 1807 by Thomas Jefferson to the formation of the Weather Bureau and the Commission of Fish and Fisheries in the 1870s, much of America's scientific heritage is rooted in NOAA.

NOAA is dedicated to enhancing economic security and national safety through the prediction and research of weather and climate-related events and information service delivery for transportation, and by providing environmental stewardship of our nation's coastal and marine resources. Through the emerging Global Earth Observation System of Systems (GEOSS), NOAA is working with its federal partners, more than 70 countries and the European Commission to develop a global monitoring network that is as integrated as the planet it observes, predicts and protects.

http://www.noaanews.noaa.gov/stories2007/20071203_eastcoastsunami.html

February 19, 2008

New global satellite system could cut disaster losses

Over the next decade, a new global satellite system could save billions of dollars and thousands of lives by increasing preparedness for natural disasters. When disaster strikes, rapid access to data on land and ocean conditions, maps of transport links and hospitals, weather forecasts, and information on socio-economic variables can save uncounted lives. The Global Earth Observation System of Systems (GEOSS) will integrate Earth observations with other information to help planners reduce vulnerability, strengthen preparedness and early-warning measures, and, after disaster strikes, rebuild housing and infrastructure in ways that limit future risks. It will also help reduce long-term risk by providing a better understanding of the relationship between natural disasters and climate change. By making it possible to integrate different types of disaster-related data and information from diverse sources, GEOSS will strengthen analysis and decision making for disaster response and risk reduction. GEOSS may also help authorities control outbreaks of contagious diseases by monitoring environmental conditions in the area where the outbreak occurred. To learn more about GEOSS, visit

<http://www.earthobservations.org/geoss.shtml>.

From: Natural Hazards Observer, v. 32, no. 4, p. 10. Natural Hazards Center, Institute of Behavioral Science, University of Colorado at Boulder

NOAA recognizes Douglas County, Ore., as TsunamiReady™ and StormReady®

March 5, 2008

Douglas County, Ore., has completed the NOAA National Weather Service [StormReady®](#) and

[TsunamiReady™](#) programs, better equipping the county to handle severe weather and tsunamis. The Douglas County emergency management team fulfilled a rigorous set of warning and evacuation criteria, including the development of a formal hazardous weather plan.

"Douglas County is vulnerable to severe weather due to its location on the coast," said John Lovegrove, meteorologist-in-charge of the [National Weather Service](#) forecast office in Medford, Ore. "With the Cascadia subduction zone located offshore, tsunamis are always a potential threat to this region. Public awareness and preparedness are essential."

Lovegrove will present a recognition letter and TsunamiReady™ and StormReady® road signs to county commissioners on Feb. 20 at 10 a.m. during a ceremony at the Douglas County Courthouse, room 216, located at 1036 SE Douglas Street, in Roseburg, Ore.

To be recognized as TsunamiReady™ and StormReady®, a community must:

- Establish a 24-hour warning point and emergency operations center;
- Have more than one way to receive tsunami and severe weather warnings and forecasts to alert the public;
- Create a system that monitors local weather conditions;
- Promote the importance of public readiness through community seminars; and
- Develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises.

The TsunamiReady™ and StormReady® recognitions expire in three years, after which the county will go through a renewal process.

The National Oceanic and Atmospheric Administration, an agency of the U.S. Commerce Department, is dedicated to enhancing economic security and national safety through the prediction and research of weather and climate-related events and information service delivery for transportation, and by providing environmental stewardship of our nation's coastal and marine resources. Through the emerging Global Earth Observation System of Systems ([GEOSS](#)), NOAA is working with its federal partners, more than 70 countries and the European Commission to develop a global monitoring network that is as integrated as the planet it observes, predicts and protects.

StormReady® and TsunamiReady™ are registered trademarks of the National Oceanic and Atmospheric Administration.

From:

http://www.noaanews.noaa.gov/stories2008/20080305_stormready.html

Accessed March 24, 2008

WEBSITES

<http://www.dnr.wa.gov/ResearchScience/Topics/Geology/PublicationsLibrary/Pages/tsuinfo.aspx>

This is the new website for *TsuInfo Alert* online and for back issues.

<http://www.emforum.org/vforum/lc080213.htm>

EIIP Virtual Forum Transcript: Principles of Emergency Management

The transcript is now available from the February 13 Emergency Information Infrastructure Partnership (EIIP) virtual forum, which featured Mike Selves, past president of the International Association of Emergency Managers and a founding member of the Emergency Management Roundtable of emergency management stakeholder organizations, which produced documents on the "Principles of Emergency Management" in 2007. Selves discussed the "Principles of Emergency Management," defining what emergency management is and does.

From: Disaster Research 496, Feb. 28, 2008, p. 3.
<http://www.colorado.edu/hazards/dr/currentdr.html>.

<http://www.gdnonline.org>

Gender and Disaster Network

The Gender and Disaster Network (GDN) has launched an updated version of its Web site, which contains recent resources and information in the gender and disaster field. The site features a more updated look with simple navigation tabs; a resources area, which hosts the Gender and Disaster Sourcebook; and the Knowledge-base, containing key resources, reports, practical guides, and case studies on gender relations in disaster contexts.

From: Disaster Research 496, Feb. 28, 2008, p. 3-4.
<http://www.colorado.edu/hazards/dr/currentdr.html>.

https://calmail.berkeley.edu/manage/list/listinfo/disaster_1aw@lists.berkeley.edu

Disaster Law and Policy Listserv

This listserv is an outgrowth of a conference held at the University of California, Berkeley, last year to consider ways of developing Disaster Law as a field of study. The listserv is intended to create a more active community of scholars in the area of disasters and the law. Many of the initial subscribers were law professors, but others include academics in other disciplines, government officials, and lawyers whose practice includes disaster-related issues.

From: Disaster Research 496, Feb. 28, 2008, p. 4.
<http://www.colorado.edu/hazards/dr/currentdr.html>.

<http://www.usfa.dhs.gov/coop/>

USFA Continuity of Operations

The Federal Emergency Management Agency (FEMA) U.S. Fire Administration (USFA) is hosting this business continuity resources site that features the Continuity Connection video series, a dozen short videos created to aid businesses in the development of a continuity of operations (COOP) plan. Related materials and other training resources are also available from the site.

From: Disaster Research 496, Feb. 28, 2008, p. 4.
<http://www.colorado.edu/hazards/dr/currentdr.html>.

CONFERENCES

May 4-7, 2008

5th International Conference on Information Systems for Crisis Response and Management (ISCRAM)—Washington, DC. This conference provides an important networking opportunity where the latest research on the design, development, use, and evaluation of information systems for crisis response and management are presented and discussed. The meeting will take place at the George Washington University and is hosted by the Institute for Crisis, Disaster, and Risk Management. The general theme of ISCRAM2008 is "Creating Advanced Systems for Inter-organizational Information Sharing and Collaboration." Visit <http://www.iscram.org>.

From: Disaster Research 496, Feb. 28, 2008, p. 5.
<http://www.colorado.edu/hazards/dr/currentdr.html>.

June 2-5, 2008

11th Annual FEMA Emergency Management High Education Conference—Emmitsburg, Maryland. This conference is designed to provide a medium for academics to discuss problems and issues faced in the fields of hazards, disaster, emergency management, and homeland security/defense educational programs. Representatives of colleges and universities that have such programs in place or are attempting to develop and implement programs in these fields are encouraged to attend. See <http://www.training.fema.gov/emiweb/edu/>.

From: Disaster Research 496, Feb. 28, 2008, p. 5.
<http://www.colorado.edu/hazards/dr/currentdr.html>.

June 15-18, 2008

18th World Conference on Disaster Management (WCDM)—Toronto, Ontario, Canada. Organizer: The Canadian Centre for Emergency Preparedness. The theme of this conference will be Resiliency - Individual, Community and Business. Participants will be from diverse backgrounds, including emergency management, business continuity, emergency response, risk management, IT disaster recovery, emergency health, or other related disaster management disciplines. The conference aims to provide a unique venue for disaster management professionals from around the world to present, network and learn. A major goal of WCDM is to offer a program

that challenges delegates by examining traditional concepts and methods and provides new ideas and approaches to problem solving, both leading edge and topical presentations, and opportunities to connect with key individuals and organizations across the disaster management spectrum. See <http://www.wcdm.org>.

From: Disaster Research 496, Feb. 28, 2008, p. 5. <http://www.colorado.edu/hazards/dr/currentdr.html>.

CLASSES

Certification course in tsunami science and preparedness

The University of Washington Extension (UWE), in conjunction with the National Oceanographic and Atmospheric Administration (NOAA), has developed a professional certification course in tsunami science and preparedness. The next course offering will be June 16-27, 2008, at the University of Washington in Seattle, Washington. The certification program consists of three courses providing overviews of tsunami hazard assessment, tsunami warning systems, and tsunami resilient communities. Designed for planners, policy makers, emergency managers, scientists, and engineers, the curriculum trains professionals to develop, establish, and maintain tsunami warning and preparedness systems at national, regional, and local community levels. Program graduates receive UWE/NOAA Professional Certification in Tsunami Science and Preparedness, a DVD containing all instructional materials, templates for developing hazard assessments and community plans, and access to an Alumni Network that includes archives of additional tsunami information and educational tools. For more information on the program, visit http://www.extension.washington.edu/ext/certificates/tsp/tsp_gen.asp. Questions may be directed via email to tsunami@extn.washington.edu

From: Natural Hazards Observer, v. 32, no. 4, p. 14. Natural Hazards Center, Institute of Behavioral Science, University of Colorado at Boulder ♦

Lincoln City, Oregon hosts community education programs about tsunami preparedness

One-hour sessions were held on Feb. 5 and Mar. 18 concerning community involvement and tsunami preparedness, hosted by Althea Turner, tsunami preparedness coordinator in Lincoln City.

Public education is a critical component of disaster preparedness. For more information about The Neighborhood Tsunami Education Program, contact Althea Turner at 996-1204, or altheat@lincolncity.org.

Documents and Presentations from NTHMP 5-year Assessment

<http://nthmp.tsunami.gov/assessments.html#>

[NTHMP 5-Year Recommendations](#)

[NTHMP 5-Year Review Agenda](#)

[NTHMP Program Overview](#)

NTHMP Program Reviews

[NTHMP 5-Year Review](#): David Green, NOAA
Tsunami Program Manager

[NTHMP 5-Year Review: Mitigation & Outreach Subcommittee Report](#): Chris Jonientz-Trisler

[NTHMP 5-Year Review: FEMA's Role in Tsunami Mitigation](#): Mike Mahoney & Chris Jonientz-Trisler

[Tsunami Research at NSF](#): Richard J. Fragaszy

[California State Tsunami Five Year Review](#): James Goltz

[California Tsunami Program 2007](#): James Goltz

[Oregon NTHMP 5-Year Review](#): Jay Wilson & George Priest

[Washington NTHMP 5-Year Review](#): George Crawford

[USGS Tsunami Activities 5-Year Review](#): Craig Weaver & David Oppenheimer

[Tsunami Preparedness in the US Virgin Islands](#): Jacqueline J. Heyliger

Individual Assessments of the NTHMP

Assessments are based on the [NTHMP Review Committee Consensus Statement](#)

[Michael K. Lindell](#)

[Lori Dengler](#)

[Jay Raskin](#)

[Richard J. McCarthy](#)

[John L. Aho](#) ♦

California's governor proclaimed March 23-29 Tsunami Awareness Week

During California's first Tsunami Awareness Week, Humboldt County held their first "live" test of the Tsunami Warning System, by broadcasting an actual tsunami warning on March 26. The test was conducted and monitored by the Governor's Office of Emergency Services (OES), the Humboldt County Office of Emergency Services, and the National Weather Service (NWS).

The proclamation can be viewed at

http://www.wrh.noaa.gov/mtr/Proclamation_Tsunami_2008.pdf

For additional details: visit

<http://www.wrh.noaa.gov/eka/misc/tsunamitest.php> ♦

VIDEO-CD-DVD RESERVATIONS

To reserve tsunami videos, CDs or DVDs, contact *TsuInfo Alert* Video Reservations, 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

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 information. 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.

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. ♦



Infrequently Asked Questions Compiled by Lee Walkling

What shape is the recently-built tsunami-proof house?

Tear drop. “The single-storeyed tsunami-proof house is ‘hydrodynamically’ shaped. “It looks like a teardrop and faces the west, the direction from which the waves come. Should the building be hit by a tsunami wave, the laminar flow around it will be protecting the walls,” he said.”

See story and photo at

<http://www.newindpress.com/NewsItems.asp?ID=IEO20070604010030&Page=O&Title=Thiruvananthapuram&Topic=0>

What's missing off the coast of Indonesia?

According to a recent news article (<http://blogs.usatoday.com/ondeadline/2008/01/report-that-som.html>), a tsunami buoy had its line cut and has disappeared. The buoy's last transmission was December 30, 2007.

An e-mail message from Ridwan Djamaluddin, head of Indonesia's marine research center. “Our Indonesian-made tsunami buoy was dragged with a strong force as indicated by the broken jacketed steel wire designed to hold 6.5 ton force. Our laboratory investigation further confirmed that the steel wire was impacted by an external force, and broke at the depth of 143 m below sea level. The anchor of the mooring system shifted 2,000 meters from its original position.” It is thought that a trawl ship cut the line.

Are there still pirates in the Indian Ocean?

Because Australia is planning to install two tsunami warning buoys in international waters between Australia and Indonesia, the Australian government is negotiating an agreement with the Indonesian government to have their navy provide security for the buoys.

Geoff Love, Australia's Bureau of Meteorology spokesman, said “We've found automatic weather stations for sale in Hong Kong and don't want that to happen again,” he said. Apparently, “pirates” searching for scrap metal to sell had taken the devices.

From: <http://www.reuters.com/article/environmentNews/idUSSYD30711020080219>

Why is there a debate on the value of planting Casuarina as bioshields to protect against tsunamis?

Scientists warn against the dangers of monocultures, particularly plantations of introduced (non-native) species. Casuarina is invasive, often destroying native vegetation which aids in sand dune conservation. Dunes are thought to do a better protective job than the casuarina. There is also concern about the location of the bioshields; they are adjacent to the villages rather than being placed between the villages and the coast, creating a dangerous tunnel effect.

For the full report:

http://www.downtoearth.org.in/full6.asp?foldername=20080115&filename=news&sec_id=50&sid=16 (Science and Environmental Online, Down to Earth) ♦



Sixth Annual Tsunami Story Festival

The Pacific Tsunami Museum is sponsoring the Sixth Annual Tsunami Story Festival on May 18, 2008, at Sangha Hall located at 424 Kilauea Avenue in Hilo, Hawaii. The dinner and program will start at 6:30 p.m. at a cost of \$25.00 per person.

The theme this year is "Living the Good Life in Wai-akea", an area that before the tsunami of 1960 was a thriving community with five hundred residences, forty businesses, a school and several churches. It was ravaged by the tsunami of 1960 and is now dedicated to open space containing a golf course and beautiful Liliuokalani Park. The Story Festival will share ten very special stories of persons who grew up there and experienced the tsunamis of 1946 and 1960.

This special event is held annually to remember the tsunami history of the island, and in telling these stories, to impart invaluable tsunami education and awareness.

From: Donna Saiki, Executive Director, Mar. 26, 2008

NOTE: To see photos and read about the Fifth Annual Tsunami Story Festival (2007) "A Taste of Mamo Street", visit website

<http://www.tsunami.org/storyfestmamo07.html> ♦

April is Earthquake and Tsunami Awareness Month in Hawaii.

A reminder from FEMA

What to do Before and During a Tsunami

The following are guidelines for what you should do if a tsunami is likely in your area:

- **Turn on your radio** to learn if there is a tsunami warning if an earthquake occurs and you are in a coastal area.
- **Move inland to higher ground** immediately and stay there.
- **Stay away from the beach.** Never go down to the beach to watch a tsunami come in. If you can see the wave you are too close to escape it.
- **CAUTION - If there is noticeable recession in water away from the shoreline this is nature's tsunami warning and it should be heeded.** You should move away immediately.

What to Do After a Tsunami

The following are guidelines for the period following a tsunami:

- **Stay away from flooded and damaged areas** until officials say it is safe to return.

- **Stay away from debris in the water;** it may pose a safety hazard to boats and people.
- **Save yourself - not your possessions**

From: http://www.fema.gov/hazard/tsunami/ts_after.shtm
http://www.fema.gov/hazard/tsunami/ts_before.shtm ♦

FEMA strengthens preparedness levels by realigning organizational structures

Release Date: March 14, 2008

Release Number: HQ-08-044

WASHINGTON, D.C. -- Officials from the Department of Homeland Security's Federal Emergency Management Agency (FEMA) announced the transfer of specific preparedness administrative and operational authority roles from FEMA Headquarters to the FEMA Regional Administrators. This transfer of responsibilities will significantly enhance FEMA's capability to develop a National preparedness system.

This transfer of authority impacts personnel associated with the Radiological Emergency Preparedness Program; Chemical Stockpile Emergency Preparedness Program; Community Preparedness; Assistance to Firefighters Grant program; Continuity of Operations; and Regional Investment Officers.

"To meet the responsibilities and follow the tenets of our vision for the New FEMA, we must integrate these programs with those already existing in FEMA and extend their implementation through robust Regions to improve stakeholder networks and coordination," said FEMA Administrator David Paulison.

The National Preparedness Divisions, led by new Federal Preparedness Coordinators at the regional level, will lead FEMA's efforts to coordinate the broad scope of preparedness missions for all-hazards. Also, the plan is to form a new Grant Programs Division to be established within each Region to serve as the central location for business management for grants administered at the Regions, as well as the program management for certain national preparedness homeland security grant programs.

This realignment supports the on-going steps to develop a uniform Regional Office structure. It will strengthen the Regions, assist our partners to comprehensively build preparedness levels and priorities, and allow for even better service to our customers and stakeholders.

The placement of additional preparedness resources closer to their end-state users empowers our federal, state, local, tribal and non-governmental partners to ready themselves for successful responses to all-hazards.

FEMA coordinates the federal government's role in preparing for, preventing, mitigating the effects of, responding to, and recovering from all domestic disasters, whether natural or man-made, including acts of terror.

From:

<http://www.fema.gov/news/newsrelease.fema?id=42934> ♦

Mitigation division director announced for Pacific NW

Release Date: January 16, 2008

Release Number: R10-08-047

SEATTLE, Wash. -- U.S. Department of Homeland Security FEMA Regional Administrator Susan Reinertson has announced the appointment of Mark Carey as the Mitigation Division Director for FEMA Region X, a jurisdiction which includes the states of Alaska, Idaho, Oregon and Washington.

"Pre-disaster mitigation is a cornerstone of Administrator Paulison's 2008 vision for FEMA," said Reinertson. "Mark is responsible for the National Flood Insurance Program (NFIP) and for strengthening, integrating, and institutionalizing this region's mitigation efforts to prevent, protect against and recover from threatened or actual disasters."

Carey joined FEMA in 2001 and has served as the Community Mitigation Programs Branch Chief and Floodplain Management and Insurance Branch Chief. Prior to coming to FEMA, Carey worked as County Planning Director and Division Manager at various local governments in Washington State. He is a graduate of the University of Washington's Cascade Public Executives Program and holds a Bachelor of Arts in Land Use Planning from Eastern Washington University in Cheney, Washington.

From:

<http://www.fema.gov/news/newsrelease.fema?id=42299> ♦

Become a Disaster Action Kid on FEMA web site

Release Date: February 18, 2008

Release Number: 1740-010

LAFAYETTE, Ind. -- Play games, enjoy stories, do puzzles, go through mazes, watch videos - welcome to FEMA for Kids, the Web site that is all fun and games ...sort of. Underneath all the fun is a lot of good information that makes kids and their families better prepared in the event of a disaster. You can even become a Disaster Action Kid and get your very own certificate to hang on the wall!

FEMA for Kids is presented by the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA). Go to www.fema.gov and click on Kids. Meet Herman the spokescrab and tag along on his search for a disaster-proof shell. You'll also meet Julia and Robbie, the Disaster Twins. Wherever these two go, trouble is sure to follow. Watch brother and sister get into - and out of - all sorts of close calls, learning along the way how to be better prepared, or how to avoid danger altogether.

The Web site shows disasters come in many shapes and sizes. Some are predictable -- like a hurricane. Some, like a flood, can surprise us. Learning about the different kinds of disasters will help us all be better prepared. Learn the best way to keep safe, and keep your family and pets safe, as you do what you like to do best - have fun!

Find out about disaster kits and learn what you need before the danger happens. Discover what you might feel during and after such an incident. Read stories from other young people your age who have been through a disaster, or tell your own story. FEMA for Kids is a tool for recovery as well as preparedness. There are even resources for parents and teachers. They can get great curriculum or safety information that can be used in the classroom or at home.



Disasters aren't fun, but learning about them can be educational. Give it a try, kids. Mom and dad can try too. You're never too old to be a kid...a Disaster Action Kid.

FEMA coordinates the federal government's role in preparing for, preventing, mitigating the effects of, responding to, and recovering from all domestic disasters, whether natural or man-made, including acts of terror.

From:

<http://www.fema.gov/news/newsrelease.fema?id=42646> ♦


CSIRO tsunami podcast

ITUNES  PODCAST 

<http://www.csiro.au/multimedia/TsunamisandVolcanos.html>

CSIRO, the Commonwealth Scientific and Industrial Research Organisation, is Australia's national science agency and one of the largest and most diverse research agencies in the world.

Computational modelling of tsunamis and volcanos (Reference: 07/01). How do you know if a natural disaster will destroy your home? In this video podcast, find out how CSIRO technology can map the potential path of a tsunami or volcanic explosion. (1:18)

 [Broadband](#) 4456 KB

Catastrophic events like tsunamis, storm surges and dam-breaks are notoriously difficult to observe and measure because they involve the large-scale movement of solids and fluids.

In this video podcast, discover how computational modelling by CSIRO Mathematical and Information sciences can help predict what would happen if a natural disaster occurred in a specific location.

Find out more about [Modelling tsunamis and other phenomena](#). ♦

NOAA podcasts

<http://www.podcast.noaa.gov/>

These are short reports on NOAA science and research. They are in mp3 files for easy downloads to desktop and laptops, as well as mobile devices capable of playing these files. You also can listen to these programs by simply clicking on the link. ♦

Undersea Cracks along Continental Shelf Could Trigger Tsunamis along U.S. East Coast

Shelley Lauzon

April 28, 2000

Woods Hole Oceanographic Institution

<http://www.whoi.edu/page.do?pid=12460&tid=282&cid=985>

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Potential landslides on the outer continental shelf and slope along the Mid-Atlantic coast could trigger tsunamis that might have devastating effects on populated coastal areas. In a paper published in the May 2000 issue of the journal *Geology*, Neal Driscoll of the Woods Hole Oceanographic Institution and colleagues Jeffrey Weissel of Columbia University's Lamont-Doherty Earth Observatory and John Goff of the University of Texas at Austin say newly discovered cracks along the edge of the continental shelf could be an early warning sign that the sea-floor is unstable in these areas.

These cracks, together with evidence of past landslides in the same area, indicate the sea floor could slump, or slide downhill like an avalanche, triggering the waves. Wave heights similar to the storm surge from a category 3 or 4 hurricane, up to several meters above normal, could occur along the Virginia-North Carolina coastline and lower Chesapeake Bay, the areas of highest risk.

Driscoll, an Associate Scientist in the Woods Hole Oceanographic Institution's Geology and Geophysics Department, and colleagues found the cracks using NOAA bathymetric data. The researchers say it is unclear whether these cracks are fossil features or are active and therefore likely to produce a potentially large submarine landslide in the near future.

"Coastal areas face increasing threats from a number of natural hazards as their population grows," Driscoll said. "The public is aware of the damage to coastal areas caused by severe storms like hurricanes thanks to better storm tracking and media coverage of these events. Tsunamis resulting from offshore earthquakes, landslides, and volcanic activity are just as destructive but are not as common. As a result, public awareness of tsunamis is limited, as is our ability to forecast when and where they will strike. The tsunami that struck northern Papua New Guinea in July 1998 with almost no warning killed some 2,000 people."

The researchers recently discovered a system of en echelon cracks along a 40-kilometer (25-mile) section of the outer continental shelf off southern Virginia and North Carolina, north of Cape Hatteras. The en echelon cracks, a series of cracks offset like the shingles on a roof, are located in water depths of 100 to 200 meters (about 300 to 600 feet) between the Norfolk Canyon and the Albemarle-Currituck submarine slide, which occurred approximately 16,000 to 18,000 years ago.

"Knowledge about submarine landslides will lead to a better understanding of how large-scale slope failure,

canyon cutting, and sedimentation interact to create the continental margins," Driscoll notes. "What kind of hazard if any does this pose? Any future submarine landslides starting on this crack system might trigger a tsunami that poses a danger to populations along the nearby coast, and we should know what the risks are for that happening."

The researchers say that, although rare on human time scales, if a large submarine landslide were to occur on a continental margin near a populated coastal area, the results could be catastrophic given the development along coastal areas in recent decades. A 1929 tsunami from a landslide associated with a magnitude 7.2 earthquake on the Grand Banks left 51 dead along the south coast of Newfoundland. Tsunami wave heights recorded from that earthquake and landslide reached an estimated 40 feet in some areas along the coast.

Driscoll and colleagues say there are a number of factors that could trigger a slope failure, such as groundwater discharge and the decomposition of gas hydrates from warmer ocean temperatures during interglacial periods. They also note that the tsunami wave heights depend on many factors, among them local topography. A sudden but small volume landslide could generate a tsunami that is more dangerous than a tsunami from a larger but slower moving landslide.

The researchers say more and better bathymetric surveys are needed to find evidence for past landslides and to identify areas of sea floor susceptible to future slope failure. The Office of Naval Research funded their study, with some additional support from NASA.

"These studies have been facilitated by multidisciplinary programs initiated by Dr. Joe Kravitz at ONR" Driscoll notes. "These are complex problems, and the Navy has had the insight to support a wide range of science and engineering efforts to address them."

The scientists plan to survey the mid-Atlantic site in great detail in May using an ONR-funded sonar system called SubScan developed by Edgetech, Florida Atlantic University, and Woods Hole Oceanographic Institution. The high resolution towed system surveys the surface layers as well as the layers beneath the surface, producing detailed three-dimensional images of the seafloor. Driscoll says the two-week cruise, which leaves Woods Hole May 6, will determine if the cracks are normal faults offsetting the seafloor or relic features that have a surface expression.

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