

WESTERN STATES SEISMIC POLICY COUNCIL POLICY RECOMMENDATION 16-1

Rapid and Effective Tsunami Identification and Response

Policy Recommendation 16-1

WSSPC recommends that each coastal state, province, and territory emergency management agency work with coastal jurisdictions to develop evacuation plans for both *near-* and *distant-*source tsunamis, and supplement these emergency plans with a preparedness education campaign focusing on instructions to evacuate based on ground shaking, that ensures all populated coastal areas in the WSSPC coastal states, territories and provinces are guided by at least one type of system, appropriate to local conditions. Strong coordination should also occur between and among federal partners, such as the U.S. Geological Survey, National Oceanic and Atmospheric Administration, etc. and state/academic institutions developing earthquake early warning system technologies, expanding upon the WSSPC Policy Recommendation on Earthquake Early Warning, to ensure appropriate community response to both earthquake and tsunami alerts.

Executive Summary

Coastal jurisdictions should develop emergency response plans which incorporate both *near-source tsunamis*, where there may be only minutes to evacuate, and *distant-source tsunamis*, where there may be hours to evacuate. For near-source tsunamis, a robust education and preparedness campaign should focus on the importance of “natural” warnings, such as earthquake ground shaking felt at the coast as precursor to an incoming tsunami. For distant-source tsunamis, emergency response plans should use redundant alert and warning notification and communication systems (standardized across the nation) which, in addition to standard evacuation and re-entry protocols, could include evacuation instructions via: 1) EAS to television and radio broadcast participants; 2) implementation of cell phone notification capabilities; 3) social media; 4) phone trees; 5) NOAA weather radios; 6) satellite and cable television; 7) door to door notification; 8) possibly beach-front sirens, if these devices are cost effective and could augment rapid dissemination of time sensitive tsunami alerts; and/or 9) aircraft (e.g. Civil Air Patrol) on-board notification systems, especially for remote coastlines, as available during emergencies. These warning and notification systems should be tested on a consistent basis (e.g. annually) for confirmation of performance and improved efficiency during an event. WSSPC will work with its federal partners (USGS, NOAA, FEMA, etc.) and the National

Tsunami Hazard Mitigation Program to help maintain a coordinated, consistent and effective, top-to-bottom earthquake and tsunami warning system and public preparedness strategy.

Background

Tsunamis have caused considerable damage and over 440,000 casualties worldwide over the last 150 years. Recent events such as the 2004 Indian Ocean and 2011 Tōhoku tsunamis are a sobering reminder of the magnitude of the problem coastal communities will face. For example, the 2011 Tōhoku tsunami killed ~15,800 people, while the economic impact is estimated to be ~\$235 billion, making it the most expensive disaster in history. Tsunamis most often are created by the rapid uplift of the sea floor offshore the coast during subduction zone earthquakes, and by localized landslides triggered in response to the earthquake shaking. Tsunamis not only affect nearby coastlines within minutes following an earthquake, but can travel long distances and impact distant shorelines within several to as many as 15 hours after the event. As a result, a clear and immediate distinction must be made between educational outreach campaigns directed at near- and distant-source tsunamis; effective public education and communication is paramount both preceding as well as following an event.

Not all earthquakes produce tsunami. Unnecessary evacuations are costly not only in terms of human risk and lost commerce, but also in the public's negative reaction to the next earthquake experienced on the coast. To eliminate unnecessary coastal evacuations, efforts directed at ongoing education are crucial to inform coastal residents and visitors of the procedures to evacuate coastal areas. For example, for a near-source tsunami, upon feeling strong or prolonged ground shaking, residents and visitors should instinctively move rapidly to high ground or inland and not wait for official notices. In contrast, a distant earthquake and tsunami can be detected by a tsunami warning system, which can determine quickly if evacuation is necessary. The warning system should include: 1) earthquake and tsunami detection by a modern seismic network and Tsunami Warning Center (e.g. the National or Pacific Tsunami Warning Centers); 2) tsunami warning transmissions from the Tsunami Warning Centers to state and local emergency operations personnel; and, 3) direct notification and support to the coastal inhabitants and visitors, through the use of various broadcast media, as well as other locally appropriate measures (such as social media, coastal sirens, reverse 911, phone tree, etc.) to initiate emergency response plans.

Distant Tsunamis

Distant tsunamis are caused by undersea earthquakes far from the affected coast. The public would not necessarily feel the earthquake and there will generally be time for an official warning and evacuation to safe areas. Tsunami preparedness and response plans for a distant tsunami should include plans, whether in “Warning” or “Advisory,” in order to help reduce over or under evacuation

of coastal areas. Evacuation strategies, both on-shore evacuation and offshore maritime evacuation, should also consider evaluation of tidal and/or weather-related conditions. The use of redundant warning systems would increase the immediacy and the coverage of the evacuation notification and could include one or more of the following:

- EAS to television and radio broadcast participants;
- Automated telephone notification systems (e.g. reverse-911) and implementation of cell phone notification capabilities. Adherence to planned implementation of the Integrated Public Alert and Warning System (WEA; IPAWS), resulting in specific alerts received by the public on their cell phones.
- Social media;
- Phone trees;
- NOAA weather radios;
- Satellite and cable television;
- Door to door notification;
- Beach-front sirens; and,
- Notification via aircraft (e.g. Civil Air Patrol) on-board notification systems, for remote coastlines as available during emergencies.

These warning and notification systems should be tested on a consistent basis (e.g. annually) for confirmation of performance and improved efficiency during an event. Only with multiple systems can the best and most immediate coverage be obtained, thereby potentially minimizing the number of injuries and loss of life from a distant tsunami. Education programs should emphasize that tsunami evacuees should only return to coastal areas in accordance with local plans and directions, which differ from cancellation of tsunami alerts by the Tsunami Warning Centers.

Near-source Tsunamis

A near-source tsunami will most likely be triggered by a major earthquake on a nearby subduction zone, such as the Cascadia subduction zone (CSZ) or Aleutian subduction zone. The earthquake would be characterized by several minutes of strong ground shaking and a tsunami would arrive at the shore within 10-30 minutes after the start of the earthquake. In the case of a near-source tsunami, the only effective warning system is the realization by the public that when strong or prolonged ground shaking is felt (in some cases when any shaking is felt), they must instinctively move rapidly away from the shoreline to reach high ground and safety. In the case of a near-source event, a Tsunami Warning Center will not be able to broadcast the message in time for the public to respond, and as such would mainly be providing a warning to other distant localities. For a near-source

tsunami, continued education is crucial to inform coastal residents and visitors of procedures to evacuate coastal areas upon feeling strong or prolonged ground shaking and not wait for official notices. Evacuation drills in at risk communities where residents practice evacuating to safe ground will help improve the muscle memory of the public during a real event.

Earthquake Early Warning

A new public alerting system is being developed to provide advance notification of earthquake shaking once an earthquake begins; for more information see WSSPC Policy Recommendation on Earthquake Early Warning. This technology allows people to take protective action and communities to secure critical infrastructure before damaging shaking arrives. An earthquake early warning is issued very rapidly following the initiation of an earthquake and provides alerts to people and communities that have not yet experienced ground shaking from the earthquake. Earthquake early warnings are possible because earthquakes produce differing types of waves that travel at different speeds. The faster P waves travel at about 6.5 kilometers per second and are first to arrive at seismic monitoring stations. These P waves contain important information about the size and location of the earthquake. Slower moving S waves (3.5 km per second) arrive after the P waves and cause more intense shaking capable of damage to buildings and infrastructure. WSSPC will work with its federal partners (USGS, NOAA, FEMA, etc.) and the National Tsunami Hazard Mitigation Program, including state/academic institutions, to help maintain a coordinated, consistent and effective, top-to-bottom earthquake and tsunami warning system and public preparedness strategy.

Education and Outreach

Placement of tsunami warning signs is an important aspect of educating the public about how to reach safety upon receipt of a warning. Signs are a proven education tool in recent tsunamis and should be implemented as determined appropriate by local authorities, with possible assistance from the National Tsunami Hazard Mitigation Program (NTHMP) in order to maintain continuity between coastal jurisdictions and states. Coastal jurisdictions should be encouraged to adopt standardized tsunami signs.

(See also: <http://www.dot.ca.gov/hq/traffops/engineering/control-devices/tsunami.htm>)

Regular and frequent testing of warning systems is essential to identify mitigation strategies for a more resilient and effective system. It is important to know that the system will work as intended should public safety officials ever need to send an alert or warning to a large region of the United

States. Only frequent, rigorous testing can provide an appropriate diagnosis of the system's performance.

Communities are encouraged to run notification and response exercises and public evacuation drills in order to ensure the evacuation plans are appropriate and well understood by the coastal population. The state and federal NTHMP partners should offer assistance to these communities in developing and running these exercises and drills.

Federal, state, and academic institutions involved in warning system development as well as public education and outreach should collaborate to ensure that when alerts (earthquake, tsunami) are issued, the appropriate response occurs.