# Tsunami inundation preparedness in coastal communities

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**Abstract.** Tsunami inundation modeling of Grays Harbor and Pacific Counties was completed in May 1999 (Walsh *et al.*, 2000) as part of our hazard assessment program. These maps are the basis for developing and testing emergency preparedness and evacuation plans.

With the tsunami inundation areas identified, planning the evacuation routes became a priority. Two types of communities were identified: those with a single access road that increased evacuation times and those with safe nearby congregation areas. With evacuation routes and congregation areas delineated, state and county emergency managers installed tsunami warning and evacuation signs. Signs save lives by raising community awareness before a tsunami and by notifying people of appropriate evacuation routes during an event.

Finally, a tsunami brochure with tsunami safety tips, NOAA Weather Radio information, and tsunami evacuation maps was developed and printed for release with the inundation maps. For those unable to evacuate before a tsunami strikes, officials distributed the book, *Surviving a Tsunami—Lessons from Chile, Hawaii, and Japan* (Atwater *et al.*, 1999). This tool allows local officials to show that tsunamis are survivable even if an evacuation isn't possible. The inundation maps and other materials were released at public forums. These presentations progressed from research findings and modeling to community tsunami preparedness issues.

## 1. Introduction

This paper documents the progress of and provides information about the State of Washington's Tsunami Program activities from 1997 to August 2001. It demonstrates our commitment to promote "Tsunami Resistant Communities" in our state and the need to collaborate with our partners in the National Tsunami Hazard Mitigation Program (NTHMP). These multi-state projects pool our resources and address common issues. For example, our tsunami warning and evacuation sign program emphasizes the use of the standardized signs designed by Oregon. This not only reduces the cost of providing the signs but also provides a consistent message along the West Coast of the United States.

## 2. State/Local Tsunami Work Group

The key ingredient of our efforts is the State/Local Tsunami Work Group, composed of representatives from coastal counties, state agencies, and federal agencies. This multi-disciplinary group meets quarterly and invites people from other disciplines to discuss tsunami issues and projects. Using the mitigation tools established by the NTHMP, the Work Group developed a strategy based on the needs assessments of individual counties. This process allows the counties to "buy into" the mitigation process, leading to rapid implementation of the mitigation and preparedness tools.

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## 3. Education

The devastating tsunami that hit New Guinea in 1998 demonstrates the potential destruction and loss of life that Washington coastal communities face. Current research indicates that the most recent Cascade subduction zone earthquake in 1700 may have had a magnitude greater than 9 and generated a 10-meter high tsunami that struck the coasts of both the Pacific Northwest and Japan. These data indicate the urgency of educating residents and tourists in our coastal communities.

### 3.1 Evacuation and educational signs

Evacuation, warning, and interpretive signs based on the Oregon model have been installed in all tsunami counties in Washington. The state and local governments worked together to plan and install these signs. Later in the program, Parks and Tribes were invited to participate, and have reciprocated with signs on park and tribal lands. These signs have become the "trade mark" of the State Tsunami Program and have demonstrated the following successes:

- Signs have proven to be a useful tool for raising pre-event awareness. They have generated significant media attention locally and nationally and have educated the communities at a broader level than any other mitigation tool. The sign program has also brought longer-term tsunami mitigation issues to the table for discussion.

- Signs are encouraging local sponsorship of tsunami mitigation programs. Local groups such as the "Beach Walkers" in Island County actively disseminate tsunami information at local beaches and on the ferries.

- A state sign program has been a cost effective way of disseminating a consistent message about the potential impact areas and how to react to tsunami warnings. Similar signs among the coastal states provide a consistent message to tourists who might be less aware of tsunami hazards than the coastal residents.

### 3.2 Media materials

The media has been a vital partner in raising public awareness of tsunamis and of the work being done at the state and local level. Local cable TV and radio stations have broadcast our tsunami workshops in the communities and major TV stations provided coverage of these events. Newspapers have worked with local emergency managers to develop full-page articles regarding tsunami education, evacuation, and on-going community tsunami projects. The State/Local Tsunami Work Group worked with film producers to develop video and TV broadcasts on tsunamis and tsunami preparedness.

### 3.3 Public service announcements

A public service announcement providing tsunami education, evacuation, and tsunami warning system information was completed and distributed statewide.

### 3.4 State video

The State uses a locally broadcast special news hour titled "On Fragile Ground" that describes the hazards of tsunamis, earthquakes, and volcanoes. Local scientists and residents are interviewed. The hour is very well organized and holds viewer interest despite the length and substantial amount of earth science material covered. The *TsuInfo Alert* program also offers a collection of videos that can be borrowed by program participants.

### 3.5 Public information products

The State/Local Tsunami Work Group has developed numerous products to disseminate tsunami information to the public. A variety of tsunami posters and magnets have been very successful at state and county fairs, conferences, workshops, and schools (The International Association of Emergency Managers awarded second place in the category "special publications" to the tsunami poster developed for our 1999 Disaster Preparedness Month). Pamphlets and brochures, available at public offices, recreation areas, hotels and motels, and other high visibility areas, educate the public on the tsunami hazard and how to remain safe.

### 3.6 Curriculum materials

Curriculum materials for K–6 and 7–12 were developed to meet the Washington State Essential Academic Learning Requirements (EALRS) established by the Washington State Superintendent of Public Instruction, from the NTHMP multi-state education material products (Washington Emergency Management Division, 1999a, 1999b). Several tsunami videos have also been purchased and distributed to school districts statewide.

### 3.7 Library-type materials inventory

The Department of Natural Resources, Geology Division, has developed two excellent inventories of tsunami materials. The annotated tsunami bibliography (Manson and Walkling, 1998) lists mostly Northwest publications and primarily appeals to scientists and others dealing with the application of science to tsunamis. The *TsuInfo Alert* newsletter (a multi-state NTHMP product), is targeted at a less technical audience and contains updated scientific and emergency management materials, book reviews, and short articles.

### 3.8 Training materials

The state uses multi-state educational materials to provide training to the public and private sector. We also use our partnership with NTHMP scien-

tists and local college professors to provide educational material and training in the local communities as well as at state level workshops.

### 3.9 Tsunami information for tourists

Tsunami interpretive signs have been installed in 32 locations along the coast and Island County, including Park and tribal lands. Island County Beach Watchers have given tsunami talks at the beaches and have partnered with the Washington State Department of Transportation Ferry System to provide tsunami/earthquake talks to passengers on the ferries. This program received the Western States Seismic Policy Council (WSSPC) National Awards in Excellence 2000 in the Non-Profit Agency Efforts category.

### 3.10 Tsunami information for state and local officials

The *TsuInfo Alert* newsletter is being used to educate government officials. Copies are sent to all elected officials and to the Washington State Congressional Delegation. Sustainment training is provided yearly at the Washington Emergency Management Division (EMD) for EMD personnel and State Agency Liaisons. NTHMP partners and international tsunami experts are brought in to support this training effort. Annual local tsunami workshops are held in the communities. At that time, appointments are made with county elected officials to brief them on the tsunami threat assessment and actions being taken by the State/Local Tsunami Work Group to reduce the impact of a tsunami strike.

### 3.11 Public education

April is designated Disaster Preparedness Month. Tsunami materials are distributed to local jurisdictions for schools and the general public. Further, September is designated Tsunami Awareness Month. Public forums, workshops, and media events are planned. This effort is also supported by the distribution of tsunami educational material. EMD took the lead to work with USGS to produce a NTHMP multi-state product, *Surviving a Tsunami—Lessons from Chile, Hawaii, and Japan* (Atwater *et al.*, 1999). This tool allows local officials to show that tsunamis are survivable even if an evacuation isn't possible. The book is available in both English and Spanish and is used by all NTHMP states as part of their public education and outreach programs.

## 4. Inundation Maps, Evacuation Routes, and Brochures

As part of the hazard assessment, tsunami inundation modeling of Grays Harbor and Pacific Counties was completed in May 1999 (Walsh *et al.*, 2000). These maps provide the basis for developing and testing emergency preparedness and evacuation plans.

With the tsunami inundation areas identified, planning the evacuation routes became a priority. Two types of communities were identified: those with a single access road that increased evacuation times, and those with safe nearby congregation areas. With evacuation routes and congregation areas delineated, state and county emergency managers installed tsunami warning and evacuation signs. Finally, a tsunami brochure with tsunami safety tips, NOAA Weather Radio information, and tsunami evacuation maps was developed and printed for release with the inundation maps.

### 4.1 Inundation maps

Inundation maps for the outer coasts of Pacific and Grays Harbor Counties were completed by the Department of Natural Resources, Geology Division, with input from the local communities. As another part of the inundation mapping effort, the communities of Taholah, La Push, Neah Bay, Port Angeles, and Port Townsend were also mapped. A Puget Sound tsunami model by Shunichi Koshimura (Japan/JSPS) and Hal Mofjeld (NOAA/PMEL) was also completed and was presented at a Puget Sound Tsunami/Landslide Workshop in January 2001.

### 4.2 Evacuation routes and brochures

Evacuation routes have been developed for Pacific, Grays Harbor, and Island Counties. A tsunami brochure with an evacuation map was developed and distributed statewide. Clallam and Jefferson Counties are developing evacuation routes based on the tsunami inundation mapping and will develop a tsunami brochure with evacuation maps in Federal Fiscal Year 2002.

## 5. Workshops

A major challenge for the emergency manager is the need to tie scientific research and emergency management principles into an effective mitigation and preparedness program to educate and provide sound emergency management decision-making policies. Our workshops have been successful because they feature the scientific community *and* emergency management personnel from NOAA, USGS, FEMA, and Washington State. This partnership brings invaluable credibility to the earthquake and tsunami mitigation effort at both the federal and state levels and must be maintained as an integral part of the state tsunami program if it is to continue to be successful.

### 5.1 Regional tsunami conference

Washington hosted the first Regional Coastal Earthquake Conference with Oregon and Alaska. Its goal was to improve disaster resistance of coastal communities to earthquake/tsunami impacts through a workshop that exposed participants to new partners, specifically, businesses and communities from other states. (This conference was awarded the WSSPC Na-

tional Awards in Excellence 2000 in the Educational Outreach to Business/Government category).

## 6. Warning System

The State/Local Tsunami Workgroup supports the use of the NOAA Weather Radio as an effective all-hazard warning system in the tsunami coastal counties. The NOAA Weather Radio has been an integral part of our tsunami workshops and has become a primary means of the all-hazards warning system among our coastal communities. This inexpensive receiver warns of a hazard prior to the mass media and county alerting systems, giving people additional time to react before danger hits their area.

### 6.1 Warning programs

Warning programs have been and are being developed in tsunami communities. The NOAA Weather Radio has been designated the primary warning system. The State/Local Tsunami Work Group developed a partnership with the National Weather Service, the U.S. Navy, coastal counties, tribal nations, and the private sector to provide complete NOAA Weather Radio coverage of the Washington State coast and shipping lanes. This partnership is the first in the nation to establish a system of weather, emergency alert, and warning for the coastline of an entire state.

### 6.2 Local warning system guidelines

Washington State uses the multi-state product "Tsunami Warning Systems and Procedures Guidance" for local communities. The State/Local Tsunami Work Group has held several meetings with state and local warning system stakeholders and has developed procedures for tsunami warning to include the Emergency Alert System (EAS).

### 6.3 NOAA Emergency Information Network

Island County Department of Emergency Services has developed a program to harden the communities' communications infrastructure to better facilitate visitors' access to emergency information. They have established an "Emergency Information Network" which has installed NOAA Weather radios at designated "Emergency Information Centers," including, but not limited to visitors' centers, hotels, marinas, parks, gas stations, and grocery stores. A NOAA Weather Radio placard is visibly posted at these sites alerting visitors that the facility has a NOAA Weather Radio. Explanatory brochures regarding this program are distributed through the local Chambers of Commerce.

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Washington State Tsunami Program. Their vision, providing a strategy based on individual county needs, has insured rapid implementation of tsunami mitigation tools for our coastal counties. Our commitment to promote "Tsunami Resistant Communities" is made possible only through their efforts.

I wish to thank Connie Manson and Lee Walking for their critical review of this paper. Their devotion to the state tsunami program has encouraged the development of publications for both the scientists and for less technical audiences such as emergency managers, responders, public officials, and teachers.

## 7. References

Atwater, B.F., M.V. Cisternas, J. Bourgeois, W.C. Dudley, J.W. Hendley, II, and P.H. Stauffer, compilers (1999): *Surviving a Tsunami–Lessons from Chile, Hawaii, and Japan.* USGS Circular 1187, 18 pp.

Koshimura, S., H.O. Mofjeld, F.I. González, and V.V. Titov (2001): Tsunamis in the Puget Sound region—New program [abstract]. In *Washington State Puget Sound Water Quality Action Team, Puget Sound research 2001; The Puget Sound/Georgia Basin ecosystem—Status, stressors and the road to recovery*: Washington State Puget Sound Water Quality Action Team [Abstracts of Oral Presentations], p. 19.

Manson, C.J., and L. Walkling, compilers (1998): Tsunamis on the Pacific Coast of Washington—A selected bibliography and directory. Washington Division of Geology and Earth Resources Open File Report 98-4, 40 pp.

Walsh, T.J., C.G. Caruthers, A.C. Heinitz, E.P. Myers, III, A.M. Baptista, G.B. Erdakos, and R.A. Kamphaus (2000): Tsunami hazard map of the southern Washington coast—Modeled tsunami inundation from a Cascadia subduction zone earthquake. Washington Division of Geology and Earth Resources Geologic Map GM-49, 1 sheet, scale 1:100,000, with 12 pp. text.

Washington Emergency Management Division (1999a): Surviving great waves of destruction; Tsunami curriculum—Grades 7–12. Washington Military Department, 52 pp.

Washington Emergency Management Division (1999b): Tsunami curriculum—Grades K–6. Washington Military Department, 68 pp.