TsuInfo Alert

prepared on behalf of the
National Tsunami Hazard Mitigation Program
by the Washington Department of Natural Resources

Contents

Volume 1, Number 12, December 1999

Tsunami Program News

FEMA Formalizes Emergency Management Policy with Native American Governments

American Indian and Alaska tribal governments hold a unique status in the U.S., having many of the rights and benefits of sovereign nations. Recently, in a final policy statement contained in the January 12 issue of the *Federal Register* (Vol. 64, No. 7, pp. 2095-2097), James L. Witt, director of the Federal Emergency Managment Agency (FEMA), announced his agency's commitment to working with native American nations on emergency management issues. ...Witt designated the agency's Preparedness, Training, and Exercises Directorate to serve as liaison between FEMA and sovereign tribes on policy issues. Further, he noted that each of the 10 FEMA regional offices has a 'designated individual as the focal point for the coordination and implementation of this policy.' (from: Natural Hazards Observer, March 1999, p. 8.) The contact people for FEMA Region X (Alaska, Washington, Oregon, and California) are Joan Rabe (425) 487-4739 and Bob Grow (425) 487-4780. Region X covers Alaska, Washington, Oregon and California. The contact person for FEMA Region IX (Hawaii) is Tessa Badua-Larsen (415) 923-7185.

Copies of the Federal Register are available at any federal depository library or online at http://www.access.gpo.gov. The DNR, Division of Geology and Earth Resources Library can also mail you a copy at no charge.

NOAA Announces Grant Opportunities for Coastal Resource Management Programs

The U.S. National Oceanic and Atmospheric Administration (NOAA) is offering grant and cooperative agreement opportunities in several areas for FY2000. As announced in the *Federal Register*, v. 64, no. 213, Nov. 4, 1999, "NOAA's Coastal Services Center seeks proposals from state or local resource management agencies, academic institutions, nonprofit organizations, and private sector companies for [pilot] projects . . . under which a cooperator(s) and the Center will scope out or design and apply prototype decision making tools and information products for coastal resource management. Emphasis will be placed on projects that address coastal habitat management and coastal hazards mitigation."

The complete notice is available from http://www.csc.noaa.gov/cms/baa.html. Additional information is available from the Web site or from National Oceanic and Atmospheric Administration, NOAA Coastal Services Center, 2234 South Hobson Avenue, Charleston, SC 29405-2413; (843) 740-1222; e-mail: csc@csc.noaa.gov.

The staff member in charge of the "Coastal Technical Services" proposals is Jeff Payne." (843) 740-1207.

from: Disaster Research 306, November 15, 1999.

Coastal Society Meeting, Portland, July 2000

The Coastal Society's 17th Annual Conference, *Coasts at the Millennium.,* will be held in Portland, Oregon, July 9-12, 2000. The meeting will include a session on "Reducing Coastal Hazards." For information, contact:

Laurie Jodice, TCS 17 Office, Marine Resource Management, College of Oceanic and Atmospheric Sciences, Oregon State University, 104 Ocean Administration Building, Corvallis, OR 97331-5503; fax: (541) 737-2064; e-mail: jodicel@oce.orst.edu; http://www.oce.orst.edu/mrm/tcs17/confhome.html

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Participants in the TsuInfo program can request copies of reports listed in this issue from:

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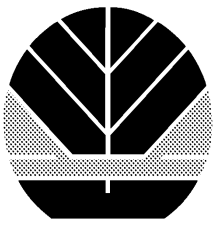

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Jennifer M. Belcher - Commissioner of Public Lands

The 4 October 1994 Warning: Critical Lessons from Hawaii for Saving Lives
by Dan Walker

All of the local evening news broadcasts on 3 October 1994 reported that an early winter surf had began to arrive along the northern shores of the Hawaiian Islands. As a result many surfers planned on being "sick" the next day, others would catch the waves either in the early hours of the morning or later in the day after school or work. As fate would have it, none of the students or state workers would have to worry about missing classes or lost work. An event thousands of miles away would force the Governor to cancel work for all but the most essential state employees.

The timing of the Hokkaido earthquakes could not have been better. Civil Defense officials breathed a sigh of relief. It allowed the cancellation to be issued in the early hours of the morning. Students had not yet arrived at school nor had state employees begun their commute to work. The incredible traffic gridlock, chaos, and criticism that resulted from the midday cancellation of school and work associated with the previous tsunami warning in 1986 could be avoided. However, we would not have felt so relieved if we knew that hundreds of unnecessary fatalities would have occurred if a significant were to arrive.

It was a typically beautiful day in Hawaii, school was cancelled, the ocean was glassy, and the surf was "up". As a result an estimated 200 to 400 surfers were in the ocean along Oahu's North Shore at the time the tsunami was due to arrive. Many lifeguards, police, and civil defense officials were frustrated in their efforts to reason with surfers and observers. Simple admonitions that "You can't surf a tsunami", "Tsunamis are much more powerful than surfing waves", and "Tsunamis can kill you" were obviously ineffective.

In retrospect it was chilling to think of how many people throughout the State were in the ocean or in other low-lying areas at the estimated arrival time of the tsunami. If emergency planners are to reduce unnecessary losses of lives in future tsunamis, they must try to understand why so many ocean enthusiasts ignored the 4 October warning.

Here are some of the answers to this question derived from many talks about tsunami hazards at schools throughout the State and discussions with students who were in the surf on 4 October.

-- Because it has been so long since we've had a significant tsunami in Hawaii, children and young adults do not understand how powerful a tsunami can be.

-- Residents of the Hawaiian Islands also are quite familiar with large, dangerous, and potentially fatal surfing waves.

-- Many children and young adults surf those waves, and many beachgoers are used to watching those waves in low-lying areas that would be inundated by tsunamis.

Considering the youthfulness of these people and their familiarity with large surfing waves, is it realistic to expect them to accept such statements as: "You can't surf a tsunami", and "Tsunamis can kill you"? They need a better appreciation of a tsunamis power. They need to understand how tsunamis differ from surfing waves. They need to be aware of the following facts.

--Even though destructive tsunamis may have the same height as large surfing waves, they are much more powerful.

-- Unlike surfing waves, the next tsunami wave is not one or two hundred feet behind its earlier wave. The crest of the next tsunami wave is out on the horizon. In other words the whole ocean that you can see is one of the tsunami's waves.

-- As a result, unlike a large surfing wave which quickly washes up and down the shore, the water keeps coming and coming with tremendous power when a tsunami floods low-lying areas.

-- As these large volumes of debris laden water (i.e., with rocks, trees, rubbish, dirt, buildings, cars, etc.) recede back into the ocean, unpredictable powerful ocean currents are produced.

-- Also, these outgoing waves can run into other onrushing tsunami waves resulting in walls of water with enormous power in a turbulent, unpredictable, and debris filled ocean.

-- It is hard to imagine that a person who really understands the destructive potential of tsunamis would even attempt to watch a tsunami from a low-lying shoreline area, let alone try to surf a tsunami. **Such a ride would most likely be short and deadly. Spectators in areas that are normally safe in big surf could also die.**

Students have told me that had they known these facts, they would not have been in the surf on 4 October and that, because of what I told them, they will never again ignore a tsunami warning. As in Hawaii, people throughout the Pacific are familiar with large waves. Therefore, safety officials must do an adequate job of explaining the differences between large surfing waves and tsunamis if needless losses of life are to be eliminated, especially among those most vulnerable – our children and young adults.

Dr. Walker is a retired seismologist from the University of Hawaii. He has published a number of tsunami research papers, as well as educational products for elementary and high school children. He also serves as a tsunami advisor to the Oahu Civil Defense Agency.

***Editor's note:TsuInfo Alert* will be published bi-monthly, beginning in January 2000. Expect the January-February 2000 issue around January 15th. If you have articles, book reviews, or photos to submit, please get them to us by March 3 for the March-April issue.**

Native American Legends of Possible Tsunamis in the Pacific Northwest
adapted from http://walrus.wr.usgs.gov/nwtsunami/NAlegends.html,
maintained by Eric L. Geist

Makah Legend (from Swan, 1868)

The only tradition that I have heard respecting any migratory movement among the Makahs, is relative to a deluge or flood which occurred many years ago, but seems to have been local, and to have had no connection with the Noachic deluge which they know nothing about, as a casual visitor might suppose they did, on hearing them relate the story of their flood. This I give as stated to me by an intelligent chief; and the statement was repeated on different occasions by several others, with a slight variation in detail.

"A long time ago," said my informant, "but not at a very remote period, the water of the Pacific flowed through what is now the swamp and prairie between Waatch village and Neeah Bay, making an island of Cape Flattery. The water suddenly receded leaving Neeah Bay perfectly dry. It was four days reaching it lowest ebb, and then rose again without any wave or breakers, till it had submerged the Cape, and in fact the whole country, excepting the tops of the mountains at Clyoquot. The water on its rise became very warm, and as it came up to the houses, those who had canoes put their effects into them, and floated off with the current, which set very strongly to the north. Some drifted one way, some another; and when the waters assumed their accustomed level, a portion of the tribe found themselves beyond Nootka, where their descendants now reside, and are known by the same name as the Makahs in Classett, or Kwenaitchechat. Many canoes came down in trees and were destroyed, and numerous lives were lost. The water was four days regaining its accustomed level."

Legend accounted by Deborah Carver (in Anderson, 1995)

"A number of stories, including one from Washington state, tell of a huge earthquake occurring in the middle of the night, Deborah Carver said, in some cases after people in a doomed village have misbehaved. Elders tell the young that they must run for high ground. Those who heed their warning survive, although the 'flood' waters follow close behind them. They spend a cold night in the hills, surrounded by animals who have also fled the flood. In the morning they find that all traces of their village, and all neighboring coastal villages, have been completely washed away and no one else has survived."

"Among the signs of danger, the elders warn, is long-lasting shaking moving from west to east, and sand that becomes so loose people walking on the beach sink into it."

original sources:

Anderson, D., 1995, Oral history--Legends give valuable hints: Times-Standard [Eureka, CA], Feb. 12, 1995.

Heaton, T. H.; Snavely, P. D., Jr., 1985, Possible tsunami along the northwestern coast of the United States inferred from Indian traditions: Seismological Society of America Bulletin, v. 75, no. 5, p. 1455-1460.

Swan, J. G., 1868, The Indians of Cape Flattery, at the entrance to the Strait of Fuca, Washington Territory: Smithsonian Contributions to Knowledge, v. 16, p. 57-58.

additional sources:

Arima, E. Y.; St. Claire, Denis; Clamhouse, Louis; Edgar, Joshua; Jones, Charles; Thomas, John, 1991, Between Ports Alberni and Renfrew--Notes of west coast peoples: Canadian Ethnology Service Mercury Series Paper 121,[excerpts only, p. 230-231]

Clague, J. J., 1995, Early historical and ethnographical accounts of large earthquakes and tsunamis on western Vancouver Island, British Columbia:Geological Survey of Canada Current Research 1995-A, p. 47-50.

Hutchinson, Ian; McMillan, A. D., 1997, Archaeological evidence for village abandonment associated with late Holocene earthquakes at the northern Cascadia subduction zone: Quaternary Research, v. 48, no. 1, p. 79-87.

Websites of Distinction!

The Cascadia Megathrust and Tectonic Stress in the Pacific Northwest, by Eric L. Geist.
http://walrus.wr.usgs.gov/stress/

Geist's research of the Cascadia Megathrust and Pacific Northwest plates. Includes great graphics to help illustrate the findings. Includes ample links to further studies and explanations. Last modified 7-10-97

The July 17, 1998 Papua New Guinea Tsunami, by Eric L. Geist. http://walrus.wr.usgs.gov/tsunami/

Thorough study of the Papua New Guinea tsunami, with photos, graphics, links, and animation. Links to current research studies provide up-to-date findings.

Mental Health Workers without Borders
http://www.mhwwb.org

"The MHWWB is an international, not-for-profit, nongovernmental network of activist mental health workers of all types and professions whose aim is to provide psycho-social assistance following natural and human-caused disasters and to provide technical assistance to developing countries so that they can provide treatment and psycho-social rehabilitation for their citizens. MHWWB encourages family- and community-based approaches to mental health therapy, while respecting cultural variation, drawing on local resources and traditions, and emphasizing community empowerment. The MHWWB Web site includes sections on "Activities," "Human Rights," "Rehabilitation," and "Disasters," with numerous links to sites providing information in these areas. It also offers a downloadable manual, "Coping with Disaster: A Guide to Psychosocial Responses to Disaster." For more information about MHWWB, contact Mental Health Workers Without Borders, c/o Martin Gittelman, 100 West 94th Street, New York, NY 10025; e-mail: mhwwb@mhwwb.org."

from: Disaster Research 306, November 15, 1999

Building Performance Assessment Teams
http://www.fema.gov/mit/bpat

Federal Emergency Management Agency Building Performance Assessment Teams (BPATs) are activated following disasters to assess building and infrastructure performance and subsequently to recommend improvements in construction codes and standards, designs, methods, and materials used for both new construction and postdisaster repair. The BPAT Web site provides current BPAT news, success stories and reports from surveys of recent disasters, as well as complete copies of the BPAT newsletter, "BPAT Update." The latest reports concern the Midwest tornadoes of May 3, 1999 and Hurricane George. FEMA is currently recruiting qualified persons to join the BPAT Roster Database. Details are also available from the BPAT Web site.

New Tsunami Mitigation Materials, November, 1999
compiled by
Connie J. Manson
***Note*: Free reprints of these materials are available.**
(See order form, p. 10)

Videos

Films for the Humanities and Sciences, 1998, The quake hunters--Tracking a monster in the subduction zone: Films for the Humanities and Sciences, 1 video, 45 min.

Oregon Department of Geology and Mineral Industries, 1998, Tsunami--Surviving the killer waves: Oregon Department of Geology and Mineral Industries, 1 video, 14 min.

Tsunami Mitigation Program

Jonientz-Trisler, Chris; Mullin, Jeanette, 1999, 1997-1998 activities of the Tsunami Mitigation Subcommittee, Alaska, California, Hawaii, Oregon, Washington, FEMA: U.S. Federal Emergency Management Agency, 45 p.

Technical Reports

Geist, E. L., 1997, The Cascadia megathrust and tectonic stress in the Pacific Northwest: U.S. Geological Survey, downloaded 11/17/1999 from http://walrus.wr.usgs.gov/stress/

Khazaradze, Giorgi; Qamar, A. I., 1999, Tectonic deformation in western Washington from continuous GPS measurements: Geophysical Research Letters, v. 26, no. 20, p. 3153-3156.

Lewis, Steve, 1998, Offshore earthquakes and landslides, the Chile margin triple junction--Modern analog to ancient California?: U.S. Geological Survey, downloaded 11/17/1999 from http://walrus.wr.usgs.gov/research/sopac.html

Smith, D. G.; Meyers, R.A.; Jol, H. M., 1999, Sedimentology of an upper-mesotidal (3.7 M) Holocene barrier, Willapa Bay, SW Washington, U.S.A.: Journal of Sedimentary Research, v. 69, no. 6, p. 1290-1296.

Stanley, W. D.; Villasenor, Antonio; Benz, H. M., 1999, Subduction zone and crustal dynamics of western Washington--A tectonic model for earthquake hazards evaluation: U.S. Geological Survey Open-File Report 99-311, 1 v., downloaded 11/17/99 from http://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-99-0311/

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Fort Richardson, Alaska 99505-5750
(907) 428-7039
Fax (907) 428-7009
http://www.ak-prepared.com/

California Office of Emergency Services
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http://www.oes.ca.gov/

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http://iao.pdc.org

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http://www.osp.state.or.us/oem/oem.htm

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http://www.wa.gov/mil/wsem/

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http://www.pep.bc.ca

Tsunami Statistics:
Destructive tsunamis on the West Coast of the United States in recorded history
compiled by Lee Walkling

Date	Tsunami Damage In:	Tsunami Generated In:	Fatalities	$ Damages
April 2 1868	Hawaii	Hawaii	81	
December 17, 1896	Santa Barbara			
February 3, 1923	Hawaii	Kamchatka Peninsula, AK		$1.5 million
April 1, 1946	Santa Cruz, CA	Aleutian Island, AK		
	Unimak Island, AK & Aleutians		159	$26 million
	Hawaii		173	$26 million
November 5, 1952	Hawaii	Kamchatka area, AK		$1 million
July 9, 1958	Lituya Bay	Lituya Bay, AK	2	
May 22, 1960	Crescent City, CA	southern Chile		$500,000
	Hawaii		61	$75 million
March 27, 1964	Crescent City, CA	Prince William Sound, AK	10	$7 million
	Alaska		107 (106)*	$84 million
	Hawaii	Gulf of Alaska		$68,000
November 29, 1975	Santa Catalina island, CA	Hawaii		$2000
	Halape, HI	Hawaii	2	$1.5 million

Sources:

Lockridge, Patricia A.; Smith, Ronald H., 1984, Tsunamis in the Pacific Basin, 1900-1983:U.S. National Geophysical Data Center, 1 sheet, scale 1:17,000,000.

*U.S. Federal Emergency Management Agency, 1998, Multi-hazard identification and risk assessment--The cornerstone of the national mitigation strategy: U.S. Federal Emergency Management Agency, p. 206.

Tsunami Factoids

"Tsunami events affecting the United States and its territories have been responsible for almost 470 fatalities and hundreds of million dollars in property, infrastructure, transportation, and lifeline damage."

"During the past 20 years, tsunamis have not resulted in federally-declared disasters."

"Since 1770, more than 46 remote-source generated tsunamis and 18 local tsunamis have been observed along the West Coast."

"Tsunami events affecting the United States and its territories have been responsible for almost 470 fatalities and hundreds of million dollars in property, infrastruc-ture, transportation, and lifeline damage."

from: U.S. Federal Emergency Management Agency, 1998, Multi-hazard identification and risk assessment--The cornerstone of the national mitigation strategy: U.S. Federal Emergency Management Agency, p. 206.

"From 1900 through 1965, a total of 13 significant tsunamis (i.e., those with wave heights equal to or greater than 1 meter) produced by distant earthquakes were reported for the Hawaiian Islands."

"5 locally generated tsunamis with runups equal to or greater than 1 meter have been reported from 1900 through 1993."

"From 1900 through 1965, 13 tsunamis with large amplitudes (i.e., wave heights of 3 or more feet) have struck the Hawaiian Islands (an average of about one every five years). However, since 1965 no large tsunamis have struck Hawaii."

from: Walker, D. A., 1994, Tsunami facts: University of Hawaii School of Ocean and Earth Science and Technology SOEST Technical Report 94-03, p. 4 and 76.

"The orientation and bathymetry of the West Coast of the United States tend to protect it from the full effects of many tsunamis."

from: American Institute of Professional Geologists, 1993, The citizens' guide to geologic hazards: American Institute of Professional Geologists, p. 115.

World's Major Tsunamis

Year	Originating site	Damage damage site(s)	Losses
1628 BC	Santorini (Thera) eruption	Crete, Greece, Egypt	Minoan civilization devasted
1640	Komagatake Volcano	Hokkaido, Japan	1,460 deaths
1707	West Pacific earthquake	Osaka Bay, Japan	4,900 deaths
1755	Lisbon earthquake (offshore)	Western Europe, N. Africa	20,000 to 30,000 deaths
1792	Unzen Volcano	Kyushu, Japan	10,000 deaths (the landslide killed 5,000 more)
1812	Santa Barbara, CA earthquake (offshore)	Santa Barbara, CA	30-ft. high waves were reported
1815	Tambora eruption	Indonesia	10,000 deaths
1868	Peru/Chile earthquake	Hilo, Hawaii	30-ft. high waves carried boats 2 miles inland)
1883	Krakatau eruption	Indonesia	36,000 deaths; waves were more than 100 ft. high
1896	Honshu earthquake	Sanriku, Japan	27,000 deaths
1905	Norway, landslide into fjord	Loen Lake, Norway	61deaths
1918	Philippines landslide	Philippines	100 deaths
1933	Honshu earthquake	Sanriku, Japan	3, 000 deaths; waves were 75 ft. high
1936	Norway, landslide into fjord	Loen Lake, Norway	73 deaths
1946	Aleutian Islands earthquake	Wainaku, Hawaii	173 deaths; waves were 55 ft. high
1960	Chile earthquake	Chile, Hawaii, Japan	1,900 deaths
1964	Alaska earthquake	Crescent City, CA; Valdez area AK	122 deaths
1971	Peru avalanche into lake in Andes	Chungar, Peru	600 deaths
1976	West Pacific earthquake	Philippines	3,000 deaths
1979	Werung Volcano with avalanche into sea	Lomblem Island, Indonesia	539 deaths
1992	Nicaragua earthquake	Masachapa & 200 miles of coast and nearby islands	116 deaths; waves were 30 ft. high

from: American Institute of Professional Geologists, 1993, The citizens' guide to geologic hazards--A guide to understanding geologic hazards, including asbestos, radon, swelling soils, earthquakes, volcanoes, landslides, subsidence, floods, and coastal hazards: American Institute of Professional Geologists, p. 115. (Data from Office of Foreign Disaster Assistance, World Almanac, Geology and Society, by D. R. Coates; and UNDRO NEWS, 1992.)

More Tsunami Factoids...

"Twenty-four tsunamis have caused damage in the United States and its territories during the last 204 years."

"Since 1946, six tsunamis have killed more than 350 people and damaged a half billion dollars of property in Hawaii, Alaska, and the West Coast."

from: Talking About Disaster: Guide for Standard Messages (http://www.redcross.org/disaster/safety/guide/tsunami.html).

"Hawaii, the highest risk area, averages one tsunami every year with a damaging occurrence every 7 years. Alaska, also at high risk, averages a tsunami every 1.75 years and a damaging event every 7 years. The West Coast experiences a damaging tsunami every 18 years on average."

from: FEMA Reference Library-Fact Sheets (1996)

Infrequently Asked Questions

compiled by
Lee Walkling

What is the correct translation of " 'Iliki ke kai i ka 'ope 'ope la, lilo, i lilo no he hawaw~?"

There are three correct translations of this Hawaiian proverb:

The sea snatches the bundle and it is gone, it goes when one isn't watchful.

A person who fails to watch out often loses.

Never turn your back on the ocean.

from: Walker, D.A., 1994, Tsunami facts: University of Hawaii School of Ocean and Earth Science and Technology SOEST Technical Report 94-03, p. 2.

What is the 100-year elevation?

"Coastal topography defines the landward penetration of tsunami wave runup and flood inundation. The elevation with a 1-percent chance of being equaled or exceeded in any given year, also known as the 100-year elevation, varies throughout the Pacific Ocean. Variations are due to differences in shoreline configuration, offshore bathymetry, upland topography, wave type, and proximity to sources of tsunami waves."

from: U.S. Federal Emergency Management Agency, 1998, Multi-hazard identification and risk assessment-- The cornerstone of the national mitigation strategy: U.S. Federal Emergency Management Agency, p. 209.

Is there a relationship between earthquake magnitude and tsunami size?

"There is no perfect relationship between earthquake size and tsunami wave heights. For example, some earthquakes with Richter magnitudes of 7.0 to 7.9 have had larger tsunamis than those of earthquakes with magnitudes of 8.0 or greater."

from: Walker, D. A., 1994, Tsunami facts: University of Hawaii School of Ocean and Earth Science and Technology SOEST Technical Report 94-03, p. 4 and 76.

New Program Participants

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FEMA Disaster Mitigation Webcourse

FEMA is now offering an independent study course for home and small business owners on how to reduce losses from natural disasters. The course, "Mitigation for Homeowners" (IS 394) is free and can be downloaded from the FEMA Web site at http://www.fema.gov/home/EMI/ishome.htm or http://www.fema.gov/emi/is394.htm
The course is intended to help residents:

- Identify the natural hazards affecting their community
- Determine which natural hazards are most likely to affect them personally
- Locate specific risks unique to their particular home or business
- Formulate a targeted plan of action to reduce risks to their property, family, and home.

The course provides nontechnical mitigation techniques for the home or small business - both pre-disaster (preventive) and post-disaster (corrective). In addition to signing up through the Web site, individuals and groups can also enroll by contacting the National Emergency Training Center, 16825 South Seton Avenue, Emmitsburg, MD 21727; (301) 447-1076. EMI's independent study Web page: http://www.fema.gov/home/EMI/ishome.htm offers numerous other independent study courses for emergency managers.

ORDER FORM
TsuInfo Alert, v. 1, no. 12, December 1999

Requests for articles (listed this issue, p. 5)

_____ Jonientz-Trisler, Chris; Mullin, Jeanette, 1999, 1997-1998 activities of the Tsunami Mitigation Subcommittee, Alaska, California, Hawaii, Oregon, Washington, FEMA: U.S. Federal Emergency Management Agency, 45 p.
_____ Geist, E. L., 1997, The Cascadia megathrust and tectonic stress in the Pacific Northwest: U.S. Geological Survey, downloaded 11/17/1999 from http://walrus. wr.usgs.gov/stress/
_____ Khazaradze, Giorgi; Qamar, A. I., 1999, Tectonic deformation in western Washington from continuous GPS measurements: Geophysical Research Letters, v. 26, no. 20, p. 3153-3156.
_____ Lewis, Steve, 1998, Offshore earthquakes and landslides, the Chile margin triple junction--Modern analog to ancient California?: U.S. Geological Survey, down-loaded 11/17/1999 from http://walrus.wr.usgs.gov/ research/sopac.html
_____ Smith, D. G.; Meyers, R.A.; Jol, H. M., 1999, Sedimentology of an upper-mesotidal (3.7 M) Holocene barrier, Willapa Bay, SW Washington, U.S.A.: Journal of Sedimentary Research, v. 69, no. 6, p. 1290-1296.
_____ Stanley, W. D.; Villasenor, Antonio; Benz, H. M., 1999, Subduction zone and crustal dynamics of western Washington--A tectonic model for earthquake hazards evaluation: U.S. Geological Survey Open-File Report 99-311, 1 v., downloaded 11/17/99 from http://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-99-0311/

Video reservations for these new (or any previously listed) titles

_____ Films for the Humanities and Sciences, 1998, The quake hunters--Tracking a monster in the subduction zone: Films for the Humanities and Sciences, 1 video, 45 min.
_____ Oregon Department of Geology and Mineral Industries, 1998, Tsunami--Surviving the killer waves: Oregon Department of Geology and Mineral Industries, 1 video, 14 min.

Check the title(s) you would like and indicate the date of your program. The video(s) will be mailed one week before the program date. You will be responsible for return postage.

Program date:_____

Name:_____phone #_____

Organization:_____

Mailing address:_____

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Selected Index
***TsuInfo Alert*, v. l, 1999**

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Natural Resources
Jennifer M. Belcher - Commissioner of Public Lands