TsuInfo Alert

prepared by the Washington State Department of Natural Resources on behalf of the

National Tsunami Hazard Mitigation Program

a state/federal partnership funded through the National Oceanic and Atmospheric Administration (NOAA)

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Contents

Special Features

Departments

TSUNAMI PROGRAM NEWS--EMERGENCY OPERATIONS CENTERS OF THE FIVE PACIFIC COASTAL STATES

Alaska Emergency Coordination Center

http://www.ak-prepared.com/ctoc/secc.htm

The State Emergency Coordination Center (SECC) exists to gather, process, and report emergency situation intelligence; to aid in State policy and decision making; to support local communities as they direct and control disaster emergency response operations; and to account for the State's response support costs.

The above URL provides links to SECC Preparedness Levels and the SECC Room Layout. The website also includes an organization chart of the SECC. Click on an area to see a detailed description of each functional section.

State of Hawaii, Civil Defense System
Birkhimer Emergency Operations Center

http://www.scd.state.hi.us

Inside the Birkhimer Emergency Operations Center (EOC), nestled within the walls of Diamond Head crater, the State of Hawaii Civil Defense System prepares and protects Hawaii in time of disaster. This system is comprised of four county jurisdictions and a State Office of Civil Defense. The system's organization, planning, and programming aligns with the Comprehensive, Integrated, All-Hazards Emergency Management concept which is supported and promoted by the Federal Emergency Management Agency and the United States Fire Administration. -

3949 Diamond Head Road
Honolulu, HI 96816-4495
Phone: (808) 733-4300

Oregon State Emergency Coordination Center

http://www.osp.state.or.us/oem/Organization/Technology%20and%20Response/tech.htm

The State Emergency Coordination Center manages the Governor's Emergency Coordination Center (ECC) staffing schedule and coordination of operational support during a crisis, disaster, or exercise; and, provides for ECC logistics planning and support, as well as training and exercise support.

The Washington State Emergency Operations Center

http://www.wa.gov/wsem/site-general/eoc-tours/eoc-idx.htm

Background: The Washington Military Department, Emergency Management Division, manages the state's Emergency Operations Center located on Camp Murray, near Tacoma, Washington, in accordance with the *Revised Code of Washington (RCW)* 38.52.030(3).

The Department, with support from the Legislature, was appropriated $9 million to construct a new facility to replace the shared property with the Washington State Patrol and commercial buildings that were rented in the Olympia area.

(continued, p. 3)

Congratulations to

HOMER, ALASKA

on becoming the most recent Tsunami Ready Community!

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a State/Federal Partnership funded through the National Oceanic and Atmospheric Administration (NOAA).

It is assembled by
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This publication is free upon request and is available in print (by surface mail),
electronically (by e-mail), and at http://www.wa.gov/dnr/htdocs/ger/tsuinfo/index.html

Participants in the TsuInfo program can request copies of reports listed in this issue from:
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Division of Geology and Earth Resources
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Olympia, WA 98504-7007
ph: 360/902-1472 or 360/902-1473
fax: 360/902-1785
e-mail: lee.walkling@wadnr.gov or connie.manson@wadnr.gov

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Doug Sutherland - Commissioner of Public Lands

:

Compare the *old Operations Room* (1,300 square feet) above, to the view of the new Operations Room (3,600 square feet) below, during a training activity shortly after the new State EOC opened.

Ground breaking occurred in March 1997 on Camp Murray, near Tacoma. The two-story, 28,000 square foot building accommodates 100 staff persons during day-to-day operations and 310 responders (staff and others) during a catastrophic emergency. Staff moved during July 1998 with a formal open house of the building in August 1998.

The facility, dedicated in the memory of Joel P. Aggergaard, serves as the Washington State Emergency Management Division headquarters and the State Emergency Operations Center (EOC). There are two virtual tours of the facility. At the website, click to view EOC Construction or EOC In Use, with operational details. There is also a video you can view to gain a greater understanding of the EOC's role in disasters.

When an emergency occurs, numerous agencies at the local, state, and federal level must carry out many different functions swiftly and effectively to protect life, property, the environment, and the economy in a concerted effort to restore normalcy. The number, nature, and urgency of problems during an emergency differ greatly from those during normal governmental operations.

Gathering information during an emergency, making decisions, and taking necessary actions to implement those decisions requires close coordination between key officials who may not normally work together. Decisions and response actions must be coordinated, integrated, and applied thoughtfully within some structure. A proven way to maximize coordination and application of resources in an emergency is by centralizing response actions in an Emergency Operations Center (EOC).

Role and Purpose: The state EOC serves as the focal point for state responses to emergencies and disasters. These emergencies or disasters are the result of natural, technological or human-caused hazards.

The Washington State EOC

The Division notifies and alerts state agencies and local governments of impending emergencies and disasters. In the EOC, staff coordinates with state, federal, and local government agencies, non-government organizations, private businesses and industry to effectively respond to a natural or technological emergency.

The numerous primary and back-up communications systems allow the state to warn local and state agencies, and the public, of an emergency and to communicate among all emergency response agencies during that event. During an emergency, representatives from other state agencies with emergency roles come to the EOC to help coordinate the state response. Federal government agencies, along with state and local volunteer organizations, also may provide representatives.

During an emergency or disaster, the EOC is designated as the central location for information gathering, disaster analysis, and response coordination. Information gathered is used by executives to make decisions concerning emergency actions and to identify and prioritize the use of state resources needed to respond to the emergency. The EOC may issue emergency warnings or disseminate critical information and instructions to government personnel and the public who may need to take emergency protective actions.

Design Features: Designed to survive and be operational during and following a major earthquake, the steel-braced and framed building has a base isolation foundation that acts as shock absorbers. With its own emergency power and auxiliary communications systems, the facility is a showcase for preparedness and hazard mitigation. During long-term emergencies, Camp Murray will provide support for lodging, feeding, emergency water supply, and sanitation services for EOC responders.

British Columbia, Canada

On May 1, 1993, Provincial Emergency Program (PEP) headquarters moved to 455 Boleskine Road, in Saanich. The new leased accommodation meets all of PEP's operational requirements for functioning both on a day-to-day basis, and for expansion of responsibilities in the event of a provincial emergency or disaster. The building meets the post-earthquake survivability requirements of the 1990 Building Code, has emergency power capability, and is equipped for radio communication to the rest of the province (and the world) in the event of telephone system disruption.

TsunamiReady Communities

date	*city*
6-30-2001	Ocean Shores, WA
1-10-2002	Long Beach, WA
1-16-2002	Seward, AK
6-04-2002	Quinault Indian Nation, WA
8-12-2002	Cannon Beach, OR
9-18-2002	Crescent City, CA
1-27-2003	Homer, AK (certified on 9-9-02)

Congratulations to Homer!

RECENT TSUNAMI EVENTS

(Editors' note: These notes are from the Internet. For more complete information about these events, see ITIC's *Tsunami Newsletter*, at http://www.prh.noaa.gov/itic/NL_home.htm)

30 December Tsunami at Stromboli

(e-mail from Fumihiko Imamura, Prof. of Tsunami Engineering, Disaster Control Research Center, Graduate School of Eng., Tohoku University, Aoba 06, Sendai 980-8579, Japan. Jan. 2, 2003)

Dear colleague:

Information on yesterday's tsunami is available at the ETH's Stromboli Online:
http://www.educeth.ch/stromboli/beso/bes02c-en.html

Further information is available on the same page and http://www.volcano.si.edu/reports/usgs/#strombol

And Dr. Sonia Calvari, Istituto Nazionale di Geofisica e Vulcanologia Sezione di Catania, reported that the large volume of rock finished in the sea caused two tsunamis that, on the island of Stromboli, caused sea regression first, and then two waves several meters high that spread on the villages of Stromboli and Ginostra causing damages to buildings and boats, and injuring a few people. Large waves have been reported up to Milazzo, on the northern coast of Sicily, at a distance of 60 km south of Stromboli.

Stromboli Pyroclastic flow and tsunami on Sciara del Fuoco

(e-mail from Laura Kong, International Tsunami Information Center, Honolulu, January 27, 2003.)

See the following URLs for more information on the eruption and tsunami:
http://www.educeth.ch/stromboli/beso/bes02c-en.html
http://it.news.yahoo.com/030109/203/23388.html
http://www.sveurop.org/gb/news/news.htm
http://gsa.confex.com/gsa/2001AM/finalprogram/abstract_20799.htm

Italy - Stromboli volcano (Eolian Islands)
(from http://www.sveurop.org/gb/news/news.htm)
January 24th, 2003

As of the 23rd of January, the Instituto Nazionale di Geofisica e Vulcanologia - Sezione di Catania has reported that the lava flow in Sciara del Fuoco is still active. The lava flows continue to descend the slope of Sciara del Fuoco, inside the scar left by the big 30 December 2002 landslide. As time passes, there are different branches issued by vents located at different heights, but always at least several tens of metres below the crateric area. In the last few days, there is an active vent at about 500 m a.m.s.l. This, together with the absence of thermal anomalies in the crater terrace, suggests that the magma level is quite low in the conduit. Therefore, the explosive activity that is still recorded instrumentally, does not manage to produce the classical strombolian eruptions visible from Pizzo sopra la Fossa. On the Sciara slope, highly unstable after the big 30 December landslide, moderate sized rockfalls and landslides continue to be observed and recorded by the seismic stations. Almost every day a report is published, in Italian, on the website of INGV - Sezione di Catania.

31 december update - The tsunami phenomenon, which yesterday we defined "small" in order to avoid useless alarms when news were still very confusing and contradictory, has revealed hour after hour all its severity. The greatest damages were recorded in Ginostra, but also in the village of Stromboli many boats were destroyed or taken away by the waves, and many buildings were damaged. At least 3 tourists are reported injured, and other sources talk of 6 injured in total. The tsunami has reached also the other Eolian islands and Milazzo harbour, where 2 tankers suffered difficulties. During the evening, following the invitation of the Civil Defense, tens of inhabitants and tourists voluntarily left the island. Moreover, since this morning non-resident people are not allowed to land on Stromboli. For what concerns the dynamics of the phenomenon producing the tsunami, there are no evidences of summit eplosions, but only of the collapse, as we suggested yesterday, of part of the lava field over the steep slope of the Sciara del Fuoco, that may have detached only by gravitational instability. This hypothesis is supported by the observation, yesterday afternoon, of a big scar at about midslope on the Sciara (source: the volcano guides Antonio Famularo and Nino Zerilli) and by the seismic data recorded by INGV- Catania, which show the presence of two non-volcanic seismic events, at 13:15 and 13:22 local time respectively. (from Stromboli on-line)

30 December 2002, 14:55 The village of Stromboli is currently without power supply, probably because of a fault in the power engine, located close to the coast. First damages to walls and buildings near the coast are reported, due to the tsunami wave. Moreover, new ash-rich explosions are reported near the Sciara, which suggests new interactions between magma and seawater. A new survey of Civil Defense and INGV is currently in progress. A strong explosion, observed at about 13:25 local time, has ejected a great amount of ash that is now falling, mixed with rain, over the village of Stromboli. The explosion must have caused a collapse of part of the lava flow deposits (or more) along the Sciara del Fuoco, as a small tsunami was observed all along the coast near the villages, from Ficogrande (up to the road) to Scari (up to the helipad). Also in Ginostra boats were moved by the tsunami in the small harbour. The explosion was apparently not so loud, and no earthquake was felt by the population. According to the Stromboli volcano guides, and in particular to Antonio Famularo, in the morning (11 a.m.) the lava flows resumed their movement after a pause, although slower than the first day. The flows seem to originate from a (new? different?) fissure, at about 800 m, below the NE crater. The flows still reach the sea, producing a smaller amount of vapour with respect to the beginning of the eruption. The lack of visibility at the top still prevents

observers from evaluating the level of strombolian activity at the craters during the lava effusion.

Colima-Mexico Tsunami

(e-mail from Modesto Ortiz, CICESE, km 107 Carretera Tijuana-Ensenada, Ensenada, Baja California, México. CP 22860 Jan. 22, 2003)

The 22 January, 2003 Colima-Mexico earthquake triggered a tsunami that was recorded at Manzanillo-Colima tide station 12 minutes after the origin time of the earthquake. The origin time of the earthquake is January 22, 2003 at 02:06:35 (UTC) or January 21, 2003 at 20:06:35 local time. The tide gauge is located in Manzanillo Bay inside of a coastal inlet with a narrow entrance, at the coordinates 19.064ºN, 104.2978ºW, which are approximately 50 km NE from the epicenter reported by NEIC (18.807ºN, 103.886ºW).

The first arrival of the tsunami has clearly an emergent character. The first peak is 28 centimeters above the tide level, followed by a maximum height (trough to peak) of 122 centimeters. This tide record is the closest one to the epicenter, and for the moment is the only available tide record.

As a reference, Manzanillo Bay is located on the northern segment of the coast of Colima. The States of Jalisco and Michoacan are north and south of Colima, respectively.

Eyewitness reports collected by telephone calls during the day after the earthquake are as follows: No tsunami was observed in Manzanillo Bay (report from Oceanographic Institute of the Navy). No tsunami along the coast of Jalisco (reports from Barra de Navidad and Melaque). No tsunami was observed in the Port of Lazaro Cardenas, Michoacan (report from the Captain of the Port). Lazaro Cardenas is on the southern end of the coast of Michoacan.

It was not possible any contact by telephone to villages along the southern segment of the coast of Colima, which is the segment of the coast facing the rupture area.

Notice that it was nighttime at the time of the earthquake. Therefore, It was difficult for eyewitness to observe sea level fluctuations that did not overpass the higher part of the beach, which is in the average 1 meter above the high tide level along the coast of Jalisco and north of Colima.

Our attention is now on the southern segment of the coast of Colima and on the northern segment of the coast of Michoacan. We hope to let you know any confirmation of tsunami reports on these areas in about 24 hours.

Solomon Tsunami

(e-mail from Lori Dengler, Department of Geology, Humboldt State University, Arcata, CA 95521, Jan. 22, 2003.)

This info is courtesy of James Goff in New Zealand.

This was on the Aussie radio:

"Clinic workers report two metre wave in Solomons.

"A powerful earthquake has shaken Solomon Islands, rattling buildings in the capital, Honiara. But officials say they have no immediate reports of damage or injury.

The quake--measured by scientists in France at 7.8 on the Richter scale--struck close to the Solomons and neighboring Papua New Guinea.

The U.S. Geological Survey said the quake was centered about 200 kilometres east-northeast of Papua New Guinea's Bougainville island.

In the Solomons, workers at a clinic on Makira island - near the main island of Guadalcanal - said a two metre wave was seen around the island but there was no major damage and residents sought safety on high ground.

(*from* 21/01/2003 05:25:08 | ABC Radio Australia News)

NZ Response to Solomon Islands Tsunami

(e-mail from Derek Goring, Coastal Hydrodynamics, National Institute of Water and Atmospheric Research, NIWA, P O Box 8602, Christchurch, New Zealand. Jan. 20, 2003)

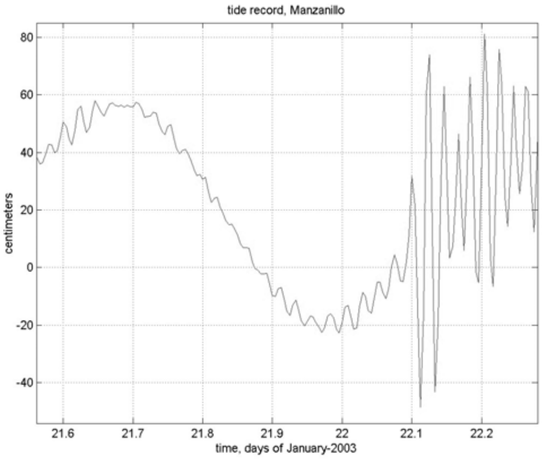
New Zealand Sea-Level Recorders report no response to Solomon Islands tsunami of 20 Jan 2003.

1-minute data recovered from sea-level recorders at Kaingaroa (Chatham Island), Moturiki Island (Bay of Plenty), Sumner Head (near Christchurch), Timaru, Dog Island (in Foveaux Strait), and Jackson Bay (South Westland) exhibit strong wave activity as a result of a large storm in the southern ocean, so no tsunami waves would be discernible, unless they were several decimeters in height.

Recorders at Kaikoura and Little Kaiteriteri (in Tasman Bay) are not affected by these waves, but they showed zero response to the Solomon Islands tsunami.

Manzanillo Tsunami

(e-mail from Lori Dengler, Department of Geology, Humboldt State University, Arcata, CA 95521, Jan. 22, 2003,)



Modesto Ortiz provided this image of the tsunami in Manzanillo and is pursuing reports of flooding.

THE ASTEROID TSUNAMI PROJECT AT LOS ALAMOS

by Jack G. Hills and M. Patrick Goda

(originally published in Science of Tsunami Hazards, v. 19, no. 1, p. 55-64, 2001
online at http://epubs.lanl.gov/tsunami/ts191.pdf; reprinted with permission)

A First Tsunami Symposium Contribution

Abstract

Tsunami may produce most of the economic damage in large asteroid impacts. The dust from large asteroid impacts would produce worldwide darkness lasting several months that may kill more people by mass starvation, especially in developing countries, than will tsunami, but the dust should not severely affect economic infrastructure. The tsunami may even kill more people in developed countries with large coastal populations, such as the United States, than the starvation resulting from the darkness. At Los Alamos we are in the middle of a systematic study of asteroid tsunami. The study is divided into three parts: A determination of those regions of Earth that are most susceptible to asteroid tsunami by simulating the effect of an asteroid impact into mid-ocean, the simulation of the formation of the initial crater and the waves generated by it by use of a SPH code, and a Monte Carlo study of the accumulative effects of many small impactors on some of the more strategically valuable regions that we find to be particularly vulnerable in the first part of this study. The first part of the study is well underway. Progress has been made on the other two. The critical factor in the third part of the study is to accurately determine the dispersion in the waves produced by the smaller impactors. Dispersion may greatly reduce the effectiveness of the smaller impactors at large distances from the impact point. We wish to understand this effect thoroughly before performing the Monte Carlo study. We have modeled the effect of mid-Atlantic and mid-Pacific impacts with craters 300 and 150 km in diameter. The larger of these craters would be produced by a KT-size impactor. The code has been progressively improved to eliminate problems at the domain boundaries, so it now runs until the tsunami inundation is finished. We find that tsunami generated by a large mid-Atlantic impactor will travel to the Appalachian mountains in the Eastern USA. We find that the larger of these two mid-Atlantic impacts would engulf the entire Florida Peninsula. The smaller one would inundate the eastern third of the peninsula while a tsunami passing through the Gulf of Cuba would inundate the west coast of Florida. Impacts at three different sites in the Pacific show the great vulnerability of Tokyo and its surroundings to asteroid tsunami.

Introduction

Asteroid and comet impacts cause a variety of damage: blastwaves, fires, craters and earthquakes on land and tsunami at sea (Hills and Goda, 1993, hereafter referred to as HG, and Hills and Goda, 1998a). If the impactor is more than 1 km in diameter, it ejects enough dust above the atmosphere to produce global darkening. Global darkening over a period of months could cause mass starvation in developing coun-tries. The work of HG showed that tsunami is the most sig-nificant form of damage for objects smaller than this thresh-old for global darkening.

HG studied the fragmentation and energy dispersal of asteroids in the atmosphere and found the fraction of their kinetic energy that remained when they hit ground. They found that common stony asteroids 200 meters in diameter and larger impact ground with most of their pre-atmospheric entry energy, which makes them very effective in producing tsunami. Asteroids of this size hit Earth about every 3000 to 5000 years, so the probability of one impacting in a given human lifetime is about 2-3%.

HG used this data on asteroid impact energies and the data on tsunami generated by nuclear explosives (Glasstone and Dolan, 1977) to estimate the tsunami height from asteroid impacts. Fig. 1 (from HG) shows the resulting full height of tsunami in deepwater (before they hit land) at 1000 miles from the impact point as a function of asteroid radius and impact velocity. (Heights above sea level are half these values.) We note that asteroid tsunami are not important unless the impactor has a radius of about 100 meters (diameter 200 meters). In the absence of wave dispersion, even an asteroid 200 meters in diameter impacting in mid-Atlantic would produce tsunami several meters high on

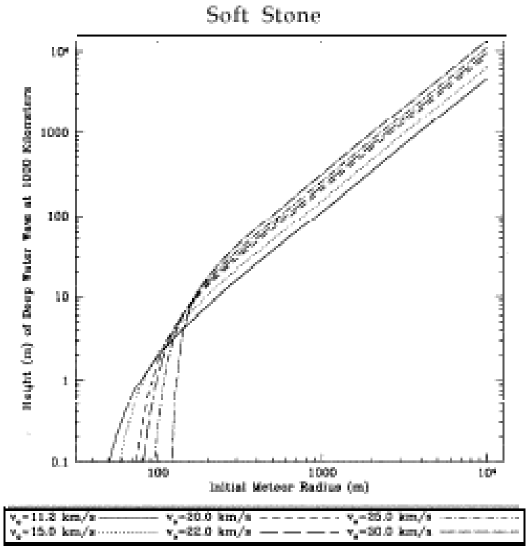


Figure 1: Full height of tsunami in deepwater at 1000 km from the impact site. (Wave height above sea level is half this value.) These values were obtained from the energy of impact of the asteroid allowing for atmospheric dissipation and scaled from experiments with nuclear explosives.

either side of the ocean. We see that an asteroid 400 meters in diameter produces waves more than 10 meters above sea level at 1000 km from the impact point. In the absence of wave dispersion an object this size falling in the mid-Atlantic would produce tsunami more than 3 meters high before they come ashore in North America and Europe as the heights drop off inversely with distance from the impact point. This height would rise several fold as it comes ashore. Dispersion would reduce the heights of these waves, but Fig. 1 shows the potential seriousness of these waves.

The smaller the asteroid, the smaller the crater it produces, and the shorter the wavelength of the tsunami. At short enough wavelengths, wave dispersion may significantly reduce the tsunami height at a large distance (many wavelengths) from the impact point. To calculate the effect of wave dispersion on tsunami height will require solution of the Navier-Stokes equation in modeling the propagation from the impact point to the shore. Dispersion is expected to be important if the wave propagation distance is several thousand kilometers.

At Los Alamos we are in the middle of a systematic study of tsunami generated by asteroid impacts. In the first part of this study we are finding the shorelines around the Earth that are most vulnerable to asteroid tsunami by using models in which a large crater is put in the middle of the ocean. These craters are large enough that the wavelength of the disturbance produced by the crater refill and its subsequent rebound is comparable to that of long-period tsunami generated by earthquakes, so we are confident that they can travel across an ocean basin without significant dispersion. In the second part of the study we are using a smooth-particle hydrodynamics (SPH) code to study the initial formation of the crater to find the size of the asteroid required to produce a given crater size. Thirdly, we are studying wave dispersion to better model how it reduces the wave heights in the shorter wavelength disturbances produced by smaller impactors. This is needed to allow us to study the accumulated effect of the numerous smaller impactors on strategic shorelines.

Runups from large impactors

The simulation of the runups by large impactors allows us to find areas of the Earth that are particularly sensitive to asteroid tsunami. Later, we will investigate how sensitive these same areas are to the multitude of many small impacts that occur between the large impacts.

The wavelengths of tsunami produced by larger asteroids are long enough (>100 km) that wave dispersion is not a problem for wave run-lengths comparable to the width of Earth's oceans. We can model these tsunami accurately using the shallow water (or long-wavelength) approximation. We initially used the SWAN code (Mader, 1988) for these calculations. This FORTRAN code has been tested extensively by comparing the runups predicted by the model against historical tsunami from earthquakes and landslides. As our first test case in our study, we modeled wave propagation resulting from a crater 150 kilometers across in the middle of the Atlantic Ocean (Hills and Mader, 1997). We estimate that such a crater would be produced by an asteroid about 5-6 kilometers in diameter. An object at least this large impacts the Earth every 10 million years. The code was used to find the wave height off the coast of North America. The code was then rerun with a piston at the eastern boundary having an amplitude comparable to that height. The run time of the code was limited by instabilities at the boundaries. However, the run time was sufficient to show that the wave travels all the way to the Appalachian Mountains in the upper two-thirds of the United States. One of the intriguing results of that simulation was the small amount of flooding in Florida. We found that most of the tsunami energy was being reflected back into the Atlantic by the gradual continental shelf. When we had to terminate the calculations due to instabilities at the boundaries, we found that only the Miami area was flooded (due to tsunami funneling by its natural shipping channel). As we shall later show, the Florida Peninsula is badly flooded when the moddel is run for a longer time.

M. P. Goda rewrote the SWAN code in the computer language C and improved the graphics package for displaying tsunami runups. This SWIM (Shallow Water Inundation Model) code was tested against the original SWAN code to assure its accuracy. The boundary conditions were later improved to allow us to run the code for times much longer than permitted by SWAN. The new boundary conditions in effect advect the component of the wave that is parallel to the boundary out of the computational domain. This improvement allowed us to run SWIM for model times that are at least twice as long as the tsunami travel time across the major ocean basins. This new code will be ported to a massively parallel computer in the near future to allow runup and wave propagation calculations on a much finer grid than is practical with our current serial machines.

The first application of SWIM was to find the vulnerability of Europe to tsunami flooding from asteroid impacts (Hills and Goda, 1998b). Again, we took as the initial condition an impact crater 150 km in diameter in the middle of the Atlantic. This calculation was done before the code improvement allowed long running times, so again we used the code to find the height of the tsunami waves before they entered Europe and then restarted the calculations just before the tsunami came ashore using a piston of the same amplitude on the western boundary of the domain. This work showed the extreme vulnerability of the Iberian Peninsula to tsunami from impacts. Waves exceeding 100 meters in height were observed all along the Iberian Peninsula. This is a result of the paucity of protective continental shelf around the peninsula. The Atlantic coast of southern France also suffered severe flooding. The British Isle were much less affected because of the massive continental shelf surrounding them.

In the current paper we would like to report our early work using the improved SWIM code that allows much longer running times. This has allowed us to dispense with the use of the piston. We simply start with the initial crater and allow the computations to proceed until the elapsed time is at least twice the time required for tsunami to travel across the given ocean basin. We find that these long running times are necessary because reflection of tsunami waves off continents and island chains can cause noticeable enhancements in the tsunami runups in certain locales.

We made simulations with impact craters 150 km and 300 km in diameter in the Atlantic at (Long., Lat.) = (40 degrees W, 35 degrees N). We also performed simulations in the Pacific with these two sizes of craters. These simulations were done for three different impact points: (Long., Lat.) = (170 degrees W, 35 degrees N), (138.25 degrees W, 27.75 degrees N), and (169.75 degrees E, 28.75 degrees N). The Atlantic and Pacific impact sites are shown in Fig. 2. A crater 300 km in diameter would be produced by a KT size impactor about 10 km in diameter while the 150 km crater would be produced by an object with half that diameter. The probability of the larger impactor hitting in a given year is about one in 100 million while the probability of the smaller impactor hitting in a given year is about 1 in 10 million. In these simulations the ocean bathymetry is determined from ETOPO5 (from the U.S. Defense Mapping Agency). This product provides topography on a grid with resolution of 5 arc minutes.

Atlantic impacts

Fig. 3 shows the maximum wave height within the Atlantic ocean as the tsunami propagates away from the impact site. We note that some of the tsunami energy is funneled south along the western edge of the mid-Atlantic Ridge. There is also a tongue of high water that moves towards Florida. This is due to an absence of sea mounts in that direction to reflect back the energy. We also note the shoaling as the tsunami hits the continental shelf. This provides good protection for the northern most part of the United States and for the Atlantic providences of Canada. It also provides good protection for the British Isles and the European coast east of it. We also note the lack of protection by continental shelves in the southern Atlantic coast of France, the Iberian Peninsula, and the Atlantic coast of Africa.

The shoaling also slows down the tsunami as is evident in Fig. 4 which shows the tsunami travel time from the impact site. We note the slowing down of the tsunami off Florida and Georgia as the wave goes into the progressively shallower water. The situation is similar around the British Isles. But, there is no significant slowing down of the tsunami around the Iberian Peninsula and North Africa.

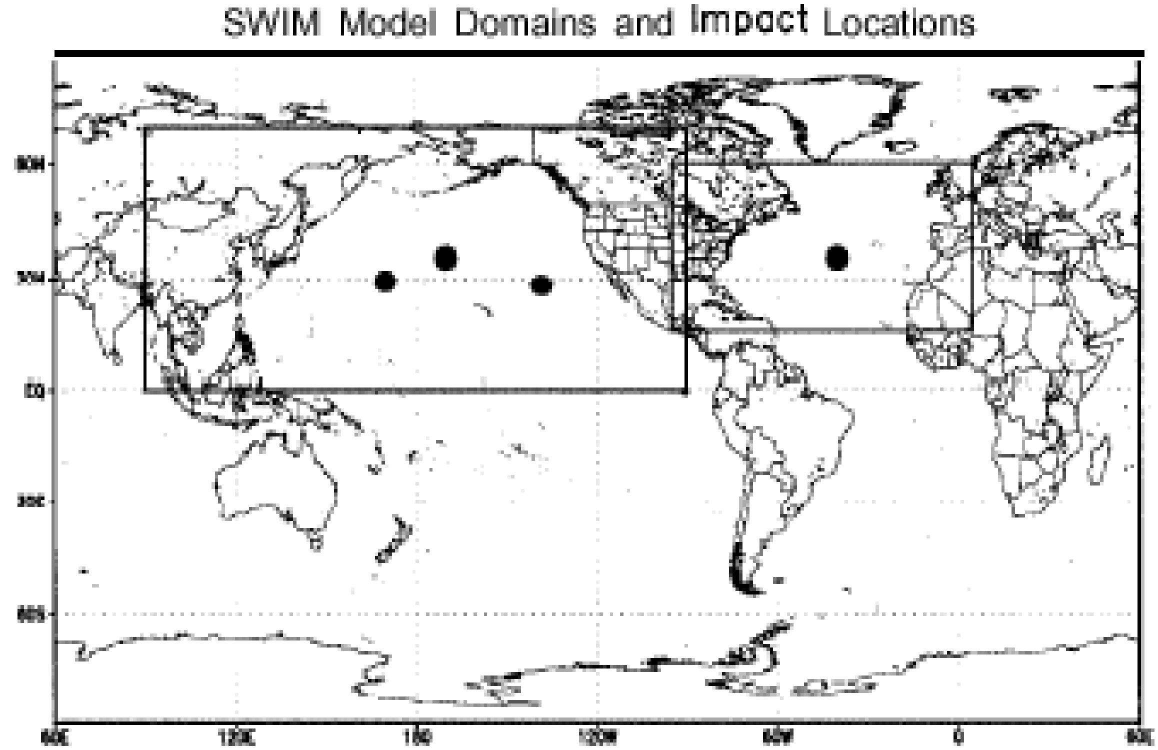


Figure 2. Positions of the four impact sites used in our models.

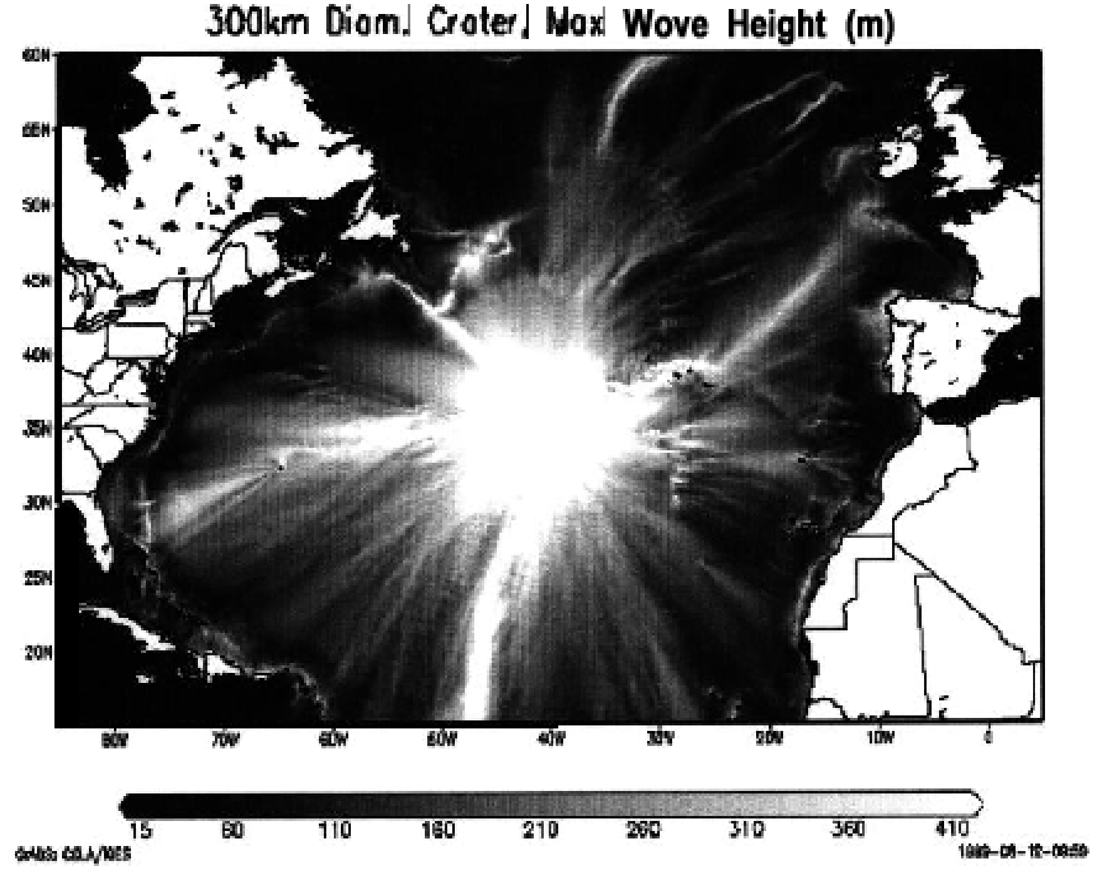


Figure 3. Maximum wave height above sea level reached at each point in the Atlantic Ocean as a result of the impactor. The grey scale gives the height in meters at each location.

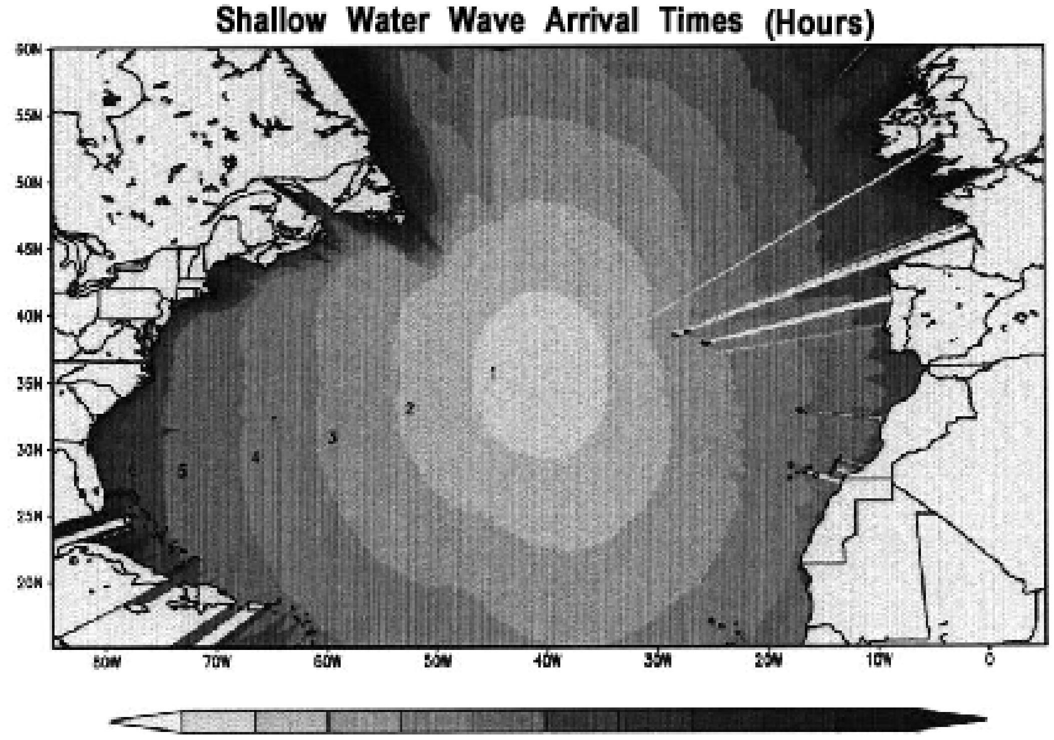


Figure 4. The grey scale shows the travel time between the impact site and each position in the Atlantic Ocean. We note the slowing down of the wave as it enters the continental shelf.

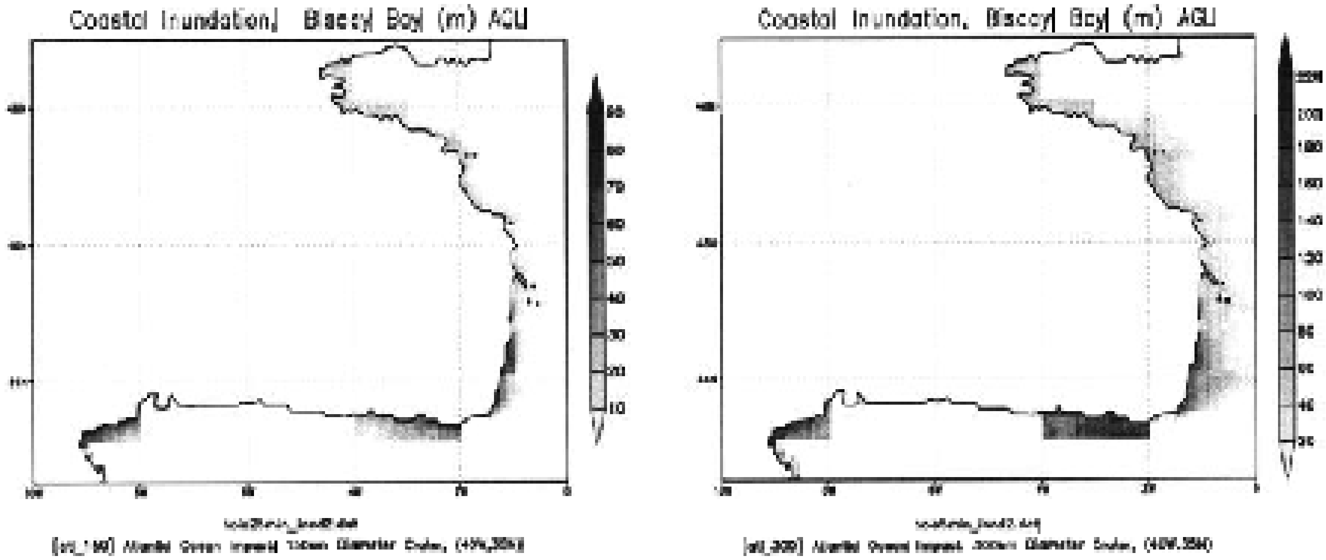


Figure 5. The depth of inundation along the Atlantic coast of France as a result of the formation of a 150 km and 30 km impact crater in the middle of the Atlantic Ocean. The grey scale gives the maximum local flood depth in meters above mean ground level.

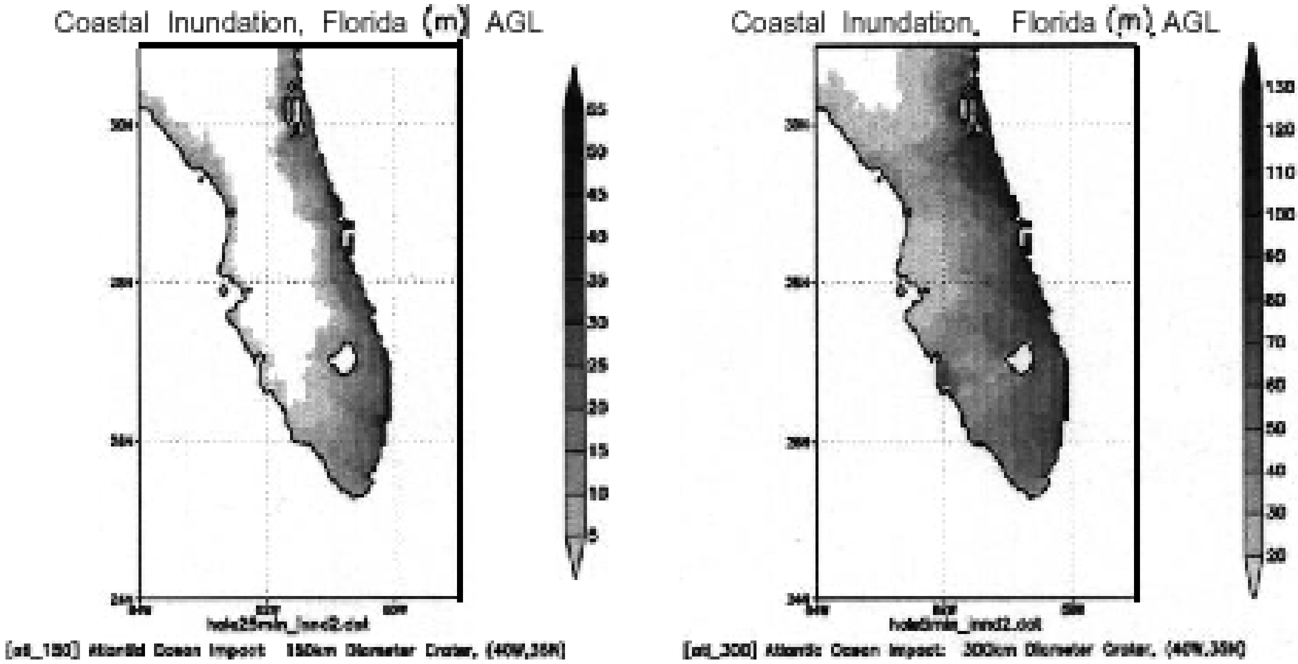


Figure 6. The depth of inundation in Florida due to the formation of a 150 km and 300 dkm diameter impact crater at the location shown in Fig. 2. The maximum flood depth shown in the figure is given in meters above the local ground level.

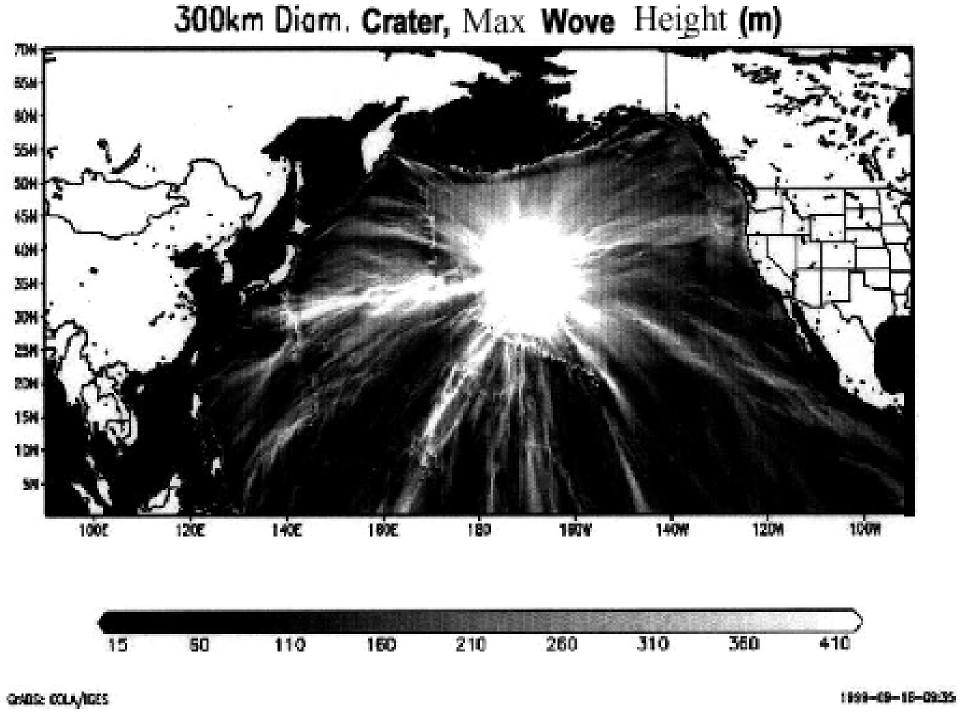


Figure 7. Maximum wave height above sea level in the Pacific due to the formation of an impact crater 300 km in diameter at the northern most of the three Pacific impact sites shown in Fig. 2.

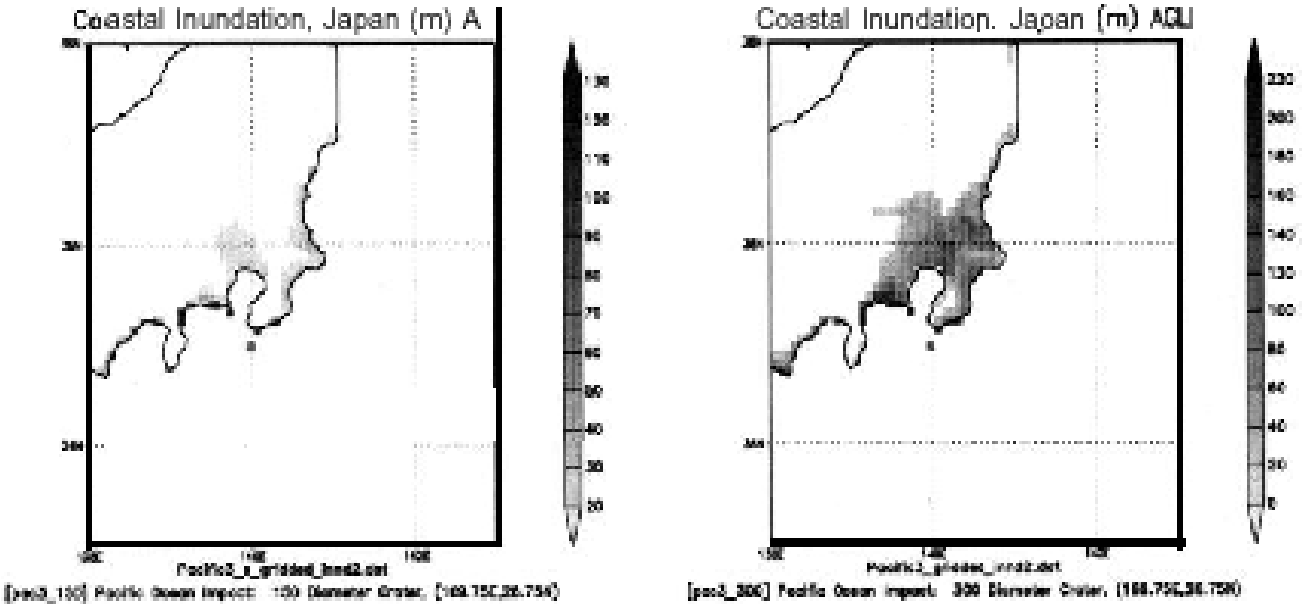


Figure 8. The maximum inundation depth in Japan due to the formation of an impact crater at the westernmost of the three Pacific impact sites shown in Fig. 2. This is shown for impact craters 150 and 300 in diameter. The depth is given as meters above local ground level. Note the extreme flooding of Tokyo and its vicinity.

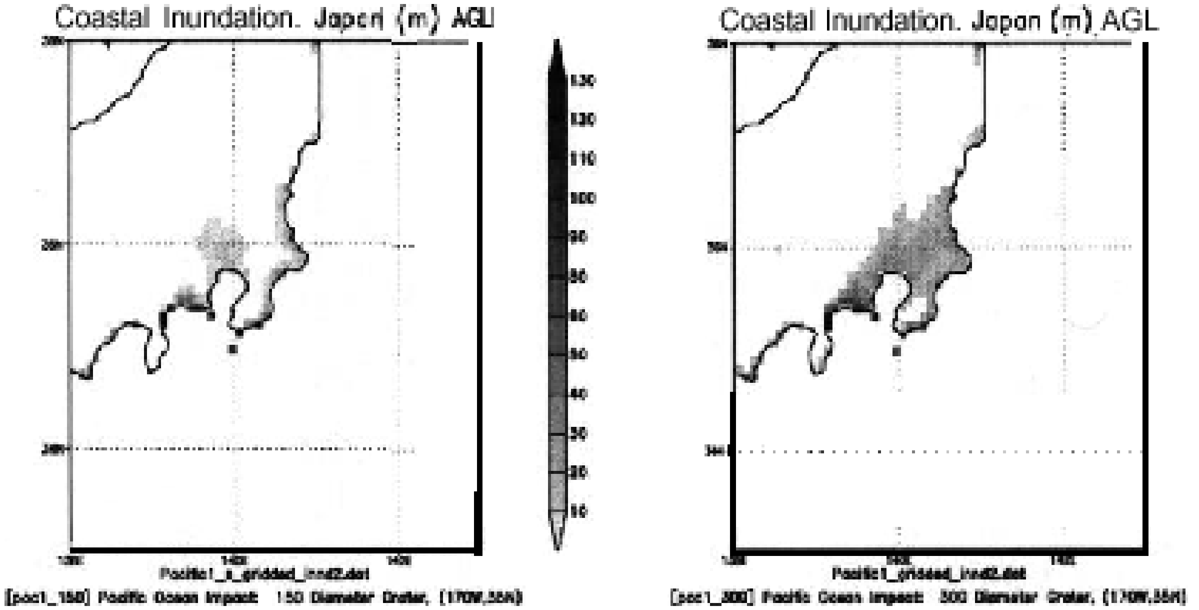


Figure 9. Same as Fig. 8 except it is due to an impact at the northernmost of the three Pacific sites shown in Fig. 2.

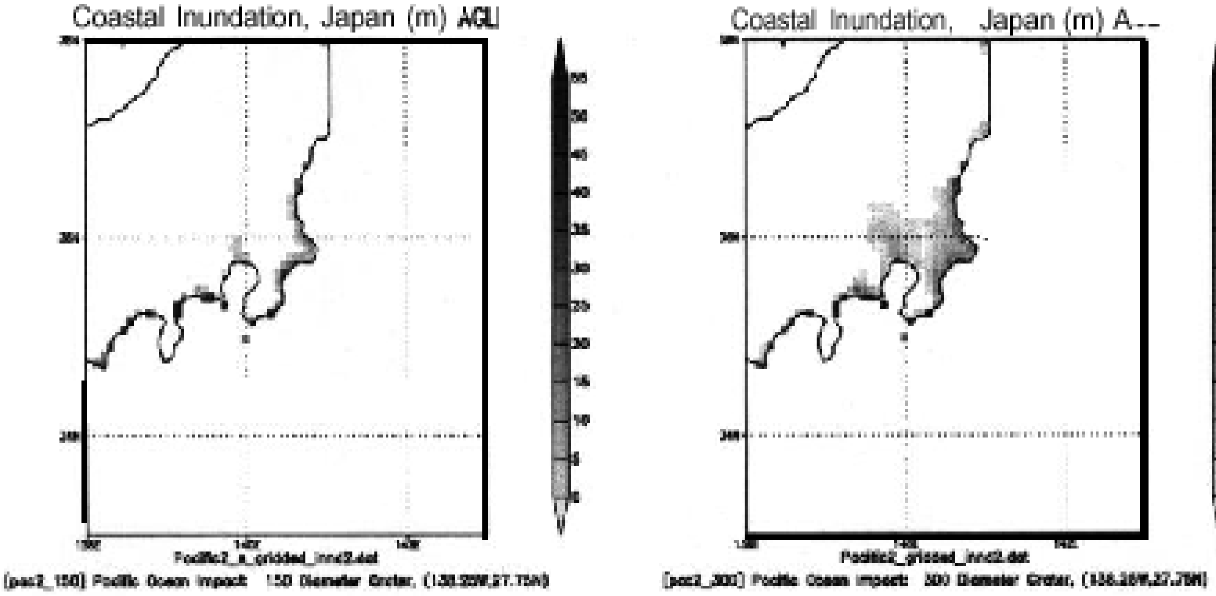


Figure 10. Same as Fig. 8 except it is due to an impact at the easternmost of the three Pacific sites shown in Fig. 2.

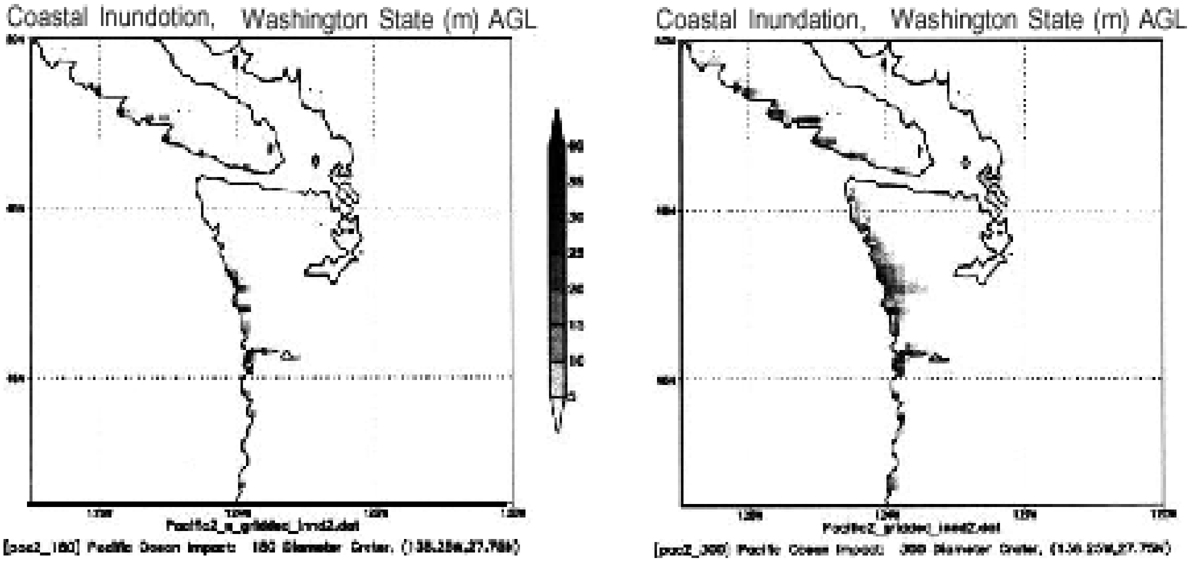


Figure 11. The maximum inundation on the Pacific Northwest coast of the United States due to an impact at the easternmost of the three impact sites in the Pacific. The plot shows the maximum depth of flooding above local ground level at each point for impact craters 300 and 150 km in diameter.

As we might guess from the previous two plots, the most significant flooding in Europe occurred along the south Atlantic coast of France and the Iberian Peninsula. Fig. 5 shows the depth of inundation along the Atlantic coast of France. The depth is shown in meters above local ground level for the simulations with craters 150 and 300 kilometers in diameter. The depth of inundation in France is not as great as it is along the Iberian Peninsula where the depth reaches over 200 meters for the larger crater and 100 meters for the smaller one, but the distance the flood moves inland in France is much greater due to the lack of mountains to contain it.

The damage is greater in North America than in Europe. The major difference between the results of the new simulations and that of the earlier one is the degree of flooding of the Florida Peninsula. Fig. 6 shows the maximum flooding produced by a crater 150 km in diameter and one 300 km in diameter. The figures show the maximum depth of inundation above local ground level at each point on the peninsula. We find much more profound flooding when we are able to run the code for a much longer time than the maximum possible in Hills and Mader (1998). The larger crater causes all of Florida to be inundated while the smaller one causes the eastern third to be inundated with additional flooding occurring on the west coast due to a tsunami wave passing through the straits between Florida and Cuba. The depth of inundation of the east coast exceeds 100 meters in some places for the larger crater.

We find that two factors are responsible for this late-stage flooding in Florida: The considerable slowing down of the tsunami as it enters the shallows off Florida causes a mesa of water to slowly build up on this shelf. Then a second tsunami wave reflects off the Bahamas chain and piles up on top of the now much deeper water left by the passage of the first tsunami wave. When this mesa of water collapses, it produces the Florida flooding.

Pacific Impacts

Fig. 7 shows the highest water reached as the tsunami travels away from the centermost of the three impact sites in the Pacific for a 300 km diameter crater. We see the significant protection afforded by the Aleutian Islands and the continental shelf off Asia. China and most of mainland Asia is relatively protected by the extensive continental shelf. Japan has no significant continental shelf, so the tsunami slams directly into it. A similar situation occurs along the west coast of the United States. The west coast is much more prone to tsunami flood than mainland Asia.

The plains around Tokyo are particularly prone to tsunami flooding. Figs. 8-10 show the depth of tsunami flooding in the vicinity of Tokyo, Japan from each of the three impact sites. Each figure shows the results for a crater 150 and 300 km in diameter. We note that the tsunami flood inundates Tokyo and its vicinity when the impact occurs at any one of the three impact sites. Tokyo appears to be especially sensitive to tsunami from nearly any impact site in the Pacific.

The runup simulations for the west coast of the United States do not look as dramatic as for Japan, principally because the coastal mountains restrict the flood to a narrow zone around the coast. However, many major cities are in this narrow coastal band. Fig. 11 shows the depth of inundation in the Pacific Northwest for the eastern most of the three Pacific impact sites. This is shown for the two different crater sizes. The tsunami tends to go up to the coastal mountains. We note the penetration of the tsunami up some of the major river valleys in this region. The apparent tranquil state in Seattle may be due to numerical limitations. The grid resolution may not be good enough to accurately model the passage of the tsunami wave through the straits between Vancouver Island and Washington State.

In the future we will improve the resolution by moving onto a 2 minute grid. This will be increased to 1 minute resolution when this data becomes available. This will require the use of a massively parallel computer, which we have available at Los Alamos.

Concluding remarks

It is difficult to imagine trying to manage by normal civil defense procedures the catastrophes produced by asteroid impacts because of the large scale of the damage and shore timescales involved. It would be far better to detect these objects well before they impact Earth. This will allow much more time for response. There should be a civil defense response to the degree it is feasible. There also should be an active defense to assure that these larger impactors never hit the ground. As we see from the presentation by Johndale Solem at this conference (Solem, 1999), such defense is possible. It should be implemented.

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OPINION

e-mail from Art Botterell, Cal-EPI, August 22, 2002 (reprinted with permission)

As you've doubtless found by now, there's hardly a telecommunications technology in existence around which some enterprise hasn't built a warning system. But the effectiveness of a system may have as much to do with its audience as with its technology. Not all technologies are perceived in the same way by their audiences. Nor are all audiences the same.

(For example, here in the U.S., both telephone and e-mail are used heavily for advertising and solicitations. This threatens to reduce the perceived credibility of alerts received over these channels. It's also led to installation of various call-blocking and spam-filtering schemes, some of which seem to have reduced the effectiveness of alerting systems based on those technologies.)

Also, it's important to remember that warning systems don't work alone. The sociologists remind us of the obvious: most people don't act on the first warning message they receive. Instead, they seek corroboration from multiple sources. If a warning over one channel isn't confirmed over several others, response to that warning will suffer... as will the future credibility of the channel. So the problem isn't finding a single "magic bullet" alerting technology nearly so much as it is making sure that the same message is delivered in the same period of time over multiple systems.

(Plug: This is where California's EDIS system [http://www.edis.ca.gov] and the developmental Common Alerting Protocol [http://www.incident.com] come in...not so much as direct channels of delivery, but as tools for coordination across multiple media. Addendum: And all that's over and above the obvious technical reliability risk of putting all one's warnings in one basket.)

Finally, the continuous change in telecommunications technology means that by the time any particular technology is deployed, a newer and arguably better one is already in the pipeline. So it's important not just to embrace a technology, but to establish an ongoing overarching process by which new tools can be brought into the warning framework, and obsolete ones retired, without creating unnecessary disruption or uncertainty for warning producers and consumers.

ESTIMATES OF THE REGIONAL AND GLOBAL FREQUENCY OF TSUNAMIS (ESPECIALLY GIANT TSUNAMIS)

from: http://www.nerc-bas.ac.uk/tsunami-risks/html/Phy11Freq.htm

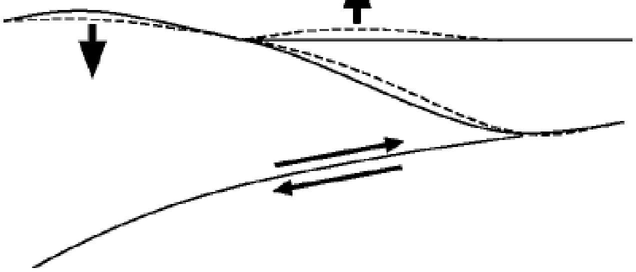
(underlined phrases are links on the website)

The variety of tsunami sources, together with differences in their frequency-magnitude characteristics and geographical distributions, greatly complicates the task of evaluating their global or regional frequency-magnitude distributions. A number of cautionary points need to be borne in mind:

1. Earthquake-generated tsunamis are the most common and dominate the historical records and compilations such as the NGDC catalogue on which the Risk Atlas is based. However, the upper size limit on earthquake generated tsunamis is well-defined and the largest such events (such as the 1960 Chile and 1964 Alaska tsunamis) are most probably represented in the historical records. Furthermore, the large normal-fault, reverse-fault and especially subduction zone thrust fault earthquakes which produce these tsunamis have a well-defined spatial distribution. Most have occurred around the Pacific Rim and in Indonesia, with smaller concentrations in the Mediterranean region and in the Caribbean, with the result that these regions have experienced most historical tsunamis. However, because of the maximum magnitude cutoff of tsunami earthquakes, this does not mean that there is not a substantial tsunami hazard in other regions due to larger but less frequent tsunamis, potentially underrepresented in the historical record, due to other mechanisms. This is best illustrated by consideration of the tsunami hazard in the North Atlantic region.

2. An important regional variation, even between regions with high levels of seismic activity, results from differences in the fault types.

Generation of tsunami at subduction zones



Most notably, whereas most of the Pacific Rim is a region of high tsunami hazard due to the occurrence just offshore of large subduction zone thrust faults, the strike-slip plate boundary along the coast of California does not produce many major tsunamis because the dominant faults are characterized by strike-slip motion. The only major local earthquake-generated tsunamis are produced by thrust faults in the Coast Ranges west of Los Angeles.

3. There is some evidence for other regional variations in the efficiency of earthquakes as tsunami sources, in the Pacific region in particular. Analysis of 20th Century Pacific Ocean tsunamis by V.K. Gusiakov (unpublished, but see http://omzg.sscc.ru/tsulab/ website for progress on the catalogue concerned) suggests that certain regions are characterized by more efficient tsunamigenic earthquakes. These include Central America, parts of South America including Chile, the Alaska-Aleutian arc, southern Japan and Indonesia. Other regions, in particular oceanic island arcs such as the Mariana arc and the Tonga-Kermadec arc, rarely produce major tsunamis even though they do produce large subduction zone earthquakes. In part this variation reflects the regional variation in the distribution of tsunami earthquakes. Gusiakov has suggested that the variation also reflects the distribution of thick sedimentary sequences in subduction zones, which are implicated in large near-surface coseismic movements with relatively little release of seismic energy (see Causes--Earthquakes for further discussion). Essentially, Gusiakov argues that earthquakes in the regions of more efficient tsunami generation share, to a lesser extent, the characteristics of tsunami earthquakes.

4. The distribution of tsunamis due to stratovolcano lateral collapses partly parallels that of earthquake-generated tsunamis, because this type of volcano is formed by volcanic activity above subduction zones. However, on most continental margin subduction zones (Peru-Chile, Mexico, Cascadia, eastern Alaska, Kamchatka, Sumatra, for example) the volcanoes are well inland and the tsunami hazard due to these is low, although non-zero. Mudflows, debris avalanches and pyroclastic flows from such volcanoes may reach inlets and enclosed bodies of water, and generate local tsunamis. In contrast, in regions such as the Aleutians, Kuriles, Bonin Islands, eastern Indonesia and most of the south west Pacific, and the eastern Caribbean, the volcanoes form islands or are submarine, and in these situations lateral collapses and a wide variety of volcanic eruptions can generate tsunamis. Some of these may be very large, although most are likely to be comparable to those which occur in the historic record.

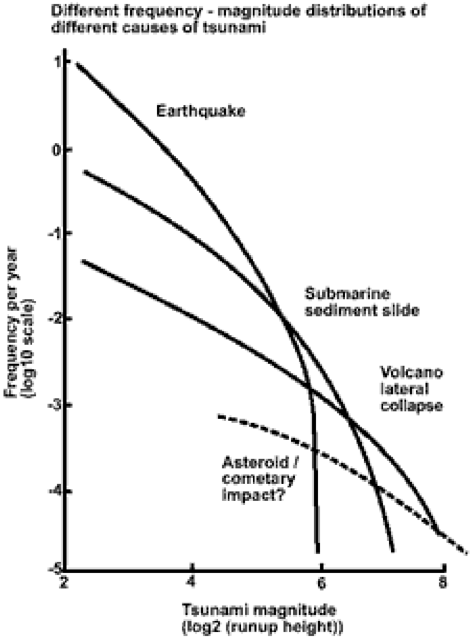
5. In contrast, the distribution of oceanic island lateral collapses follows that of true oceanic island volcanoes, which rather than being located on plate boundaries are mainly found above mantle plumes or "hot spots". Notable groups of such islands include the Hawaiian islands in the Pacific, the Comores and Reunion in the Indian Ocean and the Canaries, Azores, and Cape Verde Islands in the north-

ern and central Atlantic. No historical examples of such collapses exist and the number of tsunami deposits associated with them (even controversially) is very low. Estimates of the frequency of these events are based upon the occurrence and ages of lateral collapse scars on the islands themselves; of debris avalanches offshore; and of giant turbidite deposits associated with the debris avalanches. About 20 collapses occur in every million years in the Hawaiian Islands, and 10 or more per million years in the Canary Islands. Other archipelagoes have not yet been studied in sufficient detail to establish rates, but a global average might be one per 20,000 years. Although this frequency is low, the tsunamis produced in these events are likely to be far larger than any in the historic record. Furthermore, it is possible that environmental factors and/or random chance mean that the present-day oceanic island collapse hazard is much higher than average. Furthermore, the large number of active and potentially unstable volcanic islands in the Atlantic Ocean may mean that oceanic island lateral collapses form a major component of the tsunami hazard in this important region.

6. Fjord-type tsunamis, produced by rockfalls and landslides from steep fjord walls, are for obvious reasons restricted to a number of specific areas: Chile, Alaska, New Zealand and Norway. Other localized tsunamis due to (for example) delta front sediment landslides, rockfalls into reservoirs and so on are less common but much more widely distributed.

7. Large-scale submarine landslides, although they also occur on the trench slopes above subduction zones, are a particularly important component of the tsunami hazard offshore from the mouths of major rivers (such as the St. Lawrence river, Mississippi, Amazon, Indus and Ganges) and along passive continental margins such as those along most of the Atlantic margins outside the Caribbean. In these regions thick sequences of unstable sediment may accumulate for long periods and then be disturbed by one of the infrequent major earthquakes (as in the case of the 1929 Grand Banks tsunami) or by environmental factors to produce a large or giant tsunami. The result will be a frequency magnitude distribution of tsunamis in these regions that is very different from that of the Pacific Rim. Sedimentological evidence, largely from deep-sea drilling and coring, indicates that the frequency of the largest of these events in, for example, the North Atlantic, may be of the order of 20 to 100 per million years, with smaller events being more common, but this long-term average may be largely meaningless in view of the potential for environmental controls on these events (see Future Directions in Tsunami research).

8. Plotting of the distribution of meteors and of small meteorites which explode in the upper atmosphere in fireballs recorded by, amongst others, early warning satellites (Tagliaferri et al., 1994) has confirmed the inference from astrophysical arguments that the distribution of impacts over the surface of the Earth should be essentially random. This is in strong contrast to the distribution of impact craters, which is controlled largely by variations in the age of different parts of the continental crust: older regions have more impact craters. As a result, the impact-generated tsunami hazard will vary largely with the size of ocean: about 35% of all impact-generated tsunami will affect the Pacific Ocean since it occupies about 35% of the Earth's surface, for example. However, many of these impacts will be far out to sea and waves from smaller impacts in particular may largely dissipate before they reach major coastal population centers. In contrast, an impact in the Caribbean or Mediterranean is less probable but is more likely to cause catastrophic damage to an immediately-adjacent coastline. The central problems in assessing the tsunami hazard associated with impacts remains, however, the prediction of the efficiency of generation and propagation of these tsunamis (see Hills et al., 1994, for a pessimistic view) and the assessment of the overall probability of impacts of different sizes. This is based upon estimates of cratering rates on the Moon and other planets, estimates of the numbers and sizes of asteroids, and so on (see the book edited by Gehrels, 1994 for a recent overview of these problems).



With all these caveats and cautions taken into account, however, it is nonetheless useful to consider frequency-magnitude plots for historical tsunamis in different regions and an order-of-magnitude plot that considers the distribution of events larger than those represented in the historical record, due to different tsunami source mechanisms and based upon the various geological and other data sets discussed above. This diagram indicates that, whilst at low magnitudes (below tsunami magnitude = 6) the commonest cause of tsunamis is earthquakes, at higher magnitudes different mechanisms are predicted to take over, in succession: submarine landslides, volcano lateral collapses and, at the highest magnitudes, impacts.

An important corollary of this is that whilst the Pacific

Rim, Caribbean and Mediterranean are most at risk from the small, frequent earthquake-generated tsunamis, the pattern changes for the distribution of risk from larger, less frequent tsunamis in the magnitude range of 7 and above. The level of risk from events in the high magnitude range may be as high in the Atlantic Ocean as in the Pacific, particularly bearing in mind the much lower level of preparedness along the Atlantic coasts as compared to the Pacific (see Tsunami Mitigation).

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FEMA'S MULTIHAZARD MAPPING INITIATIVE ON-LINE ACCESS TO NATURAL HAZARDS AND SUPPORTING DATA

by Michael Buckley

Federal Insurance and Mitigation Administration (FEMA)

from: Natural Hazards Observer, v. 27, no. 2, November 2002, p. 10-11

Geographic information systems (GIS) are an important tool in land-use planning, hazard mitigation, preparedness, and response to natural hazards events. In growing recognition of their importance in efforts to reduce the impacts of natural hazards, amendments to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) in 2000 required the Federal Emergency Management Agency (FEMA), in consultation with states, local governments, and appropriate federal agencies, to develop multihazard advisory maps accessible to at least five states (see the *Natural Hazards Observer*, v. 35, no. 3, p. 8).

A multihazard advisory map is a map "on which hazard data concerning each type of natural disaster is identified simultaneously for the purpose of showing areas of hazard overlap." The Stafford Act mandated that the map system be practicable, cost-effective, and use the most efficient technology available. The maps are to be made available to appropriate state and local governments to inform the general public about hazards and to support mitigation activities and a range of public uses. For instance, a local official may need to plan countywide evacuation routes or develop land-use zoning maps. Knowing the historical overlap of events such as floods, hurricanes, earthquakes, and severe winds, for example, would be an important factor in the public policy process.

From this concept, FEMA's Federal Insurance and Mitigation Administration (FIMA) developed the Multihazard Mapping Initiative (MMI) to:

* Foster the exchange of geospatial hazards data;

* Increase hazards awareness;

* Encourage data providers to establish standards-based services that facilitate distribution of data for the creation of multihazard maps;

* Promote the concept of "E-government" and coordinate with such projects as the Geospatial One-Stop, which pro-vides standards and models for geospatial framework data, and the U.S. Geological Survey's National Map Geologic Database;

* Make FEMA spatial data holdings available as a web map service; and

* Allow FEMA easy access to outside spatial data critical to its daily operations.

To achieve these goals, the MMI included the development of a public map server and an internal FEMA MMI development site.

The Public Site

The public access site at *http://www.HazardMaps.gov* is a web-based collection of natural hazards maps and supporting data.

There are three main components to the MMI:

Web Atlas. This on-line, interactive mapping system enables users to turn multiple hazards and base map layers on and off, zoom to street level, and navigate around the U.S. with an easy-to-use interface. Users can create and save custom map views. Use of the atlas requires no plug-ins or downloads.

Data Exchange. This feature provides an on-line center for hazards and other data exchange, including free data and complete descriptions of the content, quality, condition, and other characteristics of nearly every database in the system.

Data Upload. Users can upload data to the MMI central multi-hazard data repository for access by others. In addition, uploaded data can be nominated for display on the Web Atlas.

The public access site establishes a framework of interoperable services that illustrates the advantages of using products and standards with Open GIS Consortium (OGC) interfaces to access, merge, and visualize spatial information across federal, state, and local agencies and with other organizations supporting mitigation efforts. For instance, a user can access the site from an office desktop through a web browser and display multiple datasets from numerous locations on a single map.

In the first three months of operation, the site received over 250,000 hits from 65,000 visitors. FEMA plans to extend the interoperable capabilities and data holdings of the site in the near future.

MMI Development Site

The MMI also established a parallel development site for continuing development and testing with full interoperability. This site grew out of a multi-participant demonstration project in conjunction with the OGC. The project was designed to establish a standards-based framework of interoperable services to illustrate the advantages of using products with OGC interfaces to access, integrate, and depict critical spatial information in support of FEMA multi-hazard mitigation, response, and recovery functions. By implementing these services, we demonstrated their value to federal, state, and local agencies as well as other organizations supporting mitigation efforts.

The MMI is based on shared agreements governing essential geospatial concepts implemented through communications and message protocols, information models, software interfaces, data formats, and policy. Built on open source technology and open GIS standards, the web map server allows the user to access and share any type of spatial data located worldwide. The MMI also established FEMA's node on the Federal Geographic Data Committee Clearinghouse.

Conclusions

FEMA is planning additional work to increase interoperability on the public access site. Also, we would like to work with other federal, state, and local agencies to implement a system for data exchange in which the information resides on an agency's own server, but is accessible through interoperable standards and technology.

Many within FEMA see the MMI as an impetus to coordinate web offerings within the agency and to streamline many of the day-to-day mapping needs of FEMA and the larger hazards community. The goal is to make sure that FEMA initiatives are not simply warehoused and do not become isolated information repositories unable to integrate or communicate with one another. We are now one step closer to providing a fully interoperable platform that can extend the bounds of data and accessibility.

For more information on the Multihazard Mapping Initiative, contact Scott McAfee, FEMA, 500 C Street SW, Washington, DC 20472; (202) 646-3317; e-mail: scott.mcafee@fema.gov; or Anne Flowers, FEMA, (202) 646-2748; anne.flowers@fema.gov. FEMA invites comments on the site; they can be e-mailed to mmi@hdm.com.

Additional information is also available at *http://www.opengis.org*

HAZARD MITIGATION NEWS

Red is High; Blue is Low--Where Do You Live?

More than 75 million Americans in 39 states live in cities with moderate to high risk from earthquakes. U.S. Geological Survey (USGS) scientists and partners have revised and updated the national seismic hazard maps that provide information essential to seismic design provisions of building codes in the United States. Engineers and planners now have updated information to ensure that buildings, bridges, highways, and utilities are built or rebuilt to meet modern seismic design provisions and are better able to withstand earthquakes.

The updated, color-coded versions of the maps (red is high; blue is low) are available at http://geohazards.cr.usgs.gov/eq/. In the coming weeks, other features on the website will also be updated to match the revised maps, including ground-shaking levels for 150,000 sites, the seismicity catalogs and fault parameters used to create updated maps, customizable hazard mapping, and the creation of earthquake scenarios for a given location.

from: Disaster Research 381, January 10, 2003

Improvements Urged in National Hazard Warning System, Risk Communication

Randy Showstack reported in the 12 November 2002 issue of *Eos* that the U.S. needs an adequate national warning system, as discussed at the October 31, 2002 meeting of the U.S. National Academies of Science forum in Washington, D.C. Contact TsuInfo Alert for a copy of this article (see page 2 for ordering information).

Tsunami Coordination Meeting

The NWS Western, Alaska, and Pacific Regions will hold a Tsunami Coordination Meeting in Hawaii, February 2003. The meeting will include the WC/Alaska Tsunami Warning Center, the Pacific Tsunami Warning Center, and ITIC along with Warning Coordination Meteorologists from the three regions. At least one day will be devoted to emergency managers from the three regions and British Columbia.

from: http://www.pmel.noaa.gov/tsunami-hazard/PAWG_REPORT_FY2002.pdf

Thurman Receives Awards

Barbara Thurman, who directs Washington's Emergency Management Division's public eduation outreach programs, received three International Association of Emergency Manager media awards for the campaign plan, posters and materials for the state's 2002 Disaster Preparedness Month program.

Good idea from B.C.

The British Columbia Provincial Emergency Program website (http://www.pep.bc.ca/local_government/local_ government.html) provides, in its *Local Authority Guidelines to Declaration of a State of Emergency*, a Pro Forma Declaration of a State of Local Emergency document to permit quick drafting of a declaration by a local emergency coordinator. The website also includes a complete manual (pdf) format, as well as the Declaration form, and the Delegation of Emergency Powers Matrix (MSWord format).

from: Emergency Responder, November-December 2002, p. 4

2002 WSSPC Policy Recommendations

WSSPC continues to fulfill its mission of developing, recommending and supporting seismic policies and programs throughout the western region. At the last WSSPC annual business meeting, held September 18, 2002 in Denver, the membership unanimously approved five new policy recommendations in the areas of tsunamis, partnerships and code adoption, fault definitions, fault setbacks and earthquake monitoring networks. Full text of all five recommendations is available on the WSSPC website at www.wsspc.org/publicpolicy/policyrecs/default.htm.

WSSPC Policy Recommendation 02-1, is "Improving tsunami warning systems and procedures for distant and local sources."

Distant tsunamis--WSSPC supports the efforts of the U.S. federal government to maintain the existing seismic network and tsunami detection devices in the open ocean in order to reduce false alarms from distant tsunamis and to more rapidly local potential tsunamigenic earthquakes with Pacific-wide effects.

Local tsunamis--WSSPC supports the ongoing efforts of the U.S. Federal government and coastal members of WSSPC in mapping the tsunami inundation zone, developing tsunami evacuation maps and educating the public about local tsunamis and the need to evacuate immediately after strong ground shaking stops.

from: EQ, Fall 2002, p. 4

Tsunami Session at the April, 2003 SSA Meeting

A special tsunami session will be held at the Seismological Society of America (SSA) meeting in San Juan, Puerto Rico April 30-May 4, 2003. The venue for the meeting is the Caribe Hilton near Old San Juan (http://www.caribehilton.com/). This SSA meeting commemorates the 100th anniversary of seismic instrumentation in Puerto Rico and the 100th anniversary of the University of Puerto Rico. The tsunami session is entitled "Seismological Tools for the Advancement of Tsunami Modeling and Warning" and is co-convened by Prof. Aurelio Mercado (amercado@uprm.edu) and Eric Geist (egeist@usgs.gov). Complete information about the meeting is available at http://civil.uprm.edu/ssa-2003/

Advances in seismic instrumentation and source parameterization algorithms have had a significant impact on tsunami warning and hazard assessment capabilities. Improved accuracy of event location, focal depth, and magnitude information has had a direct effect on the accuracy of tsunami warning systems. The increase in the amount and availability of near-real time seismological information makes possible novel rapid tsunami models that can predict the severity and extent of a tsunami after an earthquake. In addition, the development of new earthquake hazard models can be used to forecast tsunami hazards from offshore fault zones. This session will cover a broad range of seismological applications toward the advancement of tsunami science, including emerging tsunami warning systems in the Caribbean and how seismological information can best be integrated with tsunami measurements and modeling.

For more information about the session, contact:

Eric Geist & Aurelio Mercado
U.S. Geological Survey
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Video added to TsuInfo collection: *Tsunami Chasers*

Tsunami Chasers is the story of scientists (Costas Synolakis and team) who pursue our planet's most powerful and destructive waves. This video documents the team's study of the 1998 Papua New Guinea tsunami. It is a TLC Video produced by Beyond Productions for the Discovery Channel. 52 minutes.

Oregon's Natural Hazards Mitigation Manual,

by Falah Al-Mahan

The state of Oregon throughout its history has been the place of many natural disasters due to its special environment and geological factors. Because of these reasons, talking about disaster becomes a daily issue for many people. With these concerns in mind, the Oregon government conducted many research studies to find possible solutions or to reduce losses. As a result of these studies, two kinds of natural hazards mitigation manuals were developed. One was based on the environment and one was based on community.

Using disaster mitigation grants through FEMA, the Oregon Department of Land Conservation and Development in August of 2000 announced the availability of a new resource, the "Oregon Technical Resource Guide". This new planning tool is designed to help local governments strengthen the natural hazards element of their comprehensive land use plans by providing information on how to identify, plan for and implement programs to address floods, landslides, wildfire, seismic and coastal hazards. It is designed to be a useful tool for city clerks, planners, emergency managers, planning commissioners, elected officials and community residents. It provides information for communities to help implement both regulatory and non-regulatory programs to minimize the impact of natural hazards.

In addition to this technical tool, another disaster mitigation manual has been developed by the Oregon Emergency Management Officials to assist anyone providing disaster safety information to the public including emergency managers, meteorologists, teachers, disaster and fire educators, public affairs personnel, mitigation specialists, media personnel, and/or any other person in the severe-weather, earthquake, disaster, or communications communities. Believing that mitigation should start in the family home, planners provided family disaster preparedness in five easy steps that each family should follow:

1. **Discuss** the disasters most likely to happen in Oregon and their impact on your family's safety. Hazards in our area include home fires, severe winter weather and storms, earthquake, flooding, and hazardous materials threats.
2. **Train** all family members. Take first aid classes. Learn to use a fire extinguisher and how to shut off utilities. Do not take the chance that the only person who knows first aid or how to turn off the natural gas will be at home when needed.
3. **Assemble** your disaster supplies into a personal 72-hour emergency preparedness kit. This would include food, water, clothing and medications to last you at least 72 hours. You need a kit for each family member.
4. **Identify** in and out of state emergency names and numbers and provide copies to each family member. Post a copy near your phone and put copies in your 72-hour kit. When local phone service is out, family members can use their out of state contact to relay messages.
5. **Maintain** your readiness. Review your disaster preparedness plan with your family at least once a year. Identify what new training, equipment or supplies you may need. Conduct fire evacuation and earthquake "duck, cover and hold" drills with your family.

For more information, visit the following websites:
http://www.lcd.state.or.us/hazhtml/Guidehome.htm
http://www.lcd.state.or.us/hazapdfs/01_cpr.pdf
http://www.lcd.state.or.us/hazhtml/contents.htm
http://hazards.metro-region.org/mapoptix_hazards/adobe_docs/guide-main.pdf

Hawaiian Atlas Available

The Atlas of Natural Hazards in the Hawaiian Coastal Zone, by Charles H. Fletcher, III, Eric E. Grossman, Bruce M. Richmond, and Ann E. Gibbs, is available as U.S. Geological Survey Geologic Investigations Series I-2761. It's on the Internet at http://geopubs.wr.usgs.gov/i-map/i2761/

New Emergency Management Journal is Looking for Contributions

The Journal of Emergency Management (JEM), a new quarterly journal that covers a wide range of emergency situations, is considering papers for publication related to research, theory, and current issues in emergency management. Specifically, the journal is positioned as a vehicle for academics and practitioners to share field research. In addition to scientific studies and program descriptions, the editors will also consider letters to the editor, guest editorials, and book reviews.

JEM's goal is to provide original, relevant, and timely information from diverse sources, and to write and publish with absolute integrity. Individuals desiring to contribute should not hesitate to make topic-related inquiries, or ask about specific journal-based procedures for writing and submitting manuscripts. The editorial staff is pleased to reply to any inquiries received.

Electronic manuscript submission is preferred. Manuscripts should be between 1,500 and 2,500 words. They will be peer-reviewed. Send manuscripts to the Managing Editor, Journal of Emergency Management, 470 Boston Post Road, Weston, MA 02493; e-mail: donn_vaillancourt@pnpco.com. Complete and detailed manuscript guidelines are available as well. *from:* Disaster Research 382, January 24, 2003

Sign Up for PERI Electronic News

The Public Entity Risk Institute (PERI) will soon be sending out a regular electronic newsletter to keep interested folks current on new developments in risk management resources, products, and information available on PERI's web site. Sign up by visiting http://www. riskinstitute.org and clicking on "receive news and updates via e-mail."

from: Disaster Research 381, January 10, 2003

Disaster Safety Review. Vol. 1, No. 1 (Fall 2002). Free. Copies are available from the Institute for Business and Home Safety (IBHS), 4775 East Fowler Avenue, Tampa, FL 33617; (866) 657-4247; fax: (813) 286-9960; e-mail: creese@ibhs.org. A downloadable version can be found on the IBHS web site: http://www.ibhs.org/research_library/view.asp?id=322.

The inaugural issue of the IBHS quarterly technical journal *Disaster Safety Review* contains news, research, and articles pertaining to natural disaster safety. It was created by the organization to be a forum for communicating research and perspectives into new ways to build stronger, safer homes and businesses. Topics include "billion dollar thunderstorms," whether a market for mitigation exists, and wind-resistant retrofit testing.

from: Natural Hazards Observer, v. 27, no. 3

Confronting Catastrophe: A GIS Handbook. R.W. Greene. 2002. 160 pp. $14.95. To order the book, contact ESRI Press by calling (800) 447-9778 or by visiting their web site: http://www.esri.com/shop.

Geographic information system (GIS) technology is a practical tool that every community can use to plan for, respond to, and recover from major disasters, whether they are natural events such as hurricanes or human-caused incidents such as terrorist attacks. By giving responders and disaster managers a way to visually analyze each stage of a disaster and synthesize complex information sets, GIS permits swifter decision-making and clearer communication. *Confronting Catastrophe* guides readers through five stages of hazards management—identification and planning, mitigation, preparedness, response, and recovery—and demonstrates how GIS can be incorporated into each.

from: Natural Hazards Observer, v. 27, no. 3

The current edition of the EMSE 232 Disaster Newsletter, volume 3, no. 4, is now available online at http://www.seas.gwu.edu/~emse232/emse232jan2003.html.

FEMA update: *Proposed Changes to FEMA's Multi-hazard Mitigation Programs, Present Challenges*, by Dana Griffin. Available: The George Washington University; EMSE 232 - Crisis and Emergency Management Newsletter; Volume 3 - Number 3 (Fall 2002)http://www.seas.gwu.edu/~emse232/emse232dec2002.html

FEMA update: *FEMA's Higher Education Project Aims To Increase Access To Professional Development Through Educational Opportunities*, by Jeff Good. Available: The George Washington University; EMSE 232 - Crisis and Emergency Management Newsletter; Volume 3 - Number 3 (Fall 2002) http://www.seas.gwu.edu/%7Eemse232/emse232dec2002fem2.html

WEBSITES

Meteorite/Bolide Impact Tsunami Websites:

http://www1.tpgi.com.au/users/tps-seti/spacegd7.html
Tsunami from Asteroid/Comet Impacts

http://gsa.confex.com/gsa/2002AM/finalprogram/abstract_45027.htm

Strata at Moscow Landing, Alabama provide a dramatic record of the earthquake and tsunami generated by the Cretaceous-Tertiary (K/T) bolide impact at Chicxulub, Mexico
http://www.earth.rochester.edu/ees201/Larson/larsona2.html

Bolide impact theory
http://www.es.ucsc.edu/~asphaug/WardAsphaugTsunami.pdf

Asteroid impact tsunami: Probabilistic Hazard Assessment
http://palaeo.gly.bris.ac.uk/Palaeofiles/Triassic/bolide.htm

Bolide impacts
http://impact.arc.nasa.gov/related/biblio/

Asteroid and Comet Impact Hazard Bibliography (1992-2000)

Miscellaneous Websites

http://www.eriskcenter.org/education/confpapers/prima2002.html

Copies of workshop sessions, presentations, and papers from the Public Risk Management Association 2002 Annual Conference are available on- line.

from: Disaster Research 381, January 10, 2003

http://www.riskinstitute.org

Copies of papers and presentations from the Public Entity Risk Institute's (PERI) recent community emergency services symposium are available free and on-line, under the "symposium papers" section on PERI's web-site. Paper topics span a variety of themes.

from: Disaster Research 381, January 10, 2003

http://www.pep.bc.ca/hrva/hazard.html

The province of British Columbia, Canada has produced an on-line dynamic hazard, risk, and vulnerability assessment tool that may be of interest to communities wishing to conduct a risk assessment.

from: Disaster Research 381, January 10, 2003

https://disasterhelp.gov/portal/jhtml/index.jhtml

The Federal Emergency Management Agency launched a pilot version of an information portal designed to provide one-stop information for emergency preparedness and response information. The portal will support more than 4 million members of the first responder community firefighters, police officers and emergency medical technicians. It will pull together several systems, simplify services, and eliminate duplication.

from: Disaster Research 379, December 6, 2002

http://urban.nyu.edu/catastrophe/index.htm

A variety of reports and publications that may be of interest are listed at this web site--the urban catastrophic research page of the Taub Urban Research Center at New York University. The center explores issues affecting cities and metropolitan regions; issues reports and conducts forums with participants from government, business, nonprofit organizations, and the academic community.

from: Disaster Research 379, December 6, 2002

http://www.disabilitypreparedness.com/

The National Center on Emergency Preparedness for People with Disabilities (NCEP) web site is focused on ensuring that all individuals are included in the development of plans for protection from both natural and human-made emergencies. In almost all cases, emergency planning has not taken into consideration the communication, transportation, and medical needs of persons with disabilities and other special populations. The National Center on Emergency Planning for People with Disabilities, in cooperation with the Environmental Protection Agency, the Federal Emergency Management Agency, the American Red Cross, the National Organization on Disability, the Administration on Developmental Disabilities, and the Disability and Business Technical Assistance Centers, is working to assist those responsible for emergency planning and management for people with disabilities. The site includes training resources and related links.

from: Natural Hazards Observer, v. 27, no. 3

http://www.disabilityresources.org/DISASTER.html

The Disability Resources Monthly guide to resources on the Internet includes a section on disaster preparedness for people with disabilities that has a list of resources for disaster preparedness, emergency plans and procedures, fire safety, and other topics that impact the physically and mentally challenged during disasters.

from: Natural Hazards Observer, v. 27, no. 3

http://html.adrc.or.jp/dbs/trans2.asp?lang=en

The Asian Disaster Reduction Center (ADRC) offers an on-line glossary of natural disaster-related terms in English, French, Spanish, and Japanese. The glossary is intended to be an information sharing tool.

from: Disaster Research 382, January 24, 2003

CONFERENCES/TRAINING/CLASSES

April 30 - May 4, 2003

"Seismological Tools for the Advancement of Tsunami Modeling and Warning" Seismological Society of America meeting in San Juan, Puerto Rico. (see p. 20 for more info.)

November 4-7, 2003

GDIN 2003. Sponsor: Global Disaster Information Network (GDIN). Washington, DC. GDIN is an organization dedicated to improving the flow of information before and during natural disasters. Conference themes include: emergency telecommunications, disaster manager needs, the UN International Strategy on Disaster Reduction, information management (including homeland security), urban search and rescue, and many more. Information about abstract submission (due by February 28, 2003), chairing session presentations, and more is available from GDIN, 26128 Talamore Drive, South Riding, VA 20152; (202) 647-5070; e-mail: gdin2003@hotmail.com; http://www.gdin.org/.

from: Disaster Research 379, December 6, 2002

On-line GIS Course

Environmental Systems Research Institute (ESRI) is offering an on-line class in the spatial analysis of geohazards using ArcGIS as part of its virtual classroom. Geologic hazards loom all around us. As population growth forces more communities to expand into areas at risk from these ominous threats, concern increases about the danger that geohazards pose to people, property, and the environment. This course shows how GIS is the perfect tool for determining where geohazards are likely to occur and for assessing their potential impact on the human community. Participants work with ArcGIS software to analyze and map a variety of geohazards, including earthquakes, volcanoes, landslides, tsunamis, and floods. A better understanding of these events is the first step toward effective disaster planning.

Students should have a basic working knowledge of ArcGIS and general GIS concepts. Complete information may be found by clicking on "GIS Application Courses" at http://campus.esri.com/campus/catalog/index.cfm?CFID=4763764&CFTOKEN=11423518.

from: Disaster Research 381, January 10, 2003

Reader Request (Addressed to readers of Disaster Research):

The United Nations International Strategy for Disaster Reduction (ISDR) is interested in determining the "best" or most preferred literature regarding disaster mitigation/risk reduction. I would like to ask interested DR readers [and *TsuInfo Alert* readers] to send me the names of the two or three best references they have found on this subject.
Ms. Marie-Lou Darricau, United Nations, ISDR Secretariat, Palais des Nations, Room A-572, CH-1211 Geneva 10; darricau@un.org or http://www.unisdr.org.

EMERGENCY MANAGEMENT SCHOLARSHIPS

Joel Aggergaard Memorial Scholarship
Application deadline: May 30, 2003
http://www.wsema.org/newsinf.shtml

http://www.wsema.org/assets/pdfs/2002_01-00_aggergaard_scholarship.pdf

Joel Aggergaard began working for the Washington State Department of Emergency Management in the 1970's and served until his untimely death in 1996. He thoroughly enjoyed his career with Emergency Management, and his "heart" was with supporting local Emergency Management Programs. It may be necessary to be a local emergency manager to fully appreciate the enormous contribution Joel made to local programs during the years he worked with emergency management. If you have been stressed to the point there is not one additional free minute in your day, but you need to get an issue clarified with State Department of Emergency Management and it must be taken care of today …then… you will begin to understand. A phone call placed to Joel reached someone who was not only usually familiar with the issue but also very interested. The issues either became resolved or a commitment was made from Joel to follow-up for resolution.

Joel was commended for his extraordinary work with emergency management and named the "most helpful" state official by local, county and city emergency managers across Washington State. Joel assisted with countless floods, storms and local emergencies, and was a welcome addition to any activated Emergency Operating Center during a disaster.

Joel was also an avid supporter of youth and their activities. Because of his selfless support and commitment to local emergency management directors, WSEMA has chosen to provide an educational scholarship commemorating Joel in the hope that others who possess his worthy qualities and have a personal dedication to achievement may have expanded opportunities.

To download the application forms and get more information, go to second web site given above.

IAEM Scholarship Program

http://www.iaem.com/iaem_scholarships.html

The International Association of Emergency Managers has established the IAEM Scholarship Program to further the education of students studying the field of emergency management. The mission of the program is to assist the profession by developing students with the intellect and technical skills to advance and enhance emergency management. Application forms are available at http://www.iaem.com/scholarship_application.html. The deadline is mid-May. Check the web site for the exact date for 2003.

Conference Scholarships Available!

The Public Entity Risk Institute (PERI) and the Public Risk Mangement Association (PRIMA) are teaming up to provide scholarship funding for up to 60 people to attend the PRIMA Annual Conference in May 2003 in Las Vegas, Nevada (see http://www.colorado.edu/hazards/conf.html for full details).

The "Small Entity Scholarship" is aimed at providing staff and officials of smaller local governments, schools, and nonprofits with a valuable opportunity in risk management. Recipients receive a variety of benefits, including travel/accommodation funds and discounted registration.

The scholarship application deadline is February 22, 2003. Eligibility information and application may be obtained from PERI, 11350 Random Hills Road, Suite 210, Fairfax, VA 22030; (703) 352-1846; http://www.riskinstitute.org/news_article.asp?article_id=1015.

from: Disaster Research 381, January 10, 2003

CALENDAR OF TSUNAMI/EARTHQUAKE EVENTS AND ANNIVERSARIES

January 17, 1994 Northridge CA earthquake
http://www.scecdc.scec.org/northreq.html
http://geohazards.cr.usgs.gov/northridge/

January 17, 1995 Kobe, Japan earthquke
http://www.earthquake.org/kobe.html
http://www.agu.org/sci_soc/kobe.html

Jan. 23, 1812 New Madrid, MO earthquake (2 of 3)
Dec. 16, 1811 (1 of 3)
(See the Dec. 2002 *TsuInfo Alert* for more for information about the New Madrid quakes and seiches.)

Jan. 26, 1700 Cascadia subduction zone, WA earthquake and tsunami
http://www.geophys.washington.edu/SEIS/PNSN/HIST_CAT/STORIES/geology.html
http://www.geophys.washington.edu/SEIS/PNSN/HAZARDS/CASCADIA/historic_records.html

Feb. 7, 1812 New Madrid, MO earthquake (3 of 3)

Feb. 28, 2001 Nisqually earthquake, Olympia, WA

March 3,1933 Sanriku, Japan, earthquake

March 10, 1933 Long Beach, CA. earthquake
http://www.scecdc.scec.org/longbeac.html
http://nisee.berkeley.edu/long_beach/long_beach.html
(See the quote on p. 25.)

March 27, 1964 Alaska earthquake
damage photos: http://neic.usgs.gov/neis/eqlists/USA/1964_03_28_pics.html
seismograms: http://neic.usgs.gov/neis/eqlists/USA/1964_03_28_seismogram.html
earthquake and tsunami: http://www.wcatwc.gov/64quake.htm

Infrequently Asked Questions

compiled by Lee Walkling

Which earthquake is responsible for safe California school buildings?

The 1933 Long Beach (California) earthquake. "As a direct result of the structural failures of unreinforced masonry schools, earthquake-resistant design and construction were mandated for public schools: K-12 and community colleges. This was due largely to the efforts of California Assembly Member, Charles Field and the law, known as the Field Act was passed on April 10, 1933. It and its subsequent revisions authorized the Division of Architecture of the California State Department of Works to review and approve all public school plans and specifications and to furnish general supervision of the construction work. No Field Act school has ever failed in an earthquake."

from: http://nisee.berkeley.edu/long_beach/long_beach.html

What is capable of generating the largest tsunamis?

"Tsunamis are a constant, low-level threat along seacoasts. The worst documented death tolls for a tsunami, interestingly enough, was not from a plate-generated earthquake or continental-slope landslide, but from the sea-level explosion of Krakatau on August 27, 1883. The tsunami from that blast killed about forty thousand people. The 1815 eruption of Tambora, in Java, was even larger, but the death toll was harder to estimate. Figures of about twelve thousand are sometimes quoted, but the number is uncertain. Tsunamis caused by earthquakes are limited by the fact that earthquakes larger than Richter magnitude 10 do not occur. The largest tsunamis can only be produced by impacts."

from: Rain of Iron and Ice, by John S. Lewis: Helix Books, 1996, p. 204

How big were the tsunamis caused by the Chicxulub meteorite impact (Yucatan Peninsula) about 65 Ma?

"Tsunamis were 100-300 m high as they crashed onto the gulf coast (Bourgeois et al., 1988; Matsui et al., 1999) and ripped up seaflood sediments down to depths of 500 m."

from: GSA Today, August 2000, p. 2

How big was the Eltanin impact tsunami and when did it occur?

"Past impacts with water or ice are very difficult to detect, because they leave very little evidence. One such impact is known to have occurred in the south Pacific Ocean, near Chile, about 2 million years ago. This event--known as "Eltanin" after the ship that discovered the deposits--involved an asteroid between 1 and 3 miles in diameter that would have created a water crater at least 40 miles across. Tsunami would have swamped coasts around the Pacific and would even have reached some Atlantic coastlines. Assuming a typical run-up factor of three, the coast of Chile would have been inundated by 250-yard-high tsunami. Likely results for other locations: Hawaii 90-yard tsunami (probably higher due to the greater run-up factor); California, 60 yards; Japan and Australia, 25 yards; New Zealand, 120 yards."

from: Asteroids and tsunami: Good news and bad, by Michael Paine;
http://explorezone.com/columns/space/1999/september_tsunami.htm
(downloaded 8-16-00; on 11-21-02 page not found)

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NEW TSUNAMI MATERIALS ADDED TO THE LIBRARY

December 1, 2002 through January 31, 2003

Note: These, and all our tsunami materials, are included in our on-line catalog at http://www.wa.gov/dnr/htdocs/ger/washbib.htm
NTHMP participants are encouraged to request copies of these documents; see ordering information on p. 2.

Alaska

Abe, Kuniaki, 1988, Azimuth dependence of initial wave periods observed in three big tsunamis [abstract]: Seismological Research Letters, v. 59, no. 1, p. 37.

Abe, Kuniaki, 1999, Global distributions of peak frequency and the amplitude to the biggest three Pacific tsunamis in this century [abstract]: International Union of Geodesy and Geophysics, XXII General Assembly, Abstracts Week B, p. B.129.

Beget, J. E.; Gardner, C. A., 2002, New evidence of tsunamis from Augustine volcano, Alaska [abstract]: Eos (American Geophysical Union Transactions), v. 83, no. 47, Supplement, p. F 1465.

Fryer, G. J.; Watts, Philip, 2002, Aleutian landslides and the tsunami of 1946 [abstract]. *In* International Union of Geodesy and Geophysics Tsunami Commission; UNESCO/IOC/ICG/ITSU, The international workshop, 'Local Tsunami Warning and Mitigation': International Union of Geodesy and Geophysics Tsunami Commission; UNESCO/IOC/ICG/ITSU, 2 p.

Fryer, G. J.; Watts, Philip, 2002, The 1946 Aleutian tsunami in the far field--Inadequacy of an earthquake source, confirmation of a landslide, and implications for warning [abstract]: Eos (American Geophysical Union Transactions), v. 83, no. 47, Supplement, p. F662.

Kowalik, Zygmunt; Whitmore, P. M., 1991, Numerical investigation of two tsunamis recorded at Adak, Alaska [abstract]: Tsunami Newsletter, v. 24, no. 2, p. 13-15.

Kulikov, E. A.; Rabinovich, A. B.; Fine, I. V.; Bornhold, B. D.; Thomson, R.E., 1999, Numerical simulation of the landslide-generated tsunami of November 3, 1994 in Skagway Harbor, Alaska [abstract]: International Union of Geodesy and Geophysics, XXII General Assembly, Abstracts Week B, p. B.128.

Lockridge, P. A., 1988, Volcanoes generate devastating waves: Earthquakes and Volcanoes, v. 20, no. 5, p. 190-195.

Lopez, A. M.; Okal, E. A., 2002, Aftershock relocation, rupture area, mantle magnitude and energy estimates of the 1946 Aleutian tsunami earthquake and neighboring events [abstract]: Eos (American Geophysical Union Transactions), v. 83, no. 47, Supplement, p. F1045.

Mader, C. L.; Gittings, M. L., 2002, Modeling the 1958 Lituya Bay mega tsunami, II: Science of Tsunami Hazards, v. 20, no. 5, p. 241-250.

Pararas-Carayannis, George, 1987, An analysis of the dispersive characteristics of the 7 May 1986 tsunami: Tsunami Newsletter, v. 20, no. 1, p. 1-5.

Pararas-Carayannis, George, 1987, The earthquakes and tsunamis of 17 and 30 November 1987: Tsunami Newsletter, v. 20, no. 2, p. 1.

Preuss, Jane, 1988, Utilization of tsunami hazard maps in Alaska. *In* Hays, W. W., editor; Kitzmiller, C. J., compiler, A review of earthquake research applications in the National Earthquake Hazards Reduction Program--1977-1987: U.S. Geological Survey Open-File Report 88-13-A, p. 377-387.

Ritsema, Joroen; Ward, S. N.; González, F. I., 1995, Inversion of deep-ocean tsunami records for 1987 to 1988 Gulf of Alaska earthquake parameters: Seismological Society of America Bulletin, v. 85, no. 3, p. 747-754.

Suleimani, E. N.; Hansen, R. A.; Combellick, R. A., 2002, Tsunami hazard maps of the Kodiak area, Alaska [abstract]. *In* International Union of Geodesy and Geophysics Tsunami Commission; UNESCO/IOC/ICG/ITSU, The international workshop, 'Local Tsunami Warning and Mitigation': International Union of Geodesy and Geophysics Tsunami Commission; UNESCO/IOC/ICG/ITSU, 1 p.

Suleimani, E. N.; Hansen, R. A.; Combellick, R. A., 2002, Tsunami hazard maps of Alaska communities [abstract]: Eos (American Geophysical Union Transactions), v. 83, no. 47, Supplement, p. F694.

Synolakis, C. E.; Okal, E. A.; Titov, V. V.; Bernard, E. N., 2002, A seismic dislocation model for the 1946 Aleutian tsunami in the far-field [abstract]: Eos (American Geophysical Union Transactions), v. 83, no. 47, Supplement, p. F662.

Titov, V. V.; Mofjeld, H. O.; González, F. I.; Newman, J. C., 1999, Offshore forecasting of Alaskan tsunamis in Hawaii [abstract]: International Union of Geodesy and Geophysics, XXII General Assembly, Abstracts Week B, p. B.130-B.131.

Tsunami Newsletter, 1978, The Alaska regional tsunami warning system: Tsunami Newsletter, v. 11, no. 2, p. 18-21.

Atlantic Ocean, North

Harvey, S. V., 2001, Investigating the relationship of the Chesapeake Bay impact crater and the Virginia inland salt-water wedge [abstract]. *In* Morgan, M. L.; Warme, John E., editors and compilers, Bolide impacts on wet targets--Geological Society of America field forum: [Privately published by the authors], 1 p.

Rothman, R. L., 1968, A note on the New England earthquake of November 18, 1755: Seismological Society of America Bulletin, v. 58, no. 5, p. 1501-1502.

Stevens, A. E.; Staveley, Michael, 1991, The great Newfoundland storm of 12 September 1775: Seismological Society of America Bulletin, v. 81, no. 4, p. 1398-1402.

British Columbia

Cherniawsky, Josef; Titov, V. V.; Stephenson, F. E.; Wang, Kelin, 2002, Modelling tsunami heights and currents in B.C. harbours from Cascadia megathrust earthquake [abstract]. *In* International Union of Geodesy and Geophysics Tsunami Commission; UNESCO/IOC/ICG/ITSU, The international workshop, 'Local Tsunami Warning and Mitigation': International Union of Geodesy and Geophysics Tsunami Commission; UNESCO/IOC/ICG/ITSU, 1 p.

Rabinovich, A. B.; Kulikov, E. A.; Thomson, R. E.; Bornhold, B. D.; Fine, I. V., 1999, Numerical simulation of potential submarine slope failures and associated tsunamis along the coast of British Columbia [abstract]: International Union of Geodesy and Geophysics, XXII General Assembly, Abstracts Week B,

p. B.132.

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Rabinovich, A. B.; Thomson, R. E.; Stephenson, F. E.; Titov, V. V., 2002, Analysis and numerical modeling the Peru tsunami of June 23, 2001 for the coast of British Columbia [abstract]. *In* Karanci, Nuray; Yalçiner, A. C.; and others, editors, IX international symposium on natural and human-made hazards; Hazards 2002; Symposium theme--Disaster mitigation in the perspective of the new millennium; Book of abstracts: International Society for the Prevention and Mitigation of Natural Hazards, p. 114-115.

California

Busby, C. J.; Yip, Grant; Blikra, Lars; Renne, P. R., 2002, Coastal landsliding and catastrophic sedimentation triggered by Cretaceous-Tertiary bolide impact--A Pacific margin example?: Geology, v. 30, no. 8, p. 687-690.

Eskijian, M. L., 2002, Mitigation of seismic and meteorological hazards to marine oil terminals and other pier and wharf structures in California [abstract]. *In* Karanci, Nuray; Yalçiner, A. C.; and others, editors, IX international symposium on natural and human-made hazards; Hazards 2002; Symposium theme--Disaster mitigation in the perspective of the new millennium; Book of abstracts: International Society for the Prevention and Mitigation of Natural Hazards, 173 p.

González, F. I.; Bernard, E. N., 1993, Tsunami inundation model study of Eureka and Crescent City, California; And, the Cape Mendocino tsunami: Tsunami Newsletter, v. 25, no. 1, p. 4-6.

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___ ✪❄◗✂ Tsunami Chasers. Beyond Productions for the Discovery Channel. 52 minutes.

___Earthquake…Drop, Cover & Hold; Washington Emergency Management Division. 1998. 5 min.

___Tsunami Evacuation PSA; DIS Interactive Technologies for WA Emergency Management Division. 2000. 30 seconds.

___Cascadia: The Hidden Fire - An Earthquake Survival Guide; Global Net Productions, 2001. 9.5 minutes. 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. (The full documentary is scheduled for broadcasting on a PBS station in April 2002.)

___Not Business as Usual: Emergency Planning for Small Businesses, sponsored by CREW (Cascadia Regional Earth-quake Workgroup), 2001. 10 min. Discusses disaster prepar-edness and business continuity. Although it was made for Utah, the multi-hazard issues remain valid for everyone. Web-sites are included at the end of the video for further informa-tion and for the source of a manual for emergency prepared-ness for businesses.

___Adventures of Disaster Dudes (14 min.)
Preparedness for pre-teens

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

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

___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

___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 the development of warning systems.

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

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

___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.)

___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. The Institute provides a booklet to use with the video. 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, discussing 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 in California.

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

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

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

___Tsunami Warning (17 min.)
San Mateo (California) Operational Area Office of Emergency Services. This is a good public service program, specifically made for San Mateo County. Citizens are told what to do in cases of tsunami watches or tsunami warnings, with specific inundation zones identified for the expected 20-foot tall tsuna-mi. An evacuation checklist is provided, as well as locations of safe evacuation sites. This video gives the impression

that all tsunamis are teletsunamis (generated at a source more than 1000 km from the coastline) which therefore provide time for warnings. Locally-generated tsunamis are not discussed.

___USGS Earthquake Videotapes "Pacific Northwest" USGS Open-File Report 94-179-E

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

___The Wave: a Japanese Folktale (9 min.) Animated film to help 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 (Washington) Interpretive Center, this video deals with beach safety, including tsunamis.

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.

Name: Organization:

Mailing address:

City, State, Zip:

email:

TsuInfo Alert

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