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INTERNATIONAL TSUNAMI INFORMATION CENTER
HONOLULU

NEWSLETTER

TSUNAMI NEWSLETTER - JANUARY 1996

INTERNATIONAL TSUNAMI INFORMATION CENTER

737 Bishop Street, Suite 2200
Honolulu, Hawaii 96813-3213
Telephone: (808) 532-6422,
Fax: (808) 532-5576,
E-mail: Internet: ***itic@ptwc.noaa.gov***

Charles S. McCreery
Director, ITIC

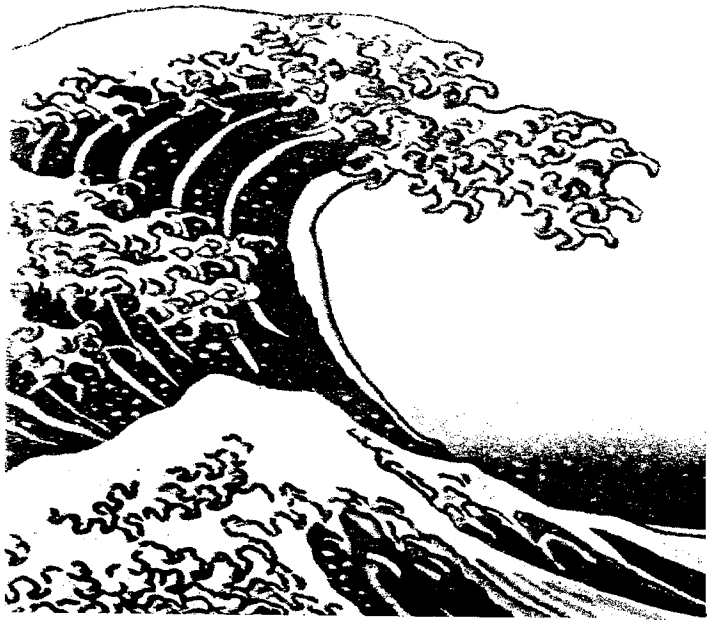
Salvador Farreras
Associate Director, ITIC

Support Provided By:
National Weather Service, Pacific Region
Graphic Design & Layout by:
Joe Hunt Graphics

The TSUNAMI NEWSLETTER is published semi-annually in January and July by the International Tsunami Information Center (ITIC) to bring news and information to scientists, engineers, educators, community protection agencies, and governments throughout the world.

We welcome contributions from our readers.

Organized under the auspices of UNESCO's Intergovermental Oceanographic Commission (IOC), the ITIC is maintained jointly by the U.S. National Oceanic & Atmospheric Administration (NOAA) and the IOC. The Center's mission is to mitigate the effects of tsunamis throughout the Pacific.



MEMBER STATES

Present membership of the IOC International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU) comprises the following 26 Member States:

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CANADA
CHILE
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COLOMBIA
COOK ISLANDS
COSTA RICA
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA
ECUADOR
FIJI
FRANCE
GUATEMALA
INDONESIA
JAPAN
MEXICO
NEW ZEALAND
NICARAGUA
PERU
PHILIPPINES
REPUBLIC OF KOREA
RUSSIAN FEDERATION
SINGAPORE
THAILAND
UNITED KINGDOM (HONG KONG)
UNITED STATES OF AMERICA
WESTERN SAMOA

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RECENT TSUNAMI AND EARTHQUAKES

Recent Tsunami and Earthquakes

The increase in tsunami activity in recent years has continued during the past six-month period, July - December, 1995, with the occurrence of seven more tsunami. These were generated by earthquakes in recognized tsunamigenic seismic zones near the Kuril Islands, Ryukyu Islands, Solomon Islands, Chile, and Mexico. The July 30th tsunami from Chile was observed Pacific-wide and caused damage to boats in a harbor at Hiva Oa in the Marquesas Islands, more than 7000 km away. The December 3rd tsunami from the Kuril Islands was also observed Pacific-wide. And the October 9th tsunami from Mexico was recorded, if only weakly, on the east coast of Australia. Fortunately, the seven tsunami caused only a single death, and no major damage. Perhaps the most surprising tsunami were the ones generated in the Ryukyu Islands by two relatively small earthquakes, M_w=7.1 and M_w=6.8. The larger produced runups on nearby islands in excess of 2m.

A tsunami was also generated on June 15th off the coast of Greece in the Gulf of Corinthos by an M_s=6.0 earthquake. A peak-to-trough wave amplitude greater than a meter was observed near the epicenter, but no damage was reported.

Lastly, 1996 was barely a few hours old when yet another tsunami was generated by a large quake off the western coast of Sulawesi in Indonesia. A brief description of that tsunami is also given, with a more complete account to be presented in the next newsletter.

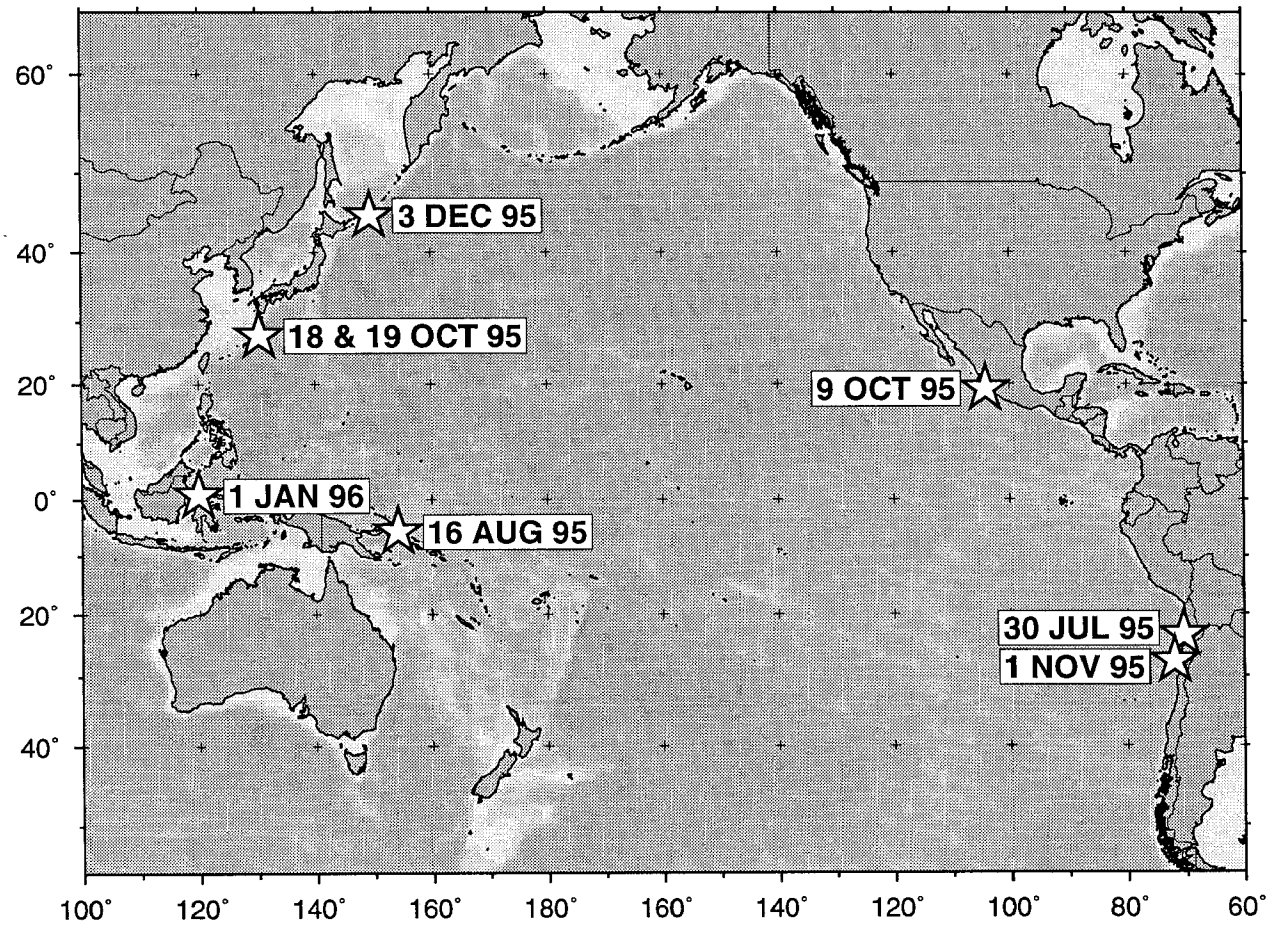
June 15, 1995, M_w=6.3, Greece

Earthquake Parameters *(as reported in NEIC Preliminary Determination of Epicenter listings)*

Origin Time:	June 15, 1995 00:15:48.6Z
Coordinates and Depth:	38.401N, 22.269E 14 km
Magnitudes:	mb=6.0, Ms=6.5, M_w=6.3 (GS), M_w=6.5 (HRV)
Region:	Greece

Reported Wave Heights

Eratini, Greece:	1.5 m peak-to-trough



Location of recent tsunamigenic earthquakes in the Pacific Region.

Notable Historical Tsunami Produced Nearby

• An Ms 6.5 earthquake on April 22, 1928 at 37.9N, 23.0E produced a 2.1 m runup on the island of Crete.

• An Ms 7.5 earthquake on July 9, 1956 at 36.7N, 25.8E produced respectively 30.6 and 20.4 m runups at Amorgos and Astipalaia Islands in the Cyclades.

Descriptive Account

The following account of this event was submitted for the newsletter by G.A. Papadopoulos of the Geodynamical Institute, National Observatory of Athens.

Introduction. The Corinthos Gulf in Central Greece is an area of high seismicity with earthquakes of magnitude up to about 7.0. A N-S extensional stress field in the lithosphere is responsible for the intense seismic activity there.

From historical documents and recent instrumental and field observations it is concluded that this gulf is also of high tsunamicity. According to Papadopoulos and Chalkis (1984) at least nine small or large tsunami waves, six of them being damaging or even destructive, were observed from the ancient times up to 1981.

In a recent completely revised tsunami catalog (Papadopoulos, 1995) fifteen known tsunamis have been listed, indicating the high tsunami potential of the Corinthos Gulf.

The Earthquake of 15 June 1995. On 15 June 1995, 00:16 GMT, a strong (Ms=6.0) earthquake ruptured the western side of the Corinthos Gulf. The earthquake caused extensive damage in several towns and villages along both coastlines of the Gulf, the northern and the southern ones. The maximum intensity (Im = VII + (MM)) was felt in the city of Aegion, southern coastline, where the collapse of two multi-storied buildings caused a death toll of 26. Extensive coastal ground breaks and subsequent ground submergence were reported in both coastlines.

Report of a Local Tsunami. In the northern coastline, a local tsunami wave was officially reported from the town of Eratini being located in the epicentral area. The wave was observed immediately after the earthquake occurrence. Its maximum vertical run-up was of about 0.4-0.5 m, while a water withdrawal of about 1 m occurred a few minutes after the earthquake. The water disturbance lasted for about 12 hours. Damage was not reported.

Judging from that no tsunami was reported from other coastal places of the epicentral or more remote areas I tentatively concluded that the wave could be attributed to the reported massive sliding in the sea of unconsolidated sediments accumulated at the local river mouth. A similar mechanism of tsunamigenesis at the same place was considered in association with the earthquake (Ms=6.3) of 6 July 1965 (Ambraseys, 1967). Tsunami generation from either seismic or aseismic sliding of coastal or submarine sediment masses is rather frequent in the Greek Archipelago, including the Gulf of Corinthos (Papadopoulos, 1993).

Final conclusions about that tsunami will be published in the future.

References

Ambraseys, N.N., 1967. The earthquakes of 1965-66 in the Peloponnesus, Greece; a field report. *Bull. Seismol. Soc. Am.*, 57, 1025-1046.

Papadopoulos, G.A., 1993. Seismic faulting and nonseismic tsunami generation in Greece. *Proc. Internat. Tsunami Symposium*, Wakayama, August 1993, 1115-122.

Papadopoulos, G.A., 1995. A new tsunami catalog of Greece and adjacent areas. *Genesis and Impact of Tsunamis in the European Coasts - A "Commission of the European Communities" Project*, to appear.

Papadopoulos, G.A., and Chalkis, B.J., 1984. Tsunamis observed in Greece and the surrounding area from antiquity up to the present times. *Marine Geology*, **56**, 309-317.

July 30, 1995, M_w=7.5, Near Antofagasta, Chile

Earthquake Parameters *(as reported in NEIC Preliminary Determination of Epicenter listings)*

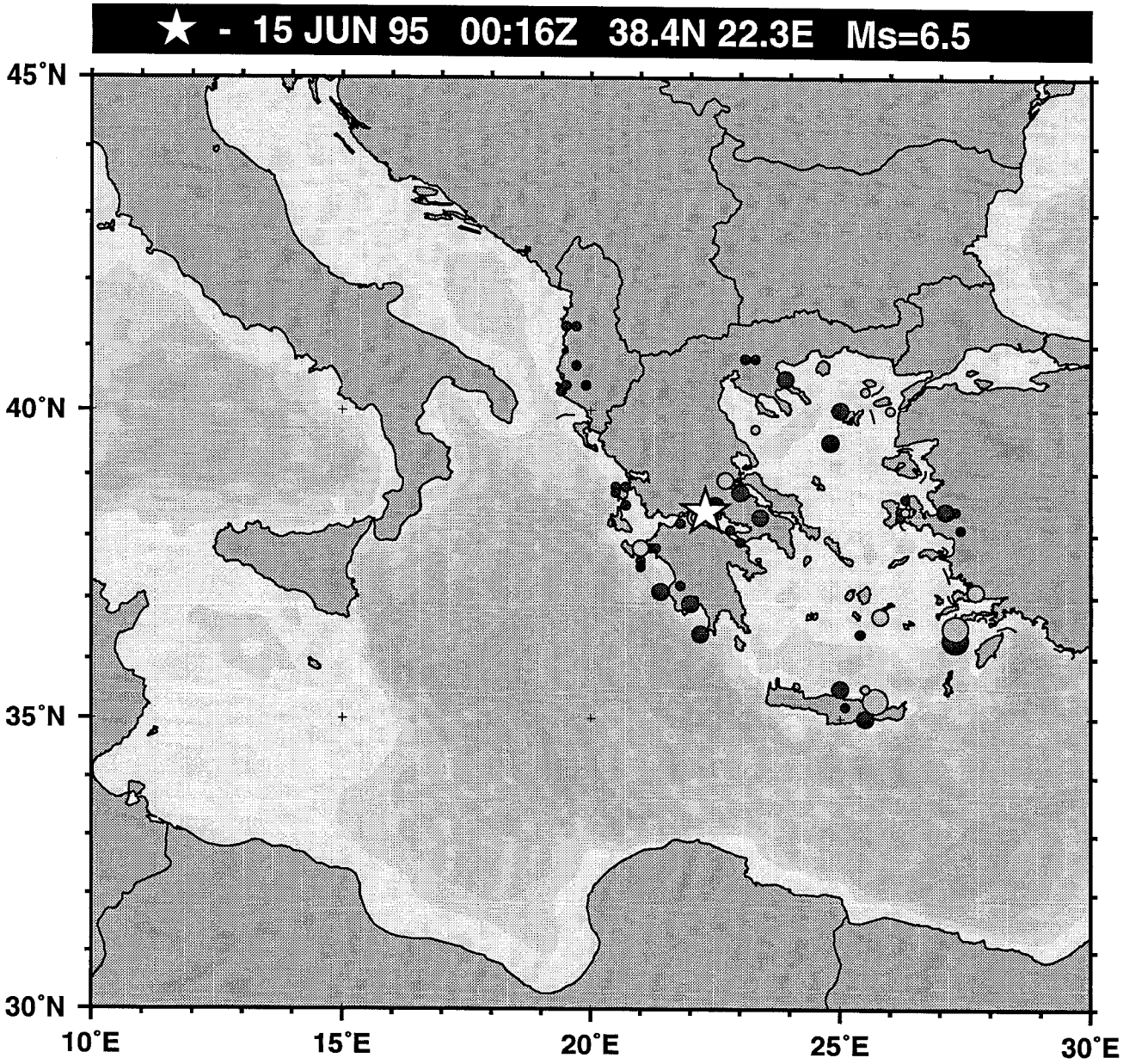
Origin Time:	July 30, 1995 05:11:23.5Z
Coordinates and Depth:	23.364S, 70.312W 47 km
Magnitudes:	mb=6.6, Ms=7.3, Mw=7.5 (GS), Mw=8.1 (HRV), Mo=2.3x10^{21} N-m (PPT)
Region:	Near Coast of Northern Chile

Selected Wave Heights

Antofagasta, Chile	2.80 m peak-to-trough
Arica, Chile	1.49 m
Talcahuano, Chile	1.06 m
Isla de Pascua	0.31 m
Pago Pago, Am. Samoa	0.33 m
Hilo, Hawaii	0.75 m
Kahului, Hawaii	0.70 m
Los Angeles, California	0.10 m
Crescent City, California	0.35 m
Wake Island	0.12 m
Adak, Alaska	0.30 m
Hachinohe, Japan	0.26 m
Chichijima Island	0.14 m

Notable Historical Tsunami Produced Nearby

• An Ms 8.5 earthquake on August 13, 1868 at 18.6S, 71.0W produced a significant Pacific-wide tsunami. Runups of 15.0, 14.0, and 7.5 m were observed in Chile at Arica, Iquique, and Coquimbo, respectively. Wave heights of 1.8 m were measured at both San Pedro and Wilmington Beach, California. At Hilo, Hawaii, the measurement was 4.5 m and at Kahului, Hawaii, 1.8 m. In Japan wave heights were typically 1-2 m, although



HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 0500 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
◌ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	∘ 6.9 OR SMALLER

An earthquake on 15 June located in the Corinthos Gulf produced a small tsunami that was observed at Eratani, near the epicenter on the northern side of the Gulf. It is suggested that the wave was initiated by a sediment slide, rather than directly from the earthquake displacement.

Hakodate registered 3 m. Wave heights in New Zealand were 1-3 m, while the measurement at Sydney, Australia was 1.2 m.

• On May 10, 1877, an Ms 8.3 earthquake at 19.6S, 70.2W was responsible for a major Pacific tsunami. Huge runups along the coast of Chile were reported — 24.0 m at Tocopilla, 21.0 m at Mejillones, and 20.0 m at Arica. Further south, Antofagasta had a 6.6 m runup but Valparaiso had only a 1.1 m wave. Wave heights in Peru ranged from 3-6 m. In Hawaii, the tsunami had heights of 1.5 m at Honolulu, 3.6 m at Lahaina, 3.7 m at Hilo, and 4.8 m at Waiakea. The waves registered up to 3 m in Japan, and up to 3 m in New Zealand.

• An Ms 8.3 earthquake on November 11, 1922 at 28.5S, 70.0W produced a damaging local tsunami. Wave heights were 9 m at Charanal, and 7 m at both Caldera and Coquimbo. The largest readings outside of Chile were 2.1 m in Hilo, Hawaii, and 2.4 m at Callao, Peru.

Descriptive Account

This large earthquake resulted in the issuance of a regional tsunami warning and watch for the southeast Pacific by the Pacific Tsunami Warning Center. After several hours the alert was canceled based on relatively small waves having been observed along the Chilean coast. Eleven hours after the earthquake, a series of 5 waves, the first of which was 3 m high, came into Tahauku Bay at Hiva Oa in the Marquesas Islands, sinking two small boats and damaging others. But this was the only damage reported outside of the source area. The unusually large waves at Tahauku Bay from this earthquake and from a Mexico earthquake in October have prompted the Centre Polynesien de Prevencion des Tsunamis to lower its threshold for issuing warnings for this bay (see Warning Center Activities later in this newsletter). The wave was also observed in Hilo, Hawaii by boaters who noticed some unusually strong currents inside the harbor.

The following is excerpted from a report submitted by Dante Gutierrez of the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA)

At 01:11 local time (05:11 UTC) of July 30, 1995, an large earthquake took place in northern Chile. Damage was concentrated in the city of Antofagasta, particularly in the harbour, where it could continue its operations at only 30% of its normal capacity. Three persons lost their lives and more than 300 buildings were heavily damaged, although this figure includes many houses that were already scheduled to be demolished.

More than thirty aftershocks of magnitude 4 were recorded during the first 40 hours, the largest being a 6.1 event. From the aftershocks distribution, a rupture area of about 180 km by 70-80 km emerges in an elongated in a north-south direction. It is located partly inland and partly offshore. The low dip angle (19.0°) of this almost pure thrust event, precludes the generation of a large tsunami. It is estimated that there should have been coastal uplift of about 1 meter. Some fishermen said that there was a wave of about 1.5 meters above the normal tide. Also, from a tide gauge installed at that moment in Punta Grande near the epicenter by specialists from Universidad de Antofagasta and from other eye witnesses reports, the sea level in some places reached 2-2.5 meters above the tide level at that time and in one particular place, La Rinconada, the water penetrated 250-300 meters inland.

During a visit carried out by specialists from SHOA to the affected zone it was observed that in addition to the port of Antofagasta, Paposo Cove was where a larger than normal amplitude of the tides was observed; around 15 minutes after the earthquake. The sea began to rise and 30 minutes later the sea rose 2 to 2.5 meters above the normal level. During the dawn, a local fisherman organized the population of the coast and evacuated them to high places in Paposo with the help of trucks from a mining company that operates in Taltal. Because the coast of this sector is rocky with scarps, it was not possible to find the usual notorious marks of the rising of the sea level, only the stories told by eye-witnesses.

In the sector named La Rinconada there is a long and wide beach, with a smooth slope. This is a depopulated area with only some summer cabins that are leased seasonally. There the sea penetrated far onshore, compared to other coastal places of the Second Region of Chile. At the moment of the visit of the SHOA team, there were still remnants of the entrance of the sea, especially in the well known sector named "Eye of Sea". It is estimated that in that place, the sea rose 1.5 meters and penetrated about 250 to 300 meters inland; one of the mining companies that operates in this zone had to reconstruct part of the road destroyed by the avalanche of water and mud that flooded an extensive area.

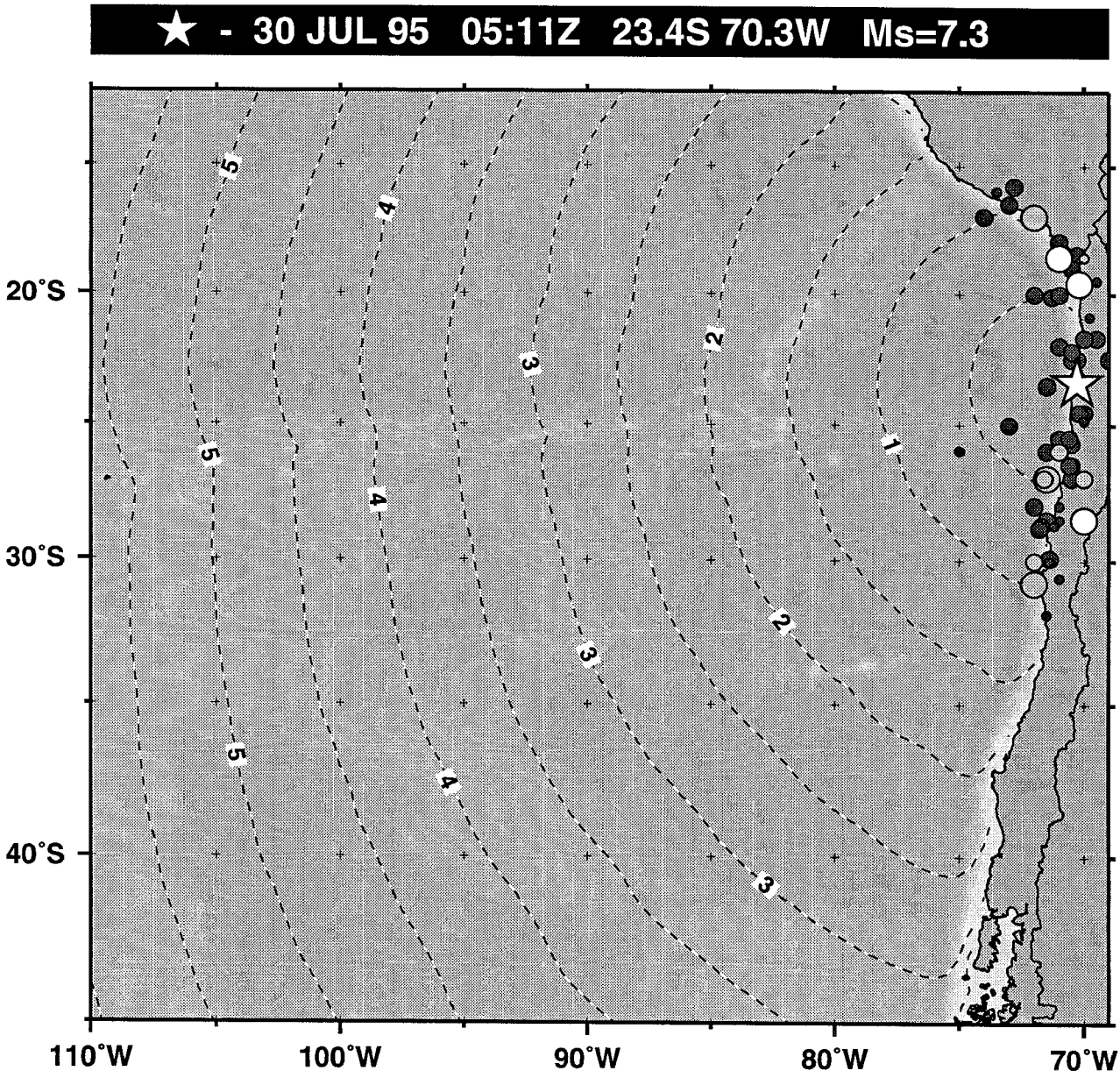
Tsunami waves were recorded at several tide gauges installed along the Chilean coast as follows:

Station	Latitude (S)	Longitude (W)	Max. Double Amplitude (m)
Arica	18° 29'	070° 19'	1.49
Iquique	20° 13'	070° 10'	0.64
Antofagasta	23° 39'	070° 25'	2.80
Caldera	27° 04'	070° 50'	1.70
Isla de Pascua	27° 09'	109° 27'	0.31
Valparaiso	33° 02'	071° 38'	0.65
Is.Juan Fernandez	33° 37'	078° 50'	0.40
Talcahuano	36° 41'	073° 06'	1.06

In spite of the fact that the distance between Talcahuano and the epicenter area exceeds 1,000 km, the tsunami wave height is explained because that port is a closed area and a resonant phenomena is observed there.

August 16, 1995, M_w=7.4, Solomon Islands

Earthquake Parameters *(as reported in NEIC Preliminary*

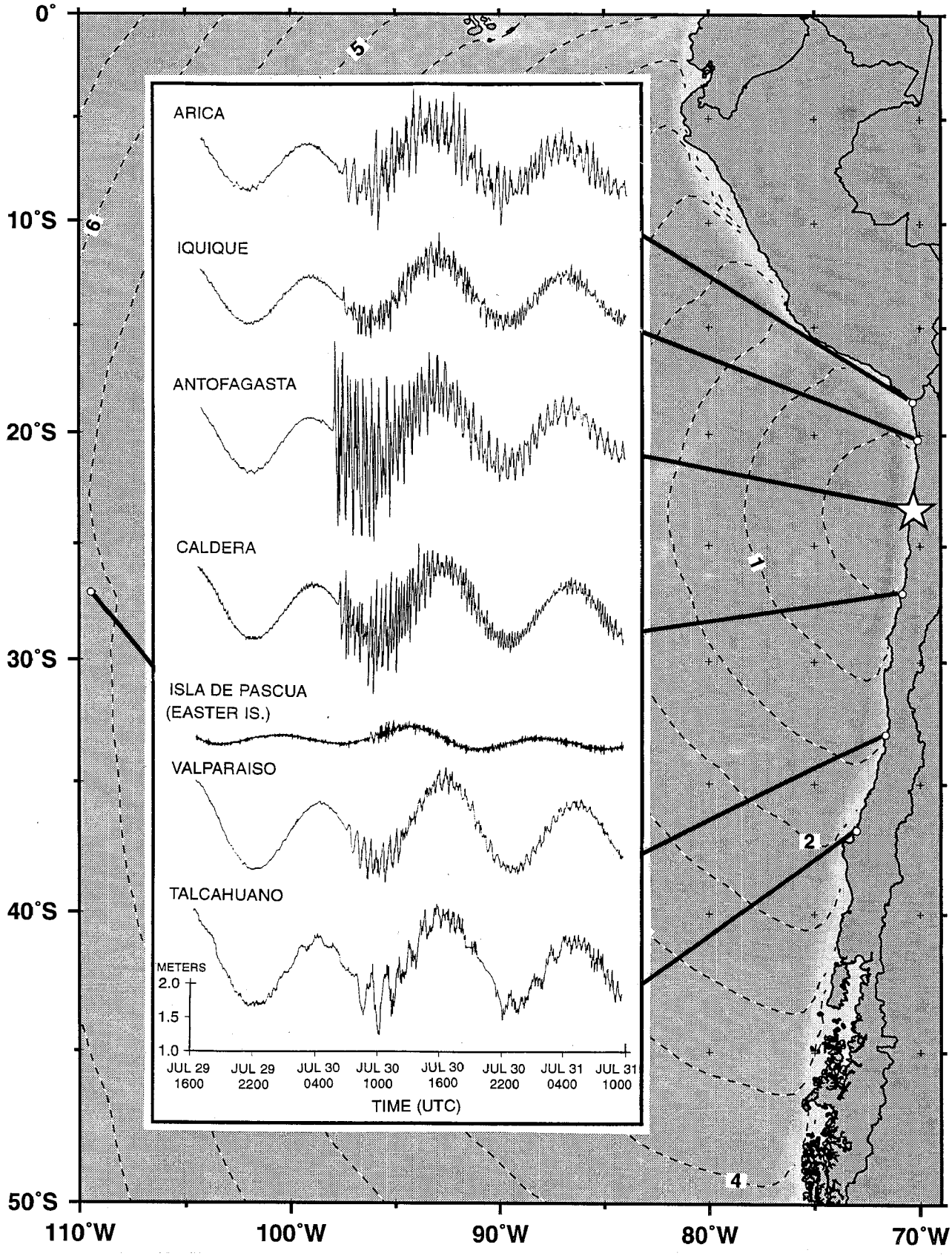


ESTIMATED TSUNAMI TRAVEL TIME (LABELED IN HOURS)

HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 1000 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
◎ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	∘ 6.9 OR SMALLER

A large earthquake occurred near Antofagasta, Chile on July 30, 1995, producing a small tsunami that was measured across the Pacific. No damage from the wave occurred outside of the source region, however, except for some boat damage at Hiva Oa in the Marquesas Islands. [Historical data in the figure are taken from the National Geophysical Data Center's tsunami database. The ocean depth is qualitatively indicated by shades of gray, with shallow water given the lighter tones. Estimated tsunami travel times were computed using software from the Pacific Tsunami Warning Center that was developed by Paul Wessel.]



Tidal gauge records of the July 30 tsunami provided by the Hydrographic and Oceanographic Service of the Chilean Navy.

Determination of Epicenter listings)

Origin Time:	August 16, 1995 10:27:26.4Z
Coordinates and Depth:	5.809S, 154.212E 16 km
Magnitudes:	mb=6.4, Ms=7.8, M_w=7.4 (GS), M_w=7.8 (HRV)
Region:	Solomon Islands

Reported Wave Heights

Rabaul, New Britain	0.55 m peak-to-trough
Kwajalein Island	0.11 m

Notable Historical Tsunami Produced Nearby

• An Ms 7.9 earthquake on October 3, 1931 at 10.6S, 161.7E produced respectively 2.0, 3.0 and 7.5 m runups at Ira Kira, Port Mary and San Cristobal in the Solomon Islands.

• An Ms 8.0 earthquake on April 30, 1939 at 10.6S, 158.6E produced respectively 5.0 and 10.5 m runups at Gasmata in the Solomon Islands and Beaufort Bay in Guadalcanal.

• An Ms 7.9 earthquake on July 26, 1971 at 4.9S, 153.2E produced a 3.4 m runup in North Rabaul, new Britain.

• An Ms 7.0 earthquake on February 1, 1974 at 7.4S, 155.6E produced respectively 1.6, 4.5 and 4.0 m runups at Choiseul, Korova and Shortland in the Solomon Islands.

Descriptive Account

Based on the earthquake parameters, a Tsunami Watch and Warning were issued for appropriate regions in the western Pacific near the epicenter by the Pacific Tsunami Warning Center. The Watch and Warning were later canceled when data from nearby water-level gauges confirmed that no Pacific-wide tsunami had been generated.

Records from tide gauges operated by the University of Hawaii's Sea Level Center indicate that the wave measured 55 cm peak-to-trough at Rabaul, New Britain, and 11 cm peak-to-trough at Kwajalein Island located about 2000 km to the northeast. It was not observed on any of the other water level gauges normally utilized by the warning system.

Mr. Tom Finnimore, National Contact of New Zealand to ICG/ITSU, contacted New Britain shortly after the quake. He indicated that surges had been observed in Rabaul Harbor and also along the east coast of New Britain.

The following report of this event was issued by the U.N. Department of Humanitarian Affairs (Geneva, Switzerland).

On 16 August at 10:27 GMT OR 8:27 PM local time an earthquake with magnitude 7.8 occurred in the Pacific Ocean off the coasts of Bougainville, New Britain and New Ireland.

The epicenter was located in the Solomon Sea about 270 km southeast of the port town of Rabaul (800 km northeast of Port Moresby) on the Island of New Britain and 50 km off the East coast of Bougainville. The preliminary hypocenter was at a latitude of 5.7 degrees South, longitude 154.1 degrees East and at normal depth. Two days before, on August 14, an earthquake with a magnitude of 6.2 and epicenter 100 km Southeast of Rabaul, was only weakly felt.

Only minor damage was reported, five landslides cut off the Rabaul/Kokopo road and one landslide occurred at the Blue Lagoon on the island of New Britain (this landslide may have generated a tsunami in the lagoon). People in care centers near the Kokopo road were moved inland as a precautionary measure. Rabaul was already devastated in September 1994 when two volcanoes erupted prompting the evacuation of 30,000 people.

October 9, 1995, M_w=7.6, Near Manzanillo, Mexico

Earthquake Parameters *(as reported in NEIC Preliminary Determination of Epicenter listings)*

Origin Time:	October 9, 1995 15:35:55.7Z
Coordinates and Depth:	19.147N 104.220W 49 km
Magnitudes:	mb=6.5, Ms=7.3, M_w=7.6 (GS), M_w=7.9 (HRV)
Region:	Near Coast of Colima, Mexico

Selected Wave Heights

Manzanillo Region, Mexico	2-5 m runups
Cabo San Lucas, Mexico	0.51 m peak -to-trough
Socorro Island, Mexico	0.20 m
Hilo, Hawaii	0.37 m
Kawaihae, Hawaii	0.11 m
Kahului, Hawaii	0.34 m
Nawiliwili, Hawaii	0.12 m
Baltra, Galapagos	0.08 m
Pago Pago, Am. Samoa	0.37 m
Nuku Hiva, Fr. Polynesia	0.30 m
Papeete, Fr. Polynesia	0.07 m
Hiva Oa, Fr. Polynesia	1.00 m
Southport, Australia	0.04 m
Mooloolaba, Australia	0.05

Notable Historical Tsunami Produced Nearby

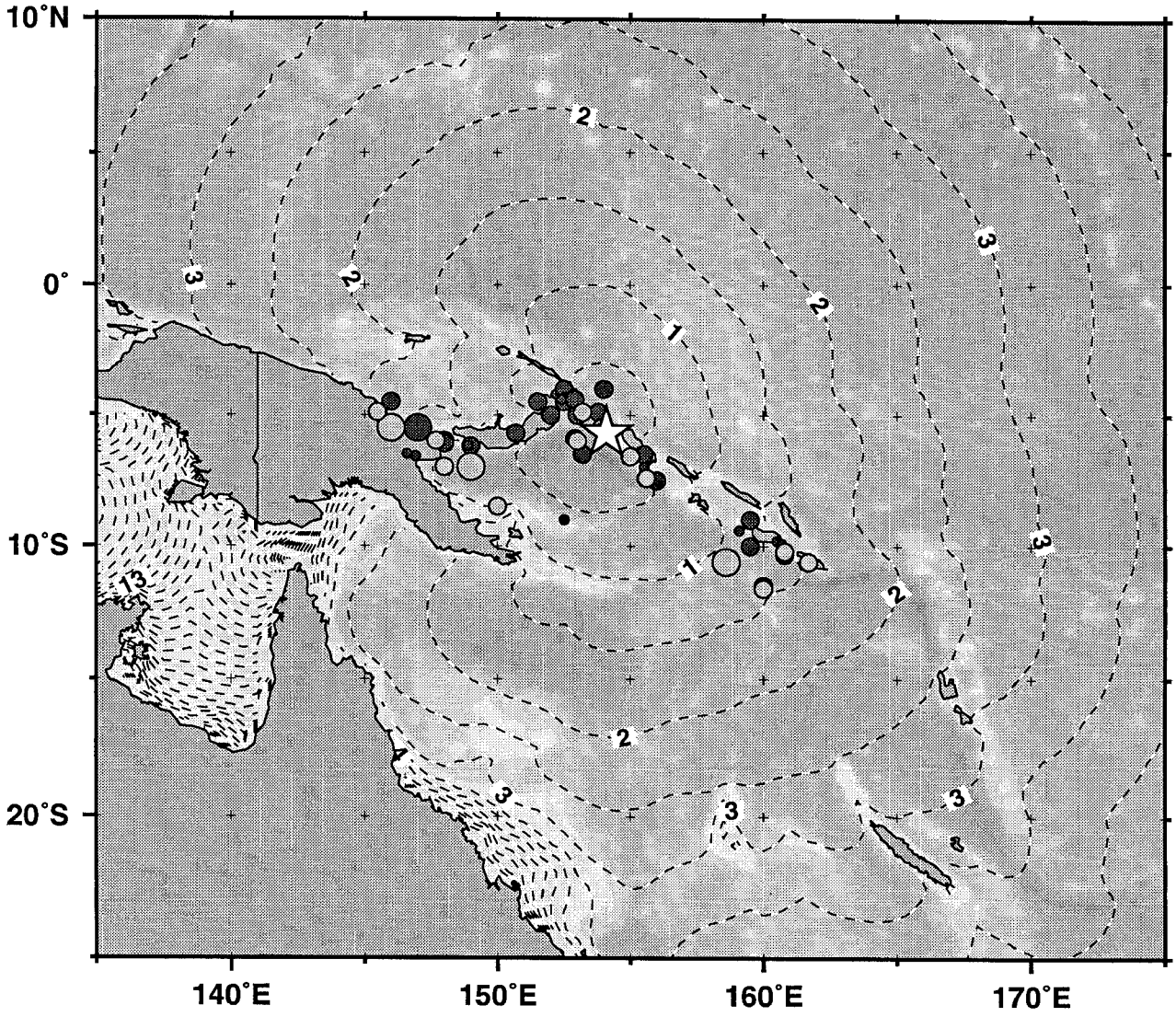
• An Ms 8.1 earthquake on June 3, 1932 at 19.8N, 104.0W produced respectively 2.0 and 3.0 m runups at Cuyutlan and Manzanillo in Mexico.

• An Ms 7.0 earthquake on June 22, 1932 at 19.0N, 104.5W produced a 10.0 m runup in Cuyutlan, Mexico (this was either a "tsunami earthquake", or a submarine landslide may have occurred).

Descriptive Account

At 9:36 local time (15:36 GMT) October 9, 1995 a powerful earthquake struck the coastal states of Jalisco and Colima in central Mexico. At least 39 people were killed, 200 were injured and nearly 1000 left homeless. The earthquake was felt strongly in Mexico City, and felt as far as Dallas and Houston, Texas. Most of the earthquake damages and casualties occurred around

★ - 16 AUG 95 23:10Z 5.7S 154.1E Ms=7.2



ESTIMATED TSUNAMI TRAVEL TIME (LABELED IN HOURS)

HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 1000 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
◌ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	∘ 6.9 OR SMALLER

A large earthquake between New Britain and Bougainville generated a tsunami in the Solomon Sea that measured 55 cm in Rabaul harbor. The wave was also measured in the Pacific at Kwajalein Atoll with a peak-to-trough amplitude of 11 cm. No injuries or damage were reported for this tsunami

the Manzanillo (Colima) area. Mud slides were triggered, power lines downed, telephone service cut and several bridges collapsed in villages and towns close to the epicenter. Eight prisoners died in their cells when a jail collapsed, and five bodies were pulled from a hotel after it crumbled in the quake.

The tsunami generated hit the coastal towns near the epicenter about 7 minutes after the earthquake. The tidal record from Manzanillo harbor indicates that the tsunami waves arrived at high tide, and shows a mean sea level rise of about 14 cm after the earthquake, evidence of land subsidence in the area due to the quake.

With the objectives of measuring runup heights and inundation distances, an International Tsunami Survey Team headed by Modesto Ortiz from CICESE, Mexico and Costas Synolakis from University of Southern California, USA visited and surveyed the tsunami damaged area, from October 15 through October 22 , 1995. What follows are excerpts of their preliminary field survey report:

Eyewitnesses reported the water level withdrawing to about 150m from the shoreline. In La Manzanilla (north of Manzanillo), a scuba diver saw the bottom around some rock outcrops about 200m offshore exposed and he reported that the depth there varied from 5-6m. Most of the damage was shaking-induced, although the flooding in some locales was extensive, with flooding depths averaging over 2m at distances of 200 m from the coastline. Runup measurements ranged from 2 to 5 meters depending on local topographic features. The maximum horizontal inland penetration measured was 500 meters. There was only one casualty attributed to the tsunami attack, it was a fisherman using his hand fishing net close to the shore at Navidad Bay. Most local residents knew about tsunamis and they ran out of harm's way after the first wave, although many returned and they were swept by the 2nd wave.

Tsunami damage photos and an area map may be found at the following URL:
http://www.cwis.usc.edu/dept/tsunamis/

October 18, 1995, M_w=6.9, Ryukyu Islands, Japan

Earthquake Parameters (as reported in NEIC Preliminary Determination of Epicenter listings)

Origin Time:	October 18, 1995 10:37:26.3Z
Coordinates and Depth:	27.920N 130.337E 27 km
Magnitudes:	mb=6.5, Ms=6.8, M_w=6.9 (GS), M_w=7.1 (HRV)
Region:	Ryukyu Islands, Japan

Selected Wave Heights

Kikai Island, Japan	1-2.6 m runup
Amani Island, Japan	1-2.4 m runup
Nakano Island, Japan	0.80 m peak-to-trough

Notable Historical Tsunami Produced Nearby

• An Ms 8.4 earthquake on October 28, 1707 at 34.1N, 137.8E produced respectively 26.0, 24.0 and 20.0 m runups at Kure, Tanesaki and Toba in Japan.

• An Ms 8.3 earthquake on December 23, 1854 at 34.0N, 137.9E produced respectively 28.0, 10.5, 10.0 and 21.0 m runups at Kochi, Kogamura, Nagashima and Okagata in Japan.

• An Ms 7.3 earthquake on March 7, 1927 at 35.6N, 135.1E produced 4.0 m runups at Bering Island and Commander Island, and 11.3 m runups at Taiza and Tango in Japan.

• An Ms 8.1 earthquake on December 20, 1946 at 33.0N, 135.6E produced respectively 6.6, 5.8 and 6.1 m runups at Fukuro, Tonda and Wakayama in Japan.

Descriptive Account

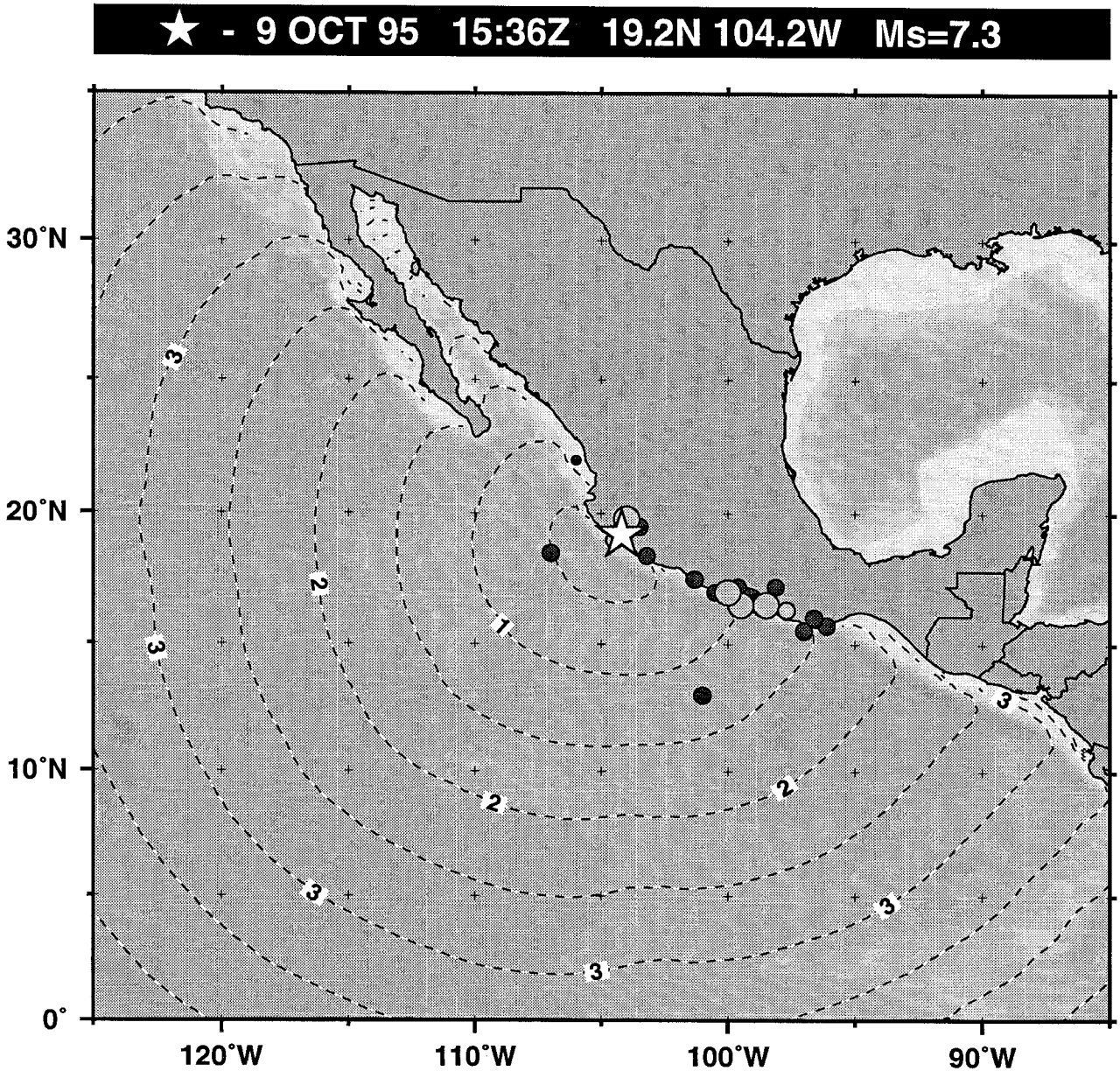
The following account of this event was submitted to the electronic Tsunami Bulletin Board by Fumihiko Imamura from the Disaster Control Research Center, Faculty of Engineering, Tohoku University, Japan.

At 7:37 (JT), 18 October 1995, an earthquake with M=6.5 (JMA), M_w=7.1 (Harvard) and Ms=6.9 (USGS) accompanied by a tsunami occurred 40-50 km offshore of Kikai island in the Ryukyu Islands, Japan where the Philippine plate is subducting under the Eurasian plate. One person was slightly injured on Amani O-shima.

Although the Japan Meteorological agency did not issue a tsunami warning after the earthquake because of its small magnitude (less than 6.6), a tsunami ranging from 20 cm to 1.5 m was observed on the islands as well as in southwestern Japan, and minor damage of boats at Kikai and Amani Island were reported. The tsunami on tidal records at islands more than 200 km from the epicenter were comparable to or larger than those at Kikai and Amani Islands near the epicenter.

A field survey was conducted after the event during the period from 19 to 23 October 1995 with three members from Tohoku University: Fumihiko Imamura, Tomoyuki Takahashi, and Syunichi Koshimura.

The field survey started at Kikai Island, within 10 km of the epicenter, where the most significant ground motion and tsunami were reported. Since the magnitude of the tsunami was small and consequently tsunami traces were not clear except for at one bay at the northeastern side of the island, we made interviews of local people to collect as much information as possible from them. It is suggested by the survey that the average tsunami runup on the island was 1-1.5 m and that the maximum was 2.6 m at Urabaru, a small fishery harbor on the southeastern side of the island facing toward the epicenter. The average runup at Amani Island was also 1-1.5 m and the maximum was 2.4 m. However, the tidal record at Nakano Island, around 200 km from the epicenter shows a maximum double amplitude of 80 cm, and those at islands more than 600 km away recorded amplitudes of more than 20 cm. These are larger than those estimated from the data at Kikai and Amami Islands taking into consideration the propagation distances.

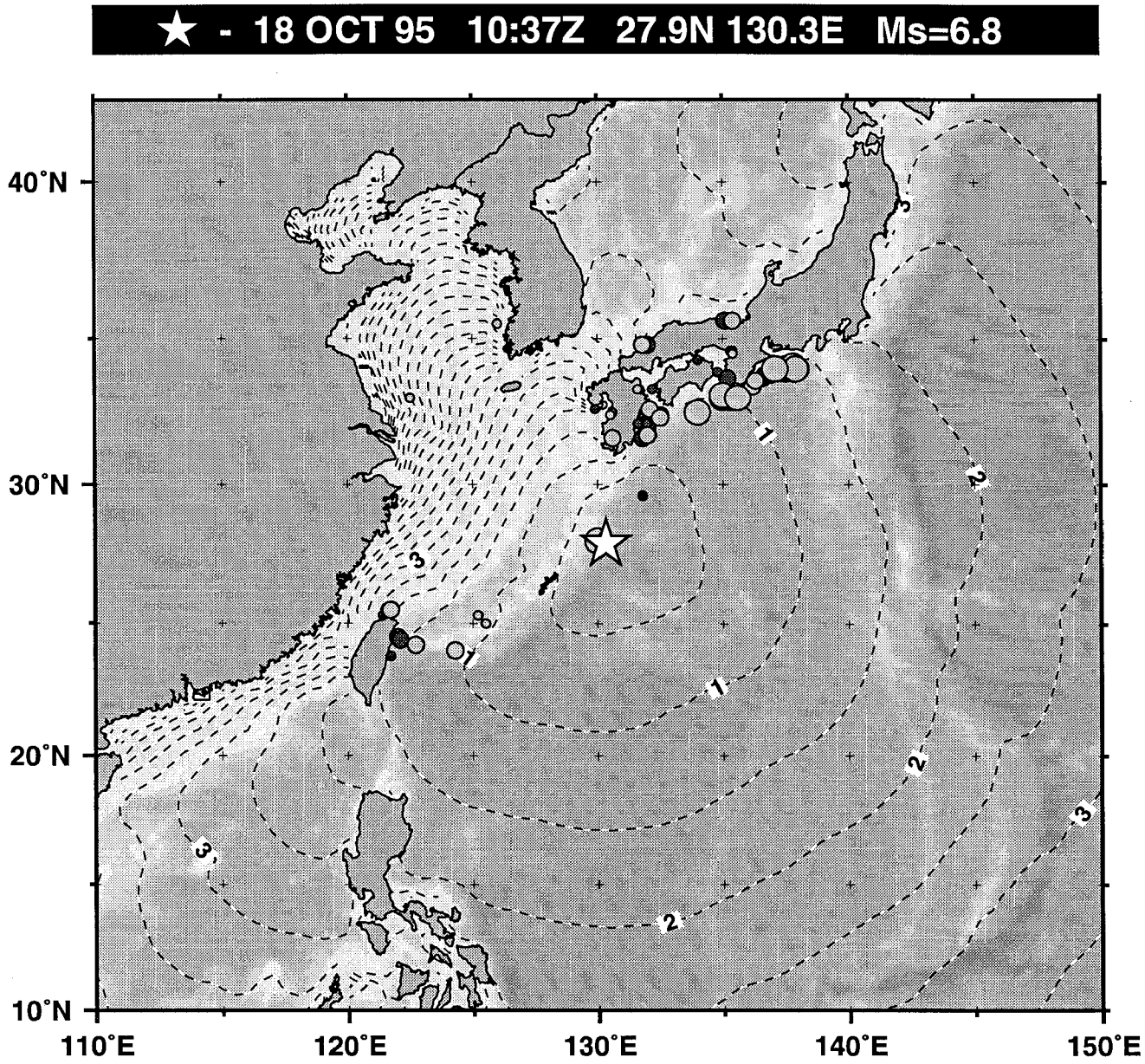


ESTIMATED TSUNAMI TRAVEL TIME (LABELED IN HOURS)

HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 1000 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
◎ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	∘ 6.9 OR SMALLER

A large earthquake near Manzanillo, Mexico on October 9, 1995, produced a locally damaging tsunami, with at least one tsunami casualty. Runups in the Manzanillo coastal region ranged from 2 to 5 m. No damage from the tsunami occurred outside of the source region, although it was detected as far away as French Polynesia and Australia.



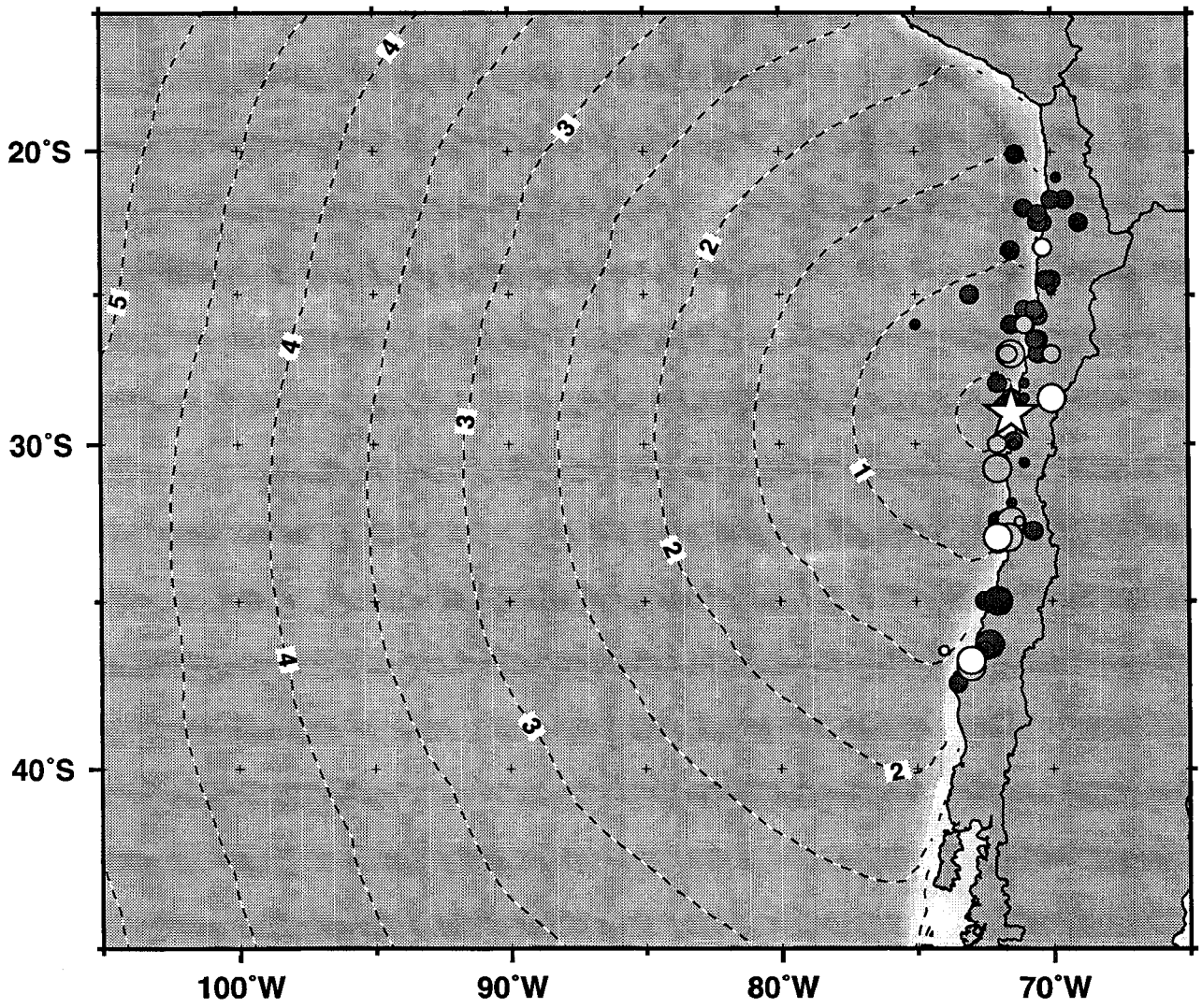
ESTIMATED TSUNAMI TRAVEL TIME (LABELED IN HOURS)

HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 1000 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
◎ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	∘ 6.9 OR SMALLER

An M_w=6.9 earthquake occurred 40-50 km offshore of Kikai island in the Ryukyu Islands, Japan, on October 18, 1995. A tsunami was observed and recorded in the coastal region near the epicenter with runups as high as 2.6 m. A second earthquake, M_w=6.6, occurred the following day at approximately the same location. It also produced an observable tsunami.

★ - 1 NOV 95 00:36Z 29.0S 71.5W Ms=6.4



ESTIMATED TSUNAMI TRAVEL TIME (LABELED IN HOURS)

HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 1000 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
◎ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	∘ 6.9 OR SMALLER

A moderate earthquake on November 1, 1995 off the coast of North-Central Chile produced a small tsunami that was recorded in Caldera, near the epicenter, with a peak-to-trough amplitude of 0.13 m.

However, we are not sure of the reason. The energy dissipation on the reef around Kikai and Amani Islands, and edge waves along the continental shelf from the source to the far field in Japan could be important and interesting factors to explain the observed amplitudes.

October 19, 1995, M_w=6.6, Ryukyu Islands, Japan

Earthquake Parameters *(as reported in NEIC Preliminary Determination of Epicenter listings)*

Origin Time:	October 19, 1995 02:41:37.9Z
Coordinates and Depth:	28.075N 130.309E 31 km
Magnitudes:	mb=6.3, Ms=6.8, M_w=6.6 (GS), M_w=6.8 (HRV)
Region:	Ryukyu, Islands, Japan

Reported Wave Heights

This earthquake is known to have produced a small tsunami in the source region, although runups separate from those reported for the October 18th event have not been received.

Notable Historical Tsunami Produced Nearby

• An Ms 8.4 earthquake on October 28, 1707 at 34.1N, 137.8E produced respectively 26.0, 24.0 and 20.0 m runups at Kure, Tanesaki and Toba in Japan.

• An Ms 8.3 earthquake on December 23, 1854 at 34.0N, 137.9E produced respectively 28.0, 10.5, 10.0 and 21.0 m runups at Kochi, Kogamura, Nagashima and Okagata in Japan.

• An Ms 7.3 earthquake on March 7, 1927 at 35.6N, 135.1E produced 4.0 m runups at Bering Island and Commander Island, and 11.3 m runups at Taiza and Tango in Japan.

• An Ms 8.1 earthquake on December 20, 1946 at 33.0N, 135.6E produced respectively 6.6, 5.8 and 6.1 m runups at Fukuro, Tonda and Wakayama in Japan.

Descriptive Account

Sixteen hours after the earthquake of October 18, 1995, an earthquake with M=6.7 (JMA) occurred in the same region of the Ryukyu Islands, and again generated a tsunami. Landslides were reported on Kikai Island as a result of this earthquake.

The results of the field survey conducted by the team from Tohoku University, as reported for the October 18th event, can be considered as representative of the effects of both the 18 October as well as this 19 October tsunami.

November 1, 1995, M_w=6.6, Off the Coast of Central Chile

Earthquake Parameters *(as reported in NEIC Preliminary Determination of Epicenter listings)*

Origin Time:	November 1, 1995 00:35:32.3Z
Coordinates and Depth:	28.958S 71.503W 20 km
Magnitudes:	mb=6.3, Ms=6.4, M_w=6.6 (GS), M_w=6.7 (HRV)
Region:	North-Central Coast of Chile

Reported Wave Heights

Caldera, Chile	0.13 m peak-to-trough

Notable Historical Tsunami Produced Nearby

• An Ms 7.8 earthquake on December 4, 1918 at 26.0S, 71.0W produced a 5.0 m runup in Caldera, Chile.

• An Ms 8.3 earthquake on November 11, 1922 at 28.5S, 70.0W produced a damaging local tsunami. Wave heights were 9 m at Chanaral, and 7 m at both Caldera and Coquimbo. The largest readings outside of Chile were 2.1 m in Hilo, Hawaii, and 2.4 m at Callao, Peru.

Descriptive Account

On November 1, 1995 at 00:35 GMT a moderate earthquake with a surface wave magnitude of 6.4 struck the north-central region of Chile. It was felt as far away as Mendoza Province in Argentina. No casualties or damage as a result of the earthquake were reported.

A small tsunami of 0.13 m maximum peak-to-trough amplitude was recorded at the tidal station of Caldera, Chile.

December 3, 1995, M_w=7.4, Southern Kuril Islands, Russia

Earthquake Parameters *(as reported in NEIC Preliminary Determination of Epicenter listings)*

Origin Time:	December 3, 1995 18:01:08.5Z
Coordinates and Depth:	44.568N 149.375E 33 km
Magnitudes:	mb=6.6, Ms=8.0, M_w=7.4 (GS), M_w=7.9 (HRV)
Region:	Kuril Islands

Selected Wave Heights

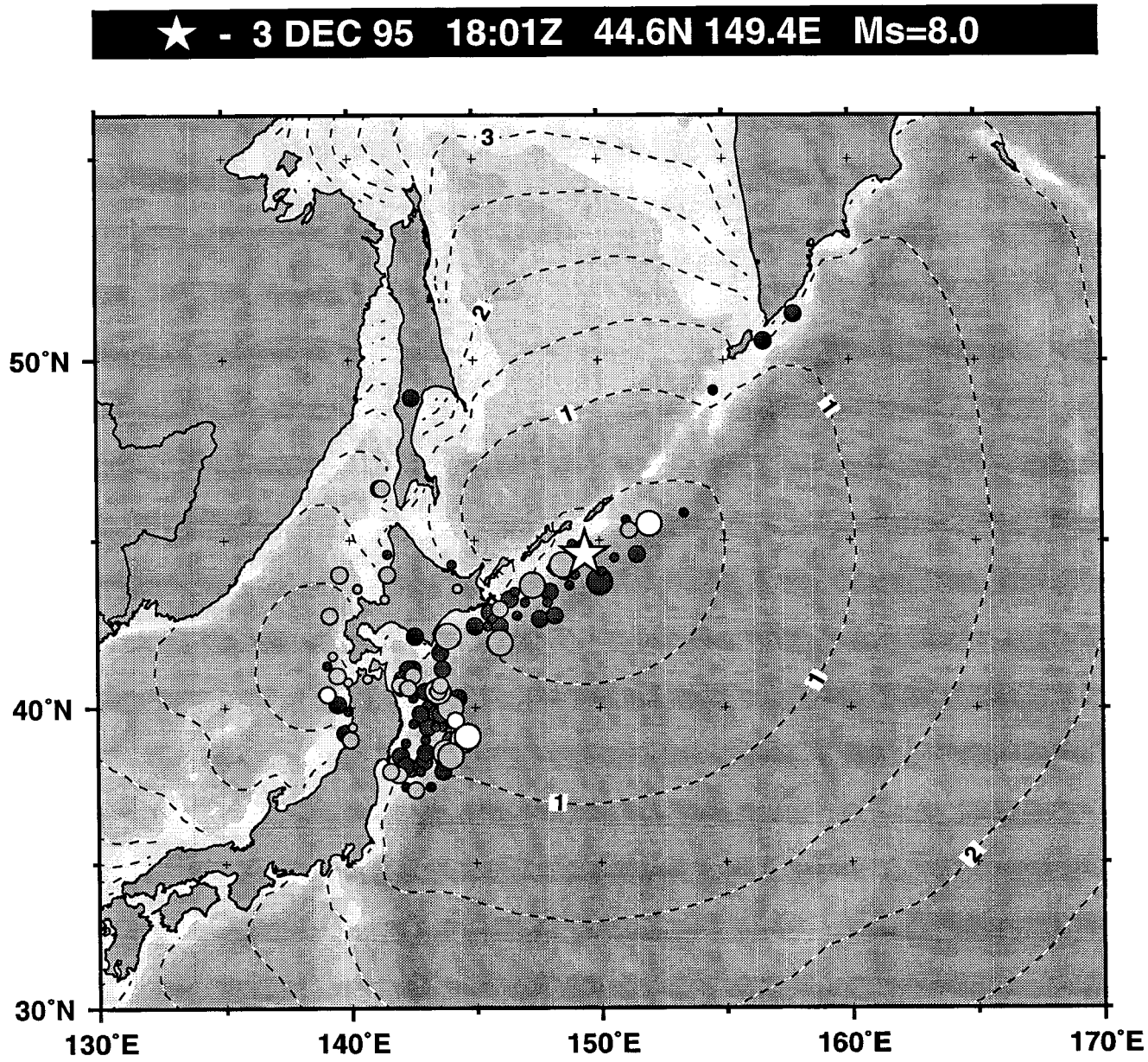
Nemuro, Japan	0.37 m peak-to-trough
Chichijima, Japan	0.44 m
Wake Island	0.13 m
Midway Island	0.41 m
Crescent City, California	0.31 m
Kahului, Hawaii	0.20 m
Hilo, Hawaii	0.09 m
Pago Pago, Am. Samoa	0.09 m
Papeete, Fr. Polynesia	0.07 m
Nuku Hiva, Fr. Polynesia	0.07 m

Notable Historical Tsunami Produced Nearby

• An Ms 8.1 earthquake on June 11, 1958, at 44.3N, 148.5E produced respectively 4.0, 2.5, 5.0 and 3.0 m runups at Iturup, Kunashir, Shikotan and Urup in the Kuril Islands.

• An Ms 7.5 earthquake on June 24, 1973 at 43.3N, 146.4E produced respectively 4.4, 3.1 and 4.6 m runups at Iturup, Kunashir and Shikotan in the Kuril Islands.

• An Ms 7.0 earthquake on June 10, 1975 at 42.8N, 148.2E



ESTIMATED TSUNAMI TRAVEL TIME (LABELED IN HOURS)

HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 1000 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
◎ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	∘ 6.9 OR SMALLER

Earthquake epicenter and estimated tsunami travel times (in hours) for the December 3, 1995 tsunami originating near the Kuril Islands. The earthquake occurred not far north from the one of October 4, 1994 which generated a locally destructive tsunami and was also observed Pacific wide.

produced respectively a 1.9 m runup at Hanasaki, Japan and a 5.0 m runup at both Kunashir and Shirukan in the Kuril Islands.

• An Ms 8.2 earthquake on October 4, 1994 at 43.2N, 147.4E generated a locally destructive tsunami that impacted the coastlines of Russia and Japan and was recorded as far away as Tahiti and Chile. Largest runups observed were respectively 6.0, 10.4, and 8.5 m at Kray Sveta Cape, the southern part of Dimitrova Bay, and the central part of Tserkovnaya Bay, all on the island of Shikotan near the epicenter in the southern Kuril Islands.

Descriptive Account

Based upon the large size, shallow depth, and undersea location of the earthquake, the Pacific Tsunami Warning Center issued a Tsunami Warning and Watch for appropriate portions of the northwest Pacific. The Warning and Watch were canceled later, when water level reports from Russia and Alaska indicated there was no threat of a Pacific-wide destructive tsunami.

The following account is from the United States Geological Survey, National Earthquake Information Center (NEIC):

This earthquake is in the same general area as the magnitude 6.5 event on December 2 at 17:13 UTC and was followed by another event of approximately magnitude 6 at 18:14 UTC on December 3. No reports of damage or casualties were received; however, this earthquake may have caused damage due to its location and size.

January 1, 1996, M_w=7.8, Near Sulawesi, Indonesia

An earthquake and tsunami struck the island of Sulawesi in Indonesia only hours after the start of the new year. The earthquake was located at about 1°N, 120°E, with a surface wave magnitude of 7.7 according to the U.S. National Earthquake Information Center. Initial reports indicate that at least 8 persons were killed and 400 wooden houses severely damaged in villages near the epicenter by the earthquake and/or tsunami. In one village, the runup height was reported to be 3-5 m. An international team headed by Efim Pelinofsky from Russia, and Dede Yuliadi and Rahman Hidayat from Indonesia, will be conducting a field survey of the area affected by the tsunami. A more detailed and extensive report about this earthquake and tsunami will be published in the next issue of the Tsunami Newsletter.

National and Regional Activities

National Report Summaries

The following are summaries of National Reports presented at the IOC/ITSU-XV meeting and representing national tsunami-related activities during the intersessional period between the ITSU-XIV and ITSU-XV meetings (mid-1993 through mid-1995). In a few cases, the summaries contain information that has been updated in the months following the meeting. In addition, a few countries not represented at ITSU-XV have kindly submitted separate summary reports of their national activities for inclusion in the newsletter.

National Report of Australia

Introduction

Recent Australian activities have focused on strengthening coordination and liaison between relevant national agencies and groups and research scientists with the aim of improving national tsunami warning capabilities.

The Tsunami Event in North-West Australia on 3 June 1994

On 3 June 1994 a seaquake of around 7.2 on the Richter Scale occurred off the Indonesian island of Java. A tsunami reached the Australian coast about 3 to 4 four hours after onset. Hundreds of fish, crustaceans, coral, rocks and other debris were carried hundreds of meters inland near Northwest Cape on the Australian mainland. The tsunami was estimated to have been around 3 to 4 meters high. Awareness has been raised about the need to develop a warning capability in the North-West, which is the center of a large offshore oil and gas industry. The environmental risk caused by ruptured pipelines and damage to storage facilities and tanker shipping has been a major concern.

National Tsunami Workshop

The National Tsunami Workshop was held in Brisbane on 25 August 1994, involving experts from a range of fields related to tsunami detection and prediction and warning. A table-top exercise based on the Pacific coast was used to illustrate the difficulties involved in communicating tsunami warnings to the public, and a number of gaps in the present system. The report of the meeting, National Tsunami Workshop, Brisbane August 1994, is available by contacting the ITSU National Contact for Australia.

Tsunami Research Activities

Tsunami-related research projects in progress, include:

• A Ph.D. study by Mr. W. Mitchell, Deputy Director of the National Tidal Facility, on The Tsunami Threat to Australia, which focuses on the characteristics of generation, propagation and inundation of tsunamis in the region to Australia's northwest, and particularly the impact on Australia's North-West coast.

• An IDNDR sponsored multidisciplinary project to assess tsunami risk and implications for early warnings in Australia is assessing the tsunami hazard in Australia and its territories.

• Investigation of the establishment of an Australian Tsunami Warning System, involving the Bureau of Meteorology, National Tidal Facility the Australian Geological Survey Organization, and Emergency Management Australia. The jointly operated system would monitor, predict and issue warnings for tsunamis affecting all Australian coasts (both Pacific and Indian Oceans).

National Report of Canada

Pacific Tsunami Warning System

The October 4, 1994 earthquake near the Kuril Islands generated a tsunami which had a maximum recorded amplitude of 10 centimetres along the British Columbia (B.C.) coast. This was the first measurable tsunami on the B.C. coast in over twenty years. The 3 tsunami warning stations operated by Canada were monitored during the period of expected wave arrival and oscillations of about 5 centimetres were observed on one of these gauges.

Notification of all communication tests initiated by either PTWC or ATWC, as well as summaries of these tests, are received on a regular basis. The present emphasis of the tests is determining the transmission times for messages. The acquisition of water level data and the communication of this information to the warning centers needs to be given renewed attention.

Regional Preparedness

Until recently the Provincial Emergency Program has received notification of a Tsunami Watch or Tsunami Warning by two routes - from Alaska by the NWS satellite, and from Hawaii by telex and fax (via FEMA to MARPAC, Esquimalt). Recently the decision was made that the ATWC would have sole responsibility for the dissemination of Tsunami Watch or Tsunami Warning messages in the northeast Pacific (from Alaska to California). Canada strongly supports this change.

During the last two years the Provincial Emergency Program carried out one test of its' Tsunami Warning Plan. Another test, designated Seaswell IV will be conducted in November 1995. In addition, a CAnadian NATional EXercise (CANATEX II) was conducted in May 1994. This exercise tested the National Earthquake Support Plan and its' interface to the B.C. Earthquake Response Plan, but unfortunately did very little to test the Tsunami Warning Plan.

The Tsunami Warning on October 4, 1994 provided an opportunity for agencies in B.C. to evaluate their plans and procedures under actual emergency conditions. While overall the warning was effective and well-managed, there were some shortcomings and omissions that came to light within the warning system, as well as local operating and alerting procedures that need to be clarified or refined.

ITSU and IOC Activities

At ITSU-XIV the decision was made to continue the activities of the Working Group for public education and awareness with revised terms of reference. Canada agreed to serve as a member of the Working Group and provided considerable assistance to the Chairman in the English translation of the Tsunami Textbooks and Teachers Guides. Canada also participated in a Working Group tasked with developing procedures for post tsunami surveys of tsunami run up and damage.

At the Eighteenth Assembly of the International Oceanographic Commission in Paris, Mr. Geoff Holland (Canada) was elected Chairman of the Commission. During the Assembly Canada expressed it's support for ITSU and it's importance as a program in the International Decade for Natural Disaster Reduction. Canada also stressed the importance of education and public awareness.

International Decade for Natural Disaster Reduction

The World Conference on Natural Disaster Reduction in Yokahama, Japan has provided the impetus for many other programs and activities. Of note are two international conferences being held in Canada in 1996 which are of interest to the tsunami warning and response communities:

• The Hazards '96 Conference, Toronto, Ontario, July 24 - 28, 1996.

• The Pan Pacific Hazards '96 Conference, Vancouver, B.C, July 29 - August 2, 1996.

Tsunami Research

Canada continues to support the concept of tsunami inundation modelling, and has until recently remained active in tsunami research. It notes, in particular, the contributions made by Drs. T.S. Murty and M.I. El-Sabh in this regard. During 1994 Dr. Murty left the Institute of Ocean Sciences to become the Director of the National Tidal Facility at Flinders University in Australia. His departure severely reduces the amount of tsunami research being done in Canada.

In support of studies being carried out by the Pacific Geoscience Center to monitor crustal deformation on Vancouver Island, the Canadian Hydrographic Service maintains a network of twelve water level stations to obtain information on rates and trends of sea level change.

Training and Education

Much of the public education for earthquake preparedness is provided by staff of the Pacific Geoscience Center. Experts from the Institute of Ocean Sciences regularly provide talks and instruction in tsunami and tsunami response to researchers, schools, and the general public in British Columbia.

In the last few years there has been compelling evidence that megathrust earthquakes occur along the Cascadia subduction zone and that the last of these earthquakes may have occurred in December 1700. This area is unusual in that it has been quiet

in recent centuries, despite having the geological characteristics that in other parts of the world are active. Although no subduction earthquakes have been reported in this area in recent times, the recent Cape Mendocino earthquake (at the edge of the subduction zone) shows that the two zones are locked and strain is building.

National Report of Chile

Introduction

This report summarizes the activities of the National Tsunami Warning System during the period since the Fourteenth Session of the ICG/ITSU held in Tokyo, Japan, until December, 1995. Several tsunami were recorded during the reporting period at tide gauges along the Chilean coast.

Instruments Upgrade

During March, 1994, a contract was signed with the "Commissariat to L'Energie Atomique" of France for the implementation of the TREMORS system - seismic monitoring equipment for estimating the tsunami risk. This system improves the existing seismic network and tsunami warning system in Chile, giving information in real time of seismic parameters and their relationship with some of the parameters of tsunami generation.

System installation in facilities of the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) began in March of 1995, and is currently in a state of testing and limited operation. Final calibration of the equipment is planned for May, 1996. After that date, the TREMORS system will be fully operational.

A new automatic satellite-linked tide station (DCP) was installed during May, 1994 at Salas y Gomez Island (26°28'S, 105°22'W).

Communication

In April, 1995, a readout ground station was installed at the head office of the National Tsunami Warning System in SHOA, in order to get data in real time from the 10 existing DCP's.

Tsunami Education and Awareness

The earthquake and tsunami textbooks produced as a result of the tsunami public education awareness program were widely distributed at several schools throughout the country. Camera-ready originals of the texts in Spanish and English were provided to the IOC Secretariat.

Several seminars on natural disasters have been organized by the national emergency office at different areas within Chile. In all of them, a special chapter has been devoted to earthquakes and tsunamis.

Contribution of Chile to the IOC Tsunami Program

Chile made a monetary contribution to the IOC Trust Fund of US$3,000.

Three experts in earthquakes and tsunamis have been nominated to be part of quick response missions to tsunami affected areas. They are Mr. Lautaro Ponce from the Department of Geophysics, University of Chile, and Mr. Alejandro Cabezas and Mr. Emilio Lorca from SHOA.

Participation at the IDNDR World Conference

As reported in the July, 1994 ITIC Newsletter, the World Conference on Natural Disaster Reduction, hosted in Yokohama by the government of Japan, was attended by over 2,000 individuals including representatives form ICG/ITSU. Mr. Emilio Lorca addressed Technical Committee F regarding the Tsunami Warning System. Tsunami textbooks in Spanish were displayed at the Exhibition Hall of the Conference Center.

IOC/ITIC Visiting Experts Program for 1995

Mr. Dante Gutierrez, Oceanographer of SHOA, was accepted to participate in the IOC/ITIC Visiting Experts Program to be held in Honolulu at ITIC from 23 October to 17 November, 1995.

Mr. Gutierrez has been involved from March, 1995 with the Tsunami Program of the Department of Oceanography of SHOA, and works in the National Tsunami Warning System.

TIME Project

SHOA and IOC have organized the Tsunami Inundation Modelling Exchange (TIME) project, a training course on numerical tsunami modelling. It will be taught in Valparaiso, Chile from March 11 to May 11, 1996, by Mr. Modesto Ortiz of CICESE in Mexico. The course will be given only in the Spanish language, and at this time we can confirm the participation of representatives from Peru, Ecuador, and Colombia, as well as three Chilean scientists.

National Report of Colombia

During the intersessional period the following activities of the Colombian Tsunami Mitigation Program progressed or were initiated, under coordination of the Direcci'on Nacional para la Prevenci'on y Atenci'on de Desastres DNPAD (Ministry of the Interior) and the Comisi'on Colombiana de Oceanograf'ia (Comit'e T'ecnico de Alerta de Tsunami). Presently most actions are aimed at he southern part of the Pacific coast of Colombia and especially the town of Tumaco (pop. about 75.000), the largest town in the most endangered segment.

During the last two years funding for the Program has been mainly from the Fondo Nacional de Calamidades, the Swiss Disaster Relief, Corporaci'on Colombia por Tumaco, UNDP, the European Community and Observatorio Sismol'ogico del SurOccidente - OSSO.

Hazards Evaluation

With support from the Swiss Disaster Relief and Tohoku University, OSSO is working on the modeling of propagation and runup for near source tsunami. OSSO presented a proposal to French scientists to study prehistoric earthquake and tsunami occurrence on the Pacific coast of Colombia and Ecuador with archaeological and geological approaches. A group of French

DNPAD and OSSO are presently completing a project of Aerial photography of settlements exposed to tsunami along the coast of S-Colombia. The middle part of the coast has already been subject of such a project.

Public Information and Education

OSSO is developing instruments for public information and education (textbooks, videos, etc.), for population exposed to tsunami and earthquakes. Initially, as a pilot project, these have been designed for the Tumaco area.

Risk Mitigation

A project to resettle 3.500 families in Tumaco, presently dwelling in areas of highest exposure, is in progress, with funding from national sources and from the European Community.

With national funding, a new bridge (20+ m wide) with capability for evacuation operations is being emplaced between Tumaco and the mainland.

Detection and Warning

Presently there is only a limited detection capability for near source tsunami, with broadband accelerometers (OSSO).

A proposal to install the TREMORS system has been presented by Colombian and French scientist to the two governments, receiving positive initial response. The technical director of LDG, Msr. Andree Meesters, visited OSSO in Sept. 1995. At the earliest, installation would begin in mid-1996.

Communication

The Defensa Civil expanded its network of VHF voice communication on the Pacific coast. OSSO improved its communication capability, with a full Internet link and transceivers for the regional channels of Defensa Civil, Red Cross and regional authority networks.

A proposal has been presented to the Swiss Disaster Relief, to support the design and installation of a specific warning communications network to link OSSO with settlements along the coast, where most places have no access to infrastructure (electricity, telephone, etc.).

OSSO's communications with PTWC have mainly been over Internet and Fax. All warning messages in the Pacific System in 1994-95 were received by OSSO in time and handled by all participating institutions efficiently, without unnecessary reactions and disruptions.

International Cooperation

OSSO received in 1995 about US$10,000 from UNDP/ DNPAD, to continue cooperative activities with Ecuador.

National Report of the Cook Islands

Introduction

The Cook Islands are relatively unaffected by tsunami. The only tsunami of note in this century was in 1960, when the tide drained out of the two harbors on the northern side of Rarotonga Island and filled back up again. (Still to be verified). So far, very little damage has occurred in the Cook Islands from tsunami. In the last four years six warnings were received from the Pacific Tsunami Warning Center (PTWC); two in 1995 alone, but fortunately no tidal waves eventuated.

Location

The nearest earthquake-prone countries to the Cook Islands are Fiji - 1,500 km west, New Zealand - 2,000 km southwest; and Chile - 5,000 km east. The Cook Islands itself is not on the Pacific earthquake belt. There is no name for tsunami in the native Cook Islands dialect.

Monitoring Equipment

A Seismological Recording Station is located on the main island of Rarotonga and it is monitored on a regular basis by staff from the Cook Islands Meteorological Service. Tide gauges are located on Rarotonga and the northern island of Penrhyn, which is 9 degrees south of the equator. These gauges are part of an Australian Tidal Programme which covers eleven countries in the South Pacific.

Organization

Warnings from PTWC are received by the Meteorological Service Station and relayed to the Commissioner of Police and the Chairman of the National Disaster Management Committee (NDMC) who are responsible for activating the appropriate response plans. The national radio and television station is also advised to relay the warning to the public. Tsunami warning and response procedures were included in the recently completed National Disaster Plan.

Future Plans

The NDMC intends to include tsunami information for the first time in their 1996 Disaster Awareness Week. This public information programme is held every year during the first week of November. The intention is also to improve the speed of warning transmission for sudden-onset hazards such as tsunami to the general public with the possibility of installing sirens in critical areas to complement radio and television messages.

National Report of Costa Rica

Sea Level Gauge Network

The Tidal and Sea State Program of Costa Rica (SERMAR) from Instituto Meteorologico Nacional acts as dissemination agency for PTWC in Costa Rica, and operates a network of sea level gauge stations. In the Pacific ocean coast, Quepos station sends data on a regular basis to the Tropical Oceans and Global Atmosphere (TOGA) program.

This station and two other ones, probably at Guajiniquil and Caldera will transmit real-time data from April 1996. In addition, two new gauges in the gulfs of Nicoya and Dulce will be installed by the year end. These two last ones, plus the one in Isla del Coco (presently being upgraded) are also expected to be fully automated and equipped with satellite data transmitters by

year end, adding up to a total of 6 stations for the Pacific coast of Costa Rica.

Seismological Network

The Observatorio Sismologico y Vulcanologico de Costa Rica (OVSICORI) from Universidad Nacional, efficiently operates a seismological network across the country. Their information may become an important contribution to the operation of a future tsunami warning system.

Regional Training Center

The International Ocean Institute (IOI), also from Universidad Nacional of Costa Rica, operates a regional training center on coastal and ocean management for Central America and the Caribbean. Through this program an effort is being made to coordinate among the countries of the region the improvement of the installation, maintenance and operation of their sea level gauge stations. Besides the usual tidal processing purposes, these improvements may help monitoring sea level changes related to climate variability, as well as tsunami research and warning activities in the region.

National Report of France

Introduction

The Laboratoire de Geophysique (LDG) has been progressing in the development and implementations of the TREMORS system. The software has been improved in various aspect and 4 new stations have been implemented, one in Portugal (GITEC EEC project), one in the Ivory Coast and two in French Polynesia. Some of the TREMORS stations are equipped with a data transmission system which uses INMARSAT satellites. In such a system, several tens of parameters are transmitted instead of the waveform itself, for which the delay of transmission would be much longer. Moreover, the cost of the transmissions is minimized. These parameters are the results of the automatic analysis made in quasi real time, that is to say, the location of the epicenter, class of depth, the seismic moment, the spectral amplitudes of the Rayleigh and Love waves....etc.

Studies and Lecture

A great part of the tsunami activities concerned near field study, especially for estimating the seismic source parameters with a minimum of delay and for testing the accuracy of the estimations. We studied eight tsunamigenic earthquakes between 1992 and 1994 with data from single near-field long period stations. Simulations of early warnings based on real-time computation of the seismic moment show that a justified warning would be forwarded in each case. We demonstrated that the TREMORS system has the capability of recognizing the "tsunami earthquakes" (Nicaragua 1992 and Java 1994) as well as deeper events (Guam 1993) : this system is the unique one which gives efficient warning for the "tsunami earthquakes" in near as in far field (Schindele et al. : Analysis and automatic processing in near field of eight 1992-1994 tsunamigenic earthquakes : improvements towards real-time tsunami warning, Pageoph 1995) A 10-hour lecture on "Tsunami Warning with broad-band seismometers" was given by Dominique Reymond in Tsukuba City. This course was held in the International Institute of Seismology and Earthquake Engineering, for twenty participants from various countries.

Numerical Tsunami Modelling

The different phases of the 1960 Chilean tsunami have been modelled (generation, propagation and impact on the coast). The tsunami generation is initiated by the vertical ground deformation. The numerical model of propagation and impact uses an implicit-in-time finite-difference method with possibilities of land flooding and run-up. In 1960, most of the Polynesian islands were submerged by waves with heights of only 1 to 2 meters because of the steep offshore slopes and the protection of outer barrier reefs. The most affected islands were the Marquesas that present very few outer reefs, more gradual bottom slopes and large bays. The numerical results obtained in Tahiti and Nuku-Hiva confirmed these observations and the tide-gauge record as well as the observed run-up heights in Tahiti are well reproduced.

National Report of Indonesia

Introduction

After the Flores earthquake-tsunami of December 12, 1992, which caused more than 200 people's deaths and either totally or heavily damaged about 30,000 buildings, there was the Banyuwangi earthquake followed by a tsunami. This earthquake happened on June 3, 1994, at about 1 o'clock in the morning. The epicenter of this event is about 250 km southwest of Banyuwangi. There were almost no victims or damage due to the shock of the earthquake because the epicenter was located far enough from the island of Java. However, due to the tsunami wave, there were about 219 people killed, 21 missing, and 235 injured. The tsunami was observed along the south coast of East Java, and the maximum wave height was 14 meters in Rajegwesi (East Java Province). The tsunami also caused severe damage along the west coast of Bali Island with a maximum wave height of about 4 meters.

Seismological Network

As we have already reported at the XIV ITSU/IOC meeting, The Indonesian Meteorological and Geophysical Agency (MGA) is the only institute in Indonesia which is charged with handling seismological monitoring. At present, MGA operates 55 stations that consist of 28 non-telemetered stations and 27 telemetered stations. MGA has operated the telemetered seismological network since October, 1991. This telemetered seismological network is grouped into 5 regional networks. The National Seismological Network consists of a National Seismological Center (NSC) in Jakarta, and 5 Regional Seismological Centers (RSC) located in Medan, Ciputat, Denpasar, Ujung Padang, and Jayapura. Up to now, three of them are equipped with data processing facilities to locate the earthquake sources. Those three regional networks are RSC I Medan, RSC

II Ciputat, and RSC III Denpasar. By the end of 1995, we will have 2 more stations - one will be installed at Kupang (RSC III) and the other in Manado (RSC IV). Also, we will equip the RSC IV and V with processing facilities. This extension of the network will include as well seismic real time processing at the National Level of MGA. All these activities will improve MGA's capability to give more accurate and faster earthquake information in order to mitigate the disaster that might be generated.

Tsunami Warning

The Indonesian government does not have a tsunami warning system yet. In the near future (by the end of 1995), we will have a tsunami warning capability using TREMORS at the Tretes Geophysical Station. At this station, we have already installed a broadband seismograph with three components. Now we are installing the TREMORS at Tretes. This system will connect to the National Seismological Center in Jakarta by telephone line.

Tide Gauge Stations

The tide gauge network has been established by the National Coordinating Mapping and Survey Board (BAKOSURTANAL). This network consists of 25 stations, with 14 of them recorded continuously on paper, and the others recorded digitally every 25 minutes on punch tape.

Organization

The government of the Republic of Indonesia has established the National Coordination Board for Disaster Management (BAKORNAS PB) which is chaired by the Minister of Coordination of Social Welfare. BAKORNAS PB executes disaster management activities during and post disaster that include mitigation, relief, rehabilitation, and reconstruction at places where disasters occur.

Joined together with UNDP, BAKORNAS PB has been strengthening its secretariat and Disaster Management Executing Unit (SAKLAT PB) in two regency's locations, Minihasa and East Flores. Two regencies have been chosen due to the types of disaster. Minihasa is concerned with volcanic disaster, and East Flores with earthquake-tsunami disaster. Those places have been chosen as pilot projects for a model to manage disaster in other regencies.

Future Plan

To improve the MGA's capabilities in the field of earthquake localization, we propose to enlarge the seismological network. At the present time we have five Regional Seismological Centers. We propose to add five more as well as a number of sensors to be installed at each region. With ten RSC's we will cover all our earthquake prone areas. Any earthquakes occurring in the Indonesian region will be determined accurately by MGA. As we have already proposed to the ITSU/IOC, we still need tsunami warning capability at more than one station. The proposal should be revised with new technology since it was made six years ago.

National Report of Japan

Introduction

The Japan Meteorological Agency (JMA) is responsible for issuance of the tsunami warning and earthquake information in Japan. The JMA has six Regional Tsunami Warning Centers (RTWCs) at Sapporo, Sendai, Tokyo, Osaka, Fukuoka and Okinawa. In the case of Tokyo, JMA Headquarters functions as one of the RTWCs. When an earthquake occurs near Japan and a tsunami is expected to be generated, each center is respectively responsible for issuing warnings to their respective coasts. In addition, JMA Headquarters, as the national center, is also responsible for issuance of warnings to the whole Japanese coast and to nearby maritime regions when a remote tsunami event is regarded.

Forecast Issuance Process

JMA is monitoring seismic activity 24-hours a day using seismographs deployed all over Japan. All the seismic signals detected by seismographs are continuously transmitted to the computer system installed at each regional center (EPOS: Tokyo, ETOS: others). Soon after an earthquake occurs in and around Japan, the person in charge determines the hypocenter and magnitude of the earthquake by man-machine method. Then the computer system selects an appropriate wording of a warning and/or advisory message. After the person in charge verifies and modifies the final result, the tsunami warning and/or advisory are transmitted to the authorities related to disaster prevention in the central and local government, broadcasting media, and others through the computerized telecommunication system (Automated Data Editing and Switching System (ADESS). The same information is sent to PTWC and to some countries via GTS.

Progress in Tsunami Forecast Issuance

JMA Headquarters established the practical regulation for services in the tsunami forecasting in April 1952. Until about ten years ago, it had taken ten-plus minutes or more for issuance of the forecast after an earthquake occurrence.

Since 1987, new computer systems (EPOS: Tokyo, ETOS: Others) were installed at RTWCs successively to improve the tsunami services. In the case of the 1993 Hokkaido Nansei-oki earthquake, off southwest Hokkaido, with its magnitude of 7.8, the warning was quickly issued within 5 minutes after the earthquake by Sapporo RTWC.

On the other hand, to shorten the time for sending dissemination's, we established a new information system in cooperation with the broadcasting media. Under the new system, the prompt information regarding the occurrence of a large earthquake issued by JMA is automatically superimposed on TV on a real-time basis.

In addition, the satellite based information dissemination system was newly established in 1994 to back-up the functional disorder on the land-line based communication system, and to

insure another route for prompt dissemination of tsunami forecasts to local governmental authorities and terminal users.

In March 1995, the computer processing system in Tokyo was improved by a new one, and we started to disseminate new tsunami information, including the estimated arrival time.

Future Plan

To cope with the tsunami hazards more adequately, the practical wave-forecast that estimates heights of tsunami for fine forecast sections of coastline should be required. For this purpose, JMA started to make a new tsunami forecast method. We simulated the propagation of tsunami from earthquakes with different magnitudes and depths at each of over 1000 specified grid points under the sea floor around Japan. Consequently, the height of tsunamis reaching each coast, brought about by various kinds of earthquakes under the sea floor, can be calculated by using the numerical model.

It is safely said that about 2-3 years later, a database of tsunami heights at each specified coast obtained by the numerical model will be completed. And then the test on wave-forecast including its height, arrival time and so forth, will be continued for various types of earthquakes by using the newly developed technique and database.

Hereafter, such efforts should be continued to take measures against eventuality regarding disaster caused by tsunami, as well as the international cooperation.

National Report of Mexico

Tsunami Inundation Modeling Exchange (TIME)

The numerical models for tsunami inundation from the Disaster Control Research Center (DCRC) of Tohoku University (Japan) were adapted to a CRAY supercomputer by Mr. Modesto Ortiz from the CICESE Research Center of Mexico. Simulations of the 12 July 1993 Hokkaido tsunami and the 19 September 1985 Michoacan (Mexico) tsunami were successfully accomplished. For the last one, results show a reasonable agreement of computed runup values with the visually observed ones at the industrial port of Lazaro Cardenas and the tourist resort of Zihuatanejo; and adequate fitness of maximum wave heights simulated at the shore with the only ones recorded by gauge.

With source parameter estimates from past-earthquakes which produced large tsunami runups and others of high probability of occurrence at the seismic gaps off the Middle America Trench, eventual inundation patterns and water flows, by simulation of potentially threatening tsunamis, were obtained for Acapulco and Zihuatanejo.

The inundation maps produced by this project will be used by the Civil Protection Government Agency (Direccion General) of Mexico for tsunami hazard planning to minimize the loss of life and damage to property.

Standarization of Tsunami Survey Procedures

In support of a recommendation made at ICG/ITSU-XIV, an ad hoc working group to develop standards for post-tsunami surveys and measurements of runup, chaired by the Director of ITIC, and with assistance from representatives of Canada and Mexico, was formed. The document IOC/ITSU-XV/13: "Standards for Tsunami Surveying", prepared by this ad hoc group with the results of their work, was submitted to the ICG/ITSU XV Session. As a collateral activity, representatives of Mexico participated in the Tsunami Measurements Workshop held in Estes Park, Colorado, U.S.A. during June 1995.

Update of the ITSU Master Plan

In support of a recommendation made at ICG/ITSU-XIV, an ad hoc working group to create an addendum of additions and corrections to the ITSU Master Plan, chaired by the Director of ITIC, and with assistance from representatives of France and Mexico, was formed. The document IOC/ITSU-XV/14: "Status of Revision of the Master Plan for the Tsunami Warning System in the Pacific ", prepared by this ad hoc group with the results of their work, was submitted to the ICG/ITSU XV Session.

ITIC Brochure in Spanish

A translation to Spanish of the new updated version of the ITIC brochure was made by Mr. Salvador Farreras from CICESE, and also submitted to the ICG/ITSU XV Session.

Extension of Sea-Level Network and Participation in the PTWS

CICESE continued acting as a dissemination agency for the PTWS on a limited basis. Manzanillo, Socorro Island, and Cabo San Lucas sea level stations were permanently in operation, equipped with DCP's and transmitting through the GOES satellite to PTWC. Maintenance was given by CICESE and the Mexican Navy, with the cooperation of the Sea Level Measurements Group/Pacific Operations Section of the Sea and Lake Levels Division/NOS/NOAA, the PTWC/NOAA, and TOGA/ University of Hawaii. Actions will be taken during 1995/1996 to reconstruct Guadalupe Island sea level station.

ITIC Associate Director Position

In support of a permanent request made at several ICG/ITSU Sessions, to fill the position of Associate Director of ITIC, Mexico presented its representative to the I.U.G.G. Tsunami Commission, Mr. Salvador Farreras, as candidate to the post, for a period of 12 months. Dr. G. Kullenberg, Secretary IOC, approved the nomination and secured funding to provide him a supplemental allotment to help defray the extra cost of living in Honolulu, Hawaii. Mr. Farreras assumed his position by mid-April 1995. CICESE and the representatives of Mexico to the XV ICG/ITSU Session are very grateful to Dr. I. Oliounine, Senior Assistant Secretary IOC, Cap. Hugo Gorziglia, Chairman of ICG/ITSU, and Cdr. Dennis Sigrist, then Acting Director of ITIC, who seconded the proposition of Mexico, and

particularly to Dr. G. Kullenberg, Secretary IOC, who approved it and provided support to Mr. Farreras. We hope that his 12 months stay as Associate Director of ITIC will be fruitful and beneficial to the ITSU activities.

Research Activities and Communications

Tsunami research activities continued at CICESE, mainly in the topic of numerical simulation of tsunami generation and inundation patterns. Research papers, posters, and lectures were presented at the following international meetings or courses:

- *September 1993.* Fifth International Conference on Natural and Man Made Hazards, Natural Hazards Society, Qingdao, P.R. of China
- *May 1994.* World Conference on Natural Disaster Reduction, United Nations, Yokohama, Japan.
- *July 1994.* Summer Course on Natural Hazards, Universidad Internacional de Andalucia, La Rabida, Spain.
- *December 1994.* Fall Meeting, American Geophysical Union, San Francisco, USA.
- *June-July 1995.* International Tsunami Measurements Workshop, Estes Park, Colorado, U.S.A. and I.U.G.G. International Tsunami Symposium, Boulder, Colorado, U.S.A.

National Report of New Zealand

Tsunami Activity

No near source tsunamis have been detected or reported in New Zealand waters during the reporting period. The only activity that necessitated an activation of the national warning systems was an "alert" issued by the Ministry of Civil Defence following the Pacific wide warning disseminated as a result of the R8.2 earthquake centered off North East Hokkaido, Japan on October 5, 1994.

Nevertheless, the possible threat of a near source tsunami being generated is made aware by the ever occurring seismic activity that continues to be generated off the coast of New Zealand. The last five years has been more active in this regard than the previous 20 years.

Therefore, the Ministry of Civil Defence continues to exercise its national warning plan involving central government departments, local government civil defence organizations as well as the New Zealand Police. Quarterly testing each year is mandatory and the national plan must be reviewed at least once every three years.

Reporting Equipment Within New Zealand

Apart from the many hydrographic telemetry networks and port authority tide stations, three tide stations are maintained principally for sea level data associated with the Pacific tsunami warning system. Of these stations, Marsden Point, Whangarei and the Port of Lyttleton can be accessed by modem, whereas the Chatham Islands station is the sole data collection platform (DCP) transmitting by satellite to Hawaii. The automated tide station at the Port of Lyttleton could be configured for DCP without difficulty.

National Scientific Advisory Committee

The Tsunami Sub-group of this committee under the Chairmanship of Professor T. Healy of the University of Waikato, remains active, and was so particularly during the October 5, 1994 tsunami event.

Public Education

The Ministry of Civil Defence National Public Education Advisory Group is aware of the public education and awareness material that is being developed. It would welcome an English language version of the Spanish text books and it is interested in procuring a resource for inclusion in its education kits for some 2800 grade schools.

The Ministry of Civil Defence continues with further publication and distribution of its information pamphlets on all hazards.

Research and Hazard Analysis

Research on tsunami hazard analysis and coastal inundation is continuing particularly in the east coast regions of both the North and South Island, which are more vulnerable to tsunami particularly those which may be generated from off the South American west coast. Case studies based on tsunami threats to the New Zealand east coast areas have been conducted by regional councils during the reporting period and there is significant awareness of the need to improve warning plans and systems.

National Report of Nicaragua

Seismic Network

The Nicaraguan Seismic Network has now about 20 telemetered stations (short-period vertical components) sending their data in real time to the computerized data processing center at INETER Headquarters in Managua. At the Managua data center there are installed three-component sets of short-period, middle-period seismometers and accelerometers.

A seismic broad band station (Quanterra data logger and STS-2 three-component seismometer) was acquired at the end of 1995. It runs at the moment for testing and training purposes in Managua and will be installed in the near future as an autonomous station in the Nicaraguan mountain region, far from the coast. Data access will be possible by high-quality telephone links. This station is intended to serve for rapid magnitude determination of large seismic events.

The processing of seismic data is carried out at the Managua data center by qualified persons belonging to the Seismological Shift operating 24 hours a day. Strong events are processed and a short report (hypocenter, magnitude, origin time, map) is

presented within about 10 minutes after the event occurs. Then, within another few minutes, this report is sent to large numbers of institutions (Government, Civil Defence, Mass media), using an automatic fax server.

Improvement of the Communication System

A radio communication system was installed which connects the headquarters of the Civil Defence with the seismological data center of INETER and with the most important towns and villages of the Pacific Region of Nicaragua — especially with settlements along the Pacific coast. This system permits voice communication as well as the transmission of special codes. Though installed in the frame of the tsunami warning system, the facilities are also used in other emergency situations.

The voice communication system is generally used to transmit alerts, warnings, explanations, and information that do not require very rapid actions of the population or authorities. The transmission of coded signals will serve for the remote control of sirens and other acoustic warning devices to enable an immediate alert of the coastal population after having detected a tsunami-prone situation. These devices, partially developed in Nicaragua, will be installed in 1996.

General Aspects

The Nicaraguan Tsunami Warning System is still under development. Plans of responsibility and decision making, implementation of a formal legal base for the system, further training of personnel at all levels, improvement of the technical and seismological base, and education of the population are topics of the 1996 development program of INETER, Civil Defence, and authorities at all levels.

National Report of Peru

Organization

The Dirección de Hidrografía y Navegación de la Marina (DHNM) coordinates and operates the activities of the National Tsunami Warning System of Peru since its inception in 1970. Messages from PTWC are received via telex by the Peruvian Coordination of Commercial Airports (CORPAC) and re-routed to DHNM by a dedicated telephone line and telex. DHNM reports to the Instituto Nacional de Defensa Civil (INDC) on the eventual occurrence of a tsunami to take preventive measures or organize evacuations.

Seismological Network

The Instituto Geofísico del Perú (IGP) operates two telemetric seismic networks connected to an automatic seismic signal processing system, which gives hypocenter location and magnitude of earthquakes to DHNM through a dedicated telephone line. New equipment for seismic detection and the interconnection with worldwide digital seismic networks, like GEOSCOPE and IRIS, are expected to be in operation by two years from now.

Tide Gauge Station

DHNM maintains a network of 8 sea level measuring stations, each of them equipped with both an analog and a digital gauge. Two of them (Callao and Lobos de Afuera Island) were recently equipped by the TOGA program with Handar platforms for real-time satellite data transmission to PTWC. In addition, a Bristol gauge provided by PTWC and installed in Callao is connected via a dedicated telephone line to DHNM headquarters to monitor and receive the information in real time.

Future Plans

- Installation of a decodifier to allow automatic reception of PTWC messages at DHNM.
- Direct accessibility via modem of the Handar platform data.

Training and Education

DHNM organized a training course for CORPAC personnel, and actively participated, in coordination with the civil defense, red cross, and police in a tsunami evacuation drill exercise.

Tsunami posters and information bulletins have been printed and distributed among the coastal population of Peru. A 30 minutes tsunami video, to be shown on TV, at schools, workplaces, and to the general public, was produced by DHNM and the Catholic University of Peru, with financial help of the National Council on Science and Technology of Peru (CONCYTEC).

National Report of the Republic of Korea

Introduction

The east coast of the Korean peninsula, which stretches north to south with a length of one thousand kilometers, has experienced two significant tsunami during the past dozen years (1983 and 1993). This coastline faces the west coast of Japan - a region which occasionally produces tsunamigenic earthquakes. Consequently, the Korea Meteorological Agency (KMA) pays particular attention to large earthquakes in this area. Following the July 1993 tsunami, there have been no tsunami in the surrounding sea during the intersessional period.

Local Seismicity

For the most recent three-year period, there have been 76 earthquakes observed in and around this country. This is a relatively higher level of seismicity than was observed in the late 1980's to early 1990's. The biggest earthquake was a magnitude 6.0 which occurred in 1995 in the East Sea region.

Seismological Network

The KMA has extended the network sites from 11 to 12 by adding one at the island of Ulleung-do in 1994. This island site, located in the offsea region of the East Sea, is expected to be

very useful for detecting tsunamigenic earthquakes occurring along the west coast of Japan.

In late 1994, a digital seismological system of the Global Seismograph Network was installed by IRIS/USGS as a replacement for the old WWSSN at Seoul. Temporary Very Short Period (VSP) sensors were exchanged for Very Broad-Band (VBB) sensors, which were relocated to the new seismic vault at Incheon (INCN) in July 1995.

Tsunami Information Communication

Communication of KMA with JMA, PTWC, ATWC, and other foreign countries is carried out through the World Meteorological Organization (WMO) Global Telecommunication System (GTS). The GTS line is a point-to-point 9600-baud circuit to JMA. When a large distant earthquake is detected, KMA sends out a "TSUNAMI X" message to inform recipients of the P arrival time at Seoul, and to request the earthquake parameters and tsunami information.

In 1993 and 1994, KMA sent out "TSUNAMI X" messages 51 times, and received information including warning messages 41 times from JMA, PTWC, and Khabarovsk. Up to the present in 1995, KMA has sent 16 "TSUNAMI X" messages, with 9 replies from JMA and 5 from PTWC and Khabarovsk.

Tsunami dummy tests from PTWC were answered by KMA 19 times in 1993 and 1994, and 17 times in 1995.

Activities for Tsunami Preparedness

Joint Survey for the Indonesian Tsunami in 1994. A joint survey team was assembled and carried out a tsunami survey along the coast of Java Island in June, 1994 following the large tsunami there. A trainee of KMA who was in the training course at the International Institute of Seismological and Earthquake Engineering (IISEE), Japan joined the survey team which was lead by Professor Tsuji Yoshinobu of Tokyo University, Japan. A total of 24 survey team members were gathered from 5 countries and have successfully completed the joint work.

IOC/ITIC Visiting Experts Programme. KMA also participated in the IOC/ITIC Visiting Experts Programme 1994, for training in the field of tsunami warning services. KMA expresses appreciation to the IOC/ITIC for accepting an expert from Korea.

Research for Tsunami Detecting Technology. A research group for tsunami was formed by the KMA and associated professors from several universities in Seoul. They will develop and improve the analysis technology for the medium distant events, tsunami propagation modelling, tsunami disaster prevention, and evaluation of tsunami risks with a three-year plan from 1994 to 1997.

Future Plans

KMA plans to upgrade the seismological computer system with high level workstations, and to improve the techniques used to detect and analyze medium-range tsunamigenic earthquakes by a real-time system. The system shall be designed suitable to the application software used in an advanced operational system such as PTWC.

We also plan to strengthen tsunami-related research, to specialize the organizational system, and to activate international cooperation.

National Report of Russia

The Far East coast of Russian Federation is subject to the effects of tsunami occurring both in the immediate vicinity of the Russian shores (within the Kuril-Kamchatka trough and in the Sea of Japan) and from remote sources.

Structure of National Tsunami Warning Service

The seismological, hydrophysical, communicational and organizational aspects of the tsunami warning problem are distributed between several ministries and departments.

The Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) organizes tsunami wave propagation observations, calculations of the time of a tsunami approach to the coasts of Russia, estimation of the degree of tsunami danger, making decisions on whether to transfer or to cancel the warnings about tsunami threat, forming and communicating the signals and messages to the services of the Ministry of the Russian Federation for Civil Defence, Emergencies and Liquidation of Consequences of Natural Disasters (Emercom) the Ministry of communications and local administrations, and provides operative interaction with the International TWS centers. These functions are executed by three independent centers in Youzhno-Sakhalinsk, Petropavlovsk-Kamchatski and Vladivostok which are responsible for warnings about tsunami in their administrative regions (Sakhalinskaya and Kamchatskaya provinces and Primorski land correspondingly).

The Geophysical Service of Russian Academy of Sciences provides round-the-clock operative work of the seismological stations functioning in the TWS, operative location of underwater earthquakes and estimation of the degree of their tsunamigenity, warning of the services of Emercom and local administrations about the tsunami threat in cases of very strong close earthquakes, and transference of data on underwater earthquakes in the Pacific ocean to the subdivisions of Roshydromet.

The coordination of activities of all bodies functioning within the TWS, timely warning of the population about the tsunami threat, and the organization of the works on prevention and liquidation of emergency situations caused by tsunami are being secured by the territorial subdivisions of Emercom and by those attached to the local administration Headquarters for the liquidation of emergency situations.

Criteria Applied to the Functioning of the National TWS

As in the previous years, the functioning of the National TWS

is based on the seismic method of short-range tsunami forecasting. The magnitude-geographical criterion is used for the estimation of the potential threat according to seismological data.

Hydrophysical observations, being of secondary significance, are also, in certain of cases, important for short-range forecasting of tsunami for the adjacent coastal regions.

Development and Modernization of the National TWS

During the intersessional period (1993-1995), the modernization of the National TWS was carried on, notwithstanding the financial difficulties. Its main trends were determined by the results of experimental operation of the first version of the automated system in 1989-1992 and in accordance with the ideas of the TIME project.

The development of a new numerical seismological complex has been completed; original software has been elaborated for both the automated and the interactive processing of seismic signals and determining the parameters of earthquakes in a close-to-real-time regime based on data of one seismological station.

A hardware-software unit, performing all the activity of real-time event processing, according to the regulations for the operative tsunami service, with automated output of messages into communications channels, has been designed and put into experimental operation in 1993-1994 at the Youzhno-Sakhalinsk and Petropavlovsk-Kamchatski regional TWS Centers.

A model of an expert system and of a corresponding Pacific database has been developed, which provides for making a more justified decision about a tsunami threat to the towns of Far East coast of Russia.

In Roshydromet and the Russian Academy of Sciences a programme for further modernization of the National TWS has been developed and is realized by phases. The priorities of modernization of Russian TWS are as follows:

1. Qualitative improvement of the communications facilities of the System by transition to up-to-date telecommunications systems including satellite;

2. The development of a network of hydrophysical (level) observations based on means of remote sea level measurement;

3. The introduction of methods and means for operative dissemination of alarm signals and messages about tsunami to the local administrative services and bodies responsible for carrying out measures to protect the population and mitigate the losses from tsunami;

4. The creation of local observation and forecasting systems in the most endangered by tsunami areas; and

5. The creation of methods and means for teaching and training of personnel.

Unfortunately, there are grave fears that, due to Russia's internal economic difficulties, the realization of these plans may be postponed or considerably hampered. This is why there are high hopes in Russia for suitable help from the International society.

International Exchange of Information

The information coming through the WMO GTS from Tokyo to Khabarovsk is transmitted then to Russian Tsunami Warning Centers by the Russian internal communications channels. Pitifully, the information exchange between the Russian and Pacific TWS centers got worse: there is no operative information on the earthquakes and tsunamis from the Pacific TWS Center (Ewa Beach, Hawaii, USA) and from the Alaska Tsunami Warning Center (Palmer, Alaska, USA). The information exchange with JMA is stable enough. Data on the parameters of earthquakes from Hong-Kong were regularly received. Russian party considers the security of reliable and operative data exchange between the TWS Centers of the ICG/ITSU member-states to be the main priority of cooperation in this field.

Tsunami Events

In 1993-1995, seismic activity in the Kuril-Kamchatka trough increased considerably: about 20 earthquakes occurred in this region with magnitudes exceeding 6.0 on the Richter scale. However, almost no report of a tsunami in the area had been received in Russian TWS centers.

On 4 October 1994 a strong earthquake occurred in the vicinity of South Kurils, generating a tsunami with heights of 3.0-4.0 meters. All procedures according to regulations had been timely made by the TWS. Yet, due to the destruction of technical and communications means, the tsunami warning was transmitted to the South Kurils with a delay.

National Report of Singapore

Tsunami Activity

Singapore is a small island in South East Asia surrounded by the neighboring archipelagos. It has never been affected by tsunami or other earthquake related disasters.

Equipment

Singapore Meteorological Service is currently setting up its own network of seismic stations to monitor and detect seismic activities in the region. The system is expected to be operational by the end of 1996. Thereafter, it will consider implementing a suitable tsunami forecasting model.

The network of tide gauge stations near the coast of Singapore Island is maintained by the Port of Singapore Authority.

National Report of the United Kingdom - Hong Kong

A tsunami warning system is operated by the Royal Observatory (RO) in Hong Kong. This comprises a monitoring network of long and short-period seismometers to detect earth tremors

and nine tide gauges to report sea levels at selected locations in the territory. A communication system was set up linking RO with the Pacific Tsunami Warning Center on the one hand, and the Information Services Department (ISD) of the Hong Kong Government on the other. Detailed operational procedures have been set up whereby tsunami warnings will be issued to the public via ISD whenever a tsunami is expected to affect Hong Kong.

In 1996, the local seismic monitoring network will be fully computerized and enhanced with additional short-period seismographs. Real-time sea level data from tide gauges will continue to be used for operational warning of sea flooding in the territory, answering inquiries on extreme water levels and the preparation of tide tables.

The most recent tsunami event detectable in Hong Kong occurred on June 24, 1988. It originated from a submarine earthquake off the coast of northern Luzon that generated only minor wave disturbances in Hong Kong.

National Report of the United States of America

Introduction

In the United States, the Tsunami Warning System (TWS) is operated by the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS). Another component of NOAA, the National Ocean Service (NOS) is primarily responsible for the maintenance of the US tide gauges in the TWS. Tsunami research is conducted by NOAA's Environmental Research Laboratories and by various universities under the direction of the National Science Foundation (NSF). The World Data Center-A (Tsunamis) is operated by NOAA's National Environmental Satellite, Data and Information Service (NESDIS) which also supports the TWS by providing communications from remote data platforms through NOAA's Geostationary Operational Environmental Satellite (GOES). (The Japan Meteorological Agency [JMA] also provides support to the TWS by the use of its geostationary satellite [GMS] to transmit data from certain US tidal stations.) The US Geological Survey (USGS) is responsible for seismological research and assists the TWS through the provision of real-time seismic data and in instrument development and maintenance.

The US continues to operate two major Tsunami Warning Centers: the Pacific Tsunami Warning Center (PTWC) located at Ewa Beach, Hawaii, and the Alaska Tsunami Warning Center (ATWC) located in Palmer Alaska. Both centers have access to a wide array of seismic and water-level data provided via an assortment of telemetry links.

Significant developments that have occurred during the intersessional period include:

1. A planned realignment of responsibilities between PTWC and ATWC, making ATWC responsible to recipients in its regional area for bulletins related to potentially tsunamigenic events occurring anywhere in the Pacific.

2. The upgrading of certain international NOS tidal gauges that provide data to the TWS to include software for detecting significant tsunamis and reporting the data at a higher sampling rate and on an emergency transmission schedule.

3. the US hosted a meeting in Honolulu during January, 1995 of ITSU Officers to prepare for the Fifteenth session of the group.

4. In May 1995 a two-day meeting was held between TWS operators and emergency managers who are customers for the Alaska and Hawaii regional warning centers. Potential revisions to US procedures were discussed as well as methods of improving service to the emergency managers.

5. Exchange of techniques and information between ATWC and PTWC continued with a week-long visit in 1994 of two PTWC geophysicists to ATWC. Similar trips are planned for future years.

6. In November, 1994, ATWC was visited by Drs. Evgeni B. Groshev and Alexey V. Okhotnikov from Novosibirsk and Yuzhno-Sakhalinsk. Their company has established a "computer automation" office, and they hope to be the successful bidder to set up a new generation tsunami warning system on Sakhalin.

Warning Center Activities

PTWC. The Pacific Tsunami Warning Center has made significant progress during the intersessional period in its modernization effort to increase its real-time seismic waveform database, add to its capabilities for characterizing the earthquake source in real time, automate and streamline its seismic and water-level data collection and event discrimination schemes, and simplify its expanded information dissemination methods. However, while much still needs to be done, current focus is on the renovation of the physical plant and the replacement of an older generation of data acquisition electronics that is the source of noise that limits the sensitivity of the PTWC data acquisition system.

During the intersessional period, PTWC issued 37 Tsunami Information Bulletins, 2 Regional Warning/Watch Bulletins, and 1 Pacific-wide Warning Bulletin. The Pacific-wide warning was for the October 4, 1994 southern Kuril Islands earthquake (Ms 8.1). Although tsunami runups of up to 10 meters were observed near the epicentral region, only a small tsunami, averaging about 40 cm was observed throughout the rest of the Pacific. The warning was canceled when no significant wave was observed in Hawaii.

ATWC. The mission of the Alaska Tsunami Warning Center is to provide tsunami watches, warnings, information bulletins, and interpretive information to civilian and military officials in Alaska, Canada (British Colombia), Washington, Oregon, and California. In performing this mission its primary responsibil-

ity is the detection, location, and determination of magnitude for potentially tsunamigenic earthquakes occurring in the area from Attu, Alaska to the southern California border. The ATWC has secondary responsibility for performing these same functions for earthquakes whose epicenters are located outside the ATWC area of responsibility. ATWC also provides, within established criteria, earthquake parameters and other associated information to appropriate national and international interests. Although numerous non-tsunamigenic earthquakes are automatically detected and processed each month, only a small number of these earthquakes are released to officials and the public.

The ATWC personnel continue to conduct applied research and development to improve the present system, plus analyzing collected data. The center is highly automated for processing earthquakes and disseminating critical information to intended recipients.

No tsunami warnings were issued by ATWC during the intersessional period.

Research Activities

The US continues tsunami research through the Federal Agencies of NOAA, NSF, and FEMA. NOAA and FEMA supported a project to identify the hazards associated with a large subduction zone earthquake off the NW coast of the US. Tsunami inundation maps were produced for Eureka and Crescent City, California along with maps of liquefaction, landslide potential and ground shaking intensity. These all earthquake hazard maps are a first for the US. NSF tsunami research continues to focus on run-up modeling using numerical models and physical models. Observations for the 1992 Flores Island tsunami have been used to verify some runup theories.

NOAA has also conducted a series of workshops to assess the US readiness for a major tsunami. Three workshops were held to identify at risk communities, inventory existing national resources, review recent technological advances, and develop specific recommendations to mitigate the tsunami hazard for the US. Reports were written on each workshop as well as a summary report on the 12 recommendations that emerged from these workshops.

The Pacific Marine Environmental Laboratory (PMEL), on 23 May 1995 deployed a Bottom Pressure Recorder (BPR) which successfully transmitted data from the seafloor to PMEL. The BPR, placed on the ocean floor off the coast of Washington State in 2650 meters of water, relays its data to the surface buoy via an acoustic link, and thence by satellite to PMEL.

International Tsunami Information Center

The United States, recognizing the important role of the ITIC in coordinating international aspects of the Pacific Tsunami Warning System and ITSU, has continued to support the center at a stable level. Mr. Dennis Sigrist was appointed Acting Director of ITIC and has revitalized the Center's operations. Mr. Salvador Farreras entered on duty as the Associate Director in April, 1995. He has been seconded by Mexico and is receiving some support from the IOC. One group of Visiting Experts was trained in 1994 and publication of the Newsletter was resumed. Dr. Charles McCreery, formerly a geophysicist at PTWC, was selected to be permanent Director in June, 1995 and began his service in September.

Data Centers

Operating as both National and World Data Centers, NGDC acquires, processes and analyzes global data for both terrestrial and marine environments. NGDC and the co-located WDC-A have a major role in post-event data collection (including compilation, cataloging, and synthesis) of all available information on tsunami sources and effects to support modeling, engineering, planning, and educational purposes.

Other Recent Tsunami-Related Activities

Russia Establishes Tsunami Center

from information provided by Boris Levin, Evgueni Kulikov, and Alexander B. Rabinovich

A Tsunami Center located in Moscow has recently been organized. The main purpose of the Center is to coordinate the efforts of Russian scientists in the tsunami area, to collect and distribute information and data between Russian scientists, and to promote the cooperation of Russian scientists with the international tsunami community.

A permanent address, fax and e-mail have been established. They are the following:

Tsunami Center
IORAS
Krasikova 23, 117218 Moscow
RUSSIA
Fax/phone: (7095)-124-6388
E-mail: olga@tsucen.msk.ru

The head of the Scientific Board of the Tsunami Center is:
Prof. Boris V. Levin
Russian Foundation of Basic Research
E-mail: levin@rfbr.ru (RFBR) or
levin@geoph.ioras.msk.ru

Administrators of the Center are the following:
Dr. Evgueni A. Kulikov, Director
(eugene@mplus.msk.su,
eugene@tsucen.msk.ru)
Dr. Alexander B. Rabinovich, Deputy Director
(abr@tsucen.msk.ru)
Ms. Olga Yakovenko, Acting Director
(olga@tsucen.msk.ru)

The Tsunami Center would be appreciative to all tsunami scientists and specialists in the international tsunami community for sending copies of their papers (both recent and older ones) to the Center. The Center is also extremely interested in tsunami charts, videos, special volumes and collections of papers, books, etc. related to tsunami. The Center will be glad to distribute necessary information on tsunamis from Russian sources.

New Zealand's Tom Finnimore Visits PTWC

Tom Finnimore, the Manager for Response of New Zealand's Ministry of Civil Defence made a trip to Honolulu in late August to discuss a variety of tsunami-related issues with personnel from PTWC and ITIC. The primary purpose of the visit was to address problems that New Zealand had been experiencing in receiving tsunami bulletins from PTWC in a timely manner. For an unknown reason, bulletins transmitted to them on the AFTN circuit were not being received right away and sometimes arrived hours later. As a result of discussions between Tom and PTWC, a solution to the problem was found. PTWC bulletins are now being received promptly over the GTS circuit which goes to the meteorological center in Wellington. From there they are retransmitted by local means to New Zealand Civil Defence. Exercise of this communications link over the past few months has shown it to be reliable.

PTWC - ATWC Realignment of Responsibilities

On February 1, a realignment of responsibilities took place between the Pacific Tsunami Warning Center (PTWC) in Ewa Beach, Hawaii and the Alaska Tsunami Warning Center (ATWC) in Palmer, Alaska. The ATWC, a regional warning center, was formerly responsible for issuing bulletins to its area of responsibility (AOR) — Alaska, British Columbia, Washington, Oregon, and California — *only* for potentially tsunamigenic earthquakes having their epicenters located off the shores of the ATWC AOR. It will now be responsible to its AOR for all potentially tsunamigenic earthquakes in the Pacific. The change was prompted by the need to simplify emergency management procedures within the ATWC AOR by making ATWC their sole source of tsunami bulletins. The change will also provide warning system participants within the ATWC AOR with evaluations of Pacific-wide tsunami that are specific to the AOR. Details of the new procedures have already been sent to affected parties within the ATWC AOR, and will also be provided in the twelfth edition of the Communications Plan for the Tsunami Warning System (TWS) that will be issued soon to all listed TWS participants by PTWC.

Head of PTWC Visits Nicaragua

by Michael Blackford

In November the PTWC Geophysicist-in-Charge, Michael Blackford, together with Kuniaki Abe of Niigata College, made a day long presentation on tsunami hazards, warnings, and modeling to participants of the Regional International Training Course on Seismology and Seismic Hazard Assessment. The six-week long course, organized by the Instituto Nicaraguense de Estudios Territoriales (INETER) and the GeoForschungsZentrum Potsdam (GFZ), took place in Managua and Montelimar, Nicaragua.

During this brief visit to Nicaragua Mr. Blackford had the opportunity to meet Wilfried Strauch of INETER and he was given a tour of INETER's seismic facility. Over the last seven years Dr. Strauch has rebuilt the Nicaraguan seismic network, which had fallen into disuse in the 1980's, into an excellent system for the automatic detection and location of regional earthquakes. In spite of having a very small staff, Dr. Strauch is able to provide the Nicaraguan authorities with timely information on earthquakes that can affect the country, both earthquakes on land that are potentially destructive and earthquakes in the sea the may generate tsunamis. Unfortunately the system was not quite in place when the destructive 1993 Nicaraguan tsunami occurred, however, the effects of such an event should be significantly mitigated should a similar offshore earthquake occur in the future as long as the INETER system continues to operate.

The system consists of about 18 single-channel short period seismic stations distributed primarily in the seismically and volcanically active western portion of Nicaragua. Data from the stations are transmitted in real time to Managua using standard analog frequency-modulated equipment. The data are digitized and processed on 386 personal computers using the low cost IASPEI software. Staff members, working shifts around the clock, rework the events as necessary and communicate the parameters of the larger events to emergency management authorities promptly. An IRIS broadband seismic system, on site at the INETER facility awaiting repairs at the time of Mr. Blackford's visit, is destined to be deployed northeast of Managua where it will provide data to better characterize the regional earthquakes as well as contribute information to global seismology.

While the system is not officially designated as such, it possesses most of the elements necessary for a national, or local, tsunami warning system. What is lacking is the ability to make real time water level measurements to verify the presence of a tsunami. Such measurements are necessary not only to detect tsunamis but also to cancel local warnings that must be issued based on the seismic evidence alone. Currently no tide gauges or other water level measurement systems are in operation on the Nicaraguan Pacific coast. The few gauges that were in operation prior to the 1993 tsunami were destroyed by the tsunami and have not yet been restored to operation. While at Montelimar Mr. Blackford and Dr. Strauch noted a pier that could possibly be a good site for a water level measuring instrument whose data could readily be telemetered back to

Managua. This site, roughly halfway between Nicaragua's northwestern and southeastern borders, together with the restoration and telemetry of water level data from Corinto to the north and San Juan del Sur to the south would complete the necessary elements for a very good national tsunami warning system. Over the next year Mr. Blackford and Dr. Strauch will explore the possibility of the PTWC establishing a water level measurement site at Montelimar that will provide data not only to the local system in Nicaragua but also, via satellite, to the PTWC.

Hilo Tsunami Museum Update

The Hilo Tsunami Museum is a non-profit organization, currently in a fundraising stage, whose primary mission is to provide public education programs that will increase tsunami awareness. Museum plans include state-of-the-art exhibits and educational programs that will serve to educate the public, visitors, and Hawaii's school children. The museum will preserve local history and serve as a living memorial to those who lost their lives in past tsunamis. The museum will also be an added visitor attraction that will help stimulate the island of Hawaii's economy.

Activity towards establishment of the museum is continuing. On April 1, the 50th anniversary of the 1946 tsunami that devastated the Hilo waterfront and took many lives, there will be a ribbon-cutting and dedication of the museum site. And on May 22nd, a fund-raising event for the museum will be held at the University of Hawaii at Hilo's Campus Center. The museum has also organized a tsunami photo contest in an effort to bring to light some of the old tsunami photos taken by local residents that are buried in scrapbooks, as well as any old films that may still exist. They are also planning to create and sell a color poster using an old photo of the 1946 tsunami that has been digitally enhanced.

Intergovernmental Oceanographic Commission / Tsunami Warning System of the Pacific (IOC / ITSU)

ICG/ITSU Fifteenth Session

Papeete, Tahiti, French Polynesia; July 24-28, 1995

The Fifteenth Session of the IOC International Coordination Group for the Tsunami Warning System in the Pacific was opened by the Chairman, Capt. Hugo Gorziglia, who welcomed the participants and pointed out that the tsunami programme of IOC is one of the most important as itis targeted to savings lives and property. Dr. R. Bagnis, as the Representative of the High Commissioner of the French Republic in French Polynesia, praised highly the international cooperative scientific efforts made by many states of the Pacific region under the auspices of IOC to improve knowledge on tsunamis, to evaluate potentially tsunamigenic earthquakes and to monitor the tsunami warning activities. Dr. Iouri Oliounine, the Technical Secretary of the Session, Senior Assistant Secretary IOC, thanked the Government of France and the local authorities for hosting the meeting and providing excellent facilities. He reminded the participants that the System was established 30 years ago and that this Session was an opportunity to summarize achievements,

Group photograph at the ICG/ITSU Fifteenth Session held in Papeete, Tahiti, French Polynesia.

identify problems and formulate new tasks in order to respond effectively to the Recommendations of the IOC Governing Bodies and to the objectives of the International Decade on Natural Disaster Reduction (IDNDR). Mr. William Sites, USA, was elected Rapporteur for the Session. Representatives from 13 Member States were in attendance plus representation from the lac Secretary, ITIC, World Data Center A for Solid Earth Geophysics and the IUGG Tsunami Commission, and 2 observers. The Group warmly welcomed the Cook Islands as a new Member.

Following the opening remarks, the Group proceeded to review the intersessional activities since the Fourteenth Session of the ICG/ITSU. National Reports on tsunami-related activities from most of the Member States were provided to the participants, and additional presentations and comments were made by several of their Representatives (see National Report summaries in the next section of this Newsletter). The Group considered the implementation status of resolutions and recommendations of ITSU-XIV on: a) Real time exchange of telemetry, seismic and tsunami data, b) Tsunami inundation modelling exchange (TIME) project; c) Expert tsunami database (ETDB) for the Pacific, and d) Status and ways to improve tsunami communication networks.

The Agenda covered also the following topics that were extensively discussed:

ITIC Activities. Cdr. Dennis J. Sigrist, Acting Director ITIC, provided his report on ITIC's intersessional activities, higlighting the most important accomplishments. He made special mention to ITIC's continuing involvement in tsunami education and the Visiting Experts Programme. The Group noted that Mr. Sigrist was leaving the position of Acting Director ITIC at the end of August 1995, and praised his contributions to the IOC Tsunami Programme, acknowledged with great appreciation his accomplishments since his posting to ITIC in July 1993, and wished him every success in his new position.

Standards for Survey Measurements of Tsunami Runup and Damage. Mr. Salvador F. Farreras, Associate Director ITIC, presented a document which contained recommended guidelines to establish tsunami field survey teams, procedures to conduct the field investigations and identified simple and efficient field survey equipment. The Group recommended that the Secretary IOC allocate necessary funds in the IOC budget for emergency operations at the occurrence of tsunamis which may qualify for a survey of an international team, and noted that the ICG/ITSU National Contact of the country to be surveyed should arrange in advance the procedures to access the area, and coordinate the main aspects and expedite the survey. An *ad hoc* Working Group opment and completion of draft of a Field Guide for Post-Tsunami Surveys.

Follow-up actions to the World Conference on Natural Disaster Reduction. The Technical Secretary informed the Group on the IOC participation in the May 1994 Yokohama IDNDR World Conference and the main decisions taken. The Yokohama Strategy and Plan of Action for a Safer World were provided to the participants. The Group emphasized that the Plan of Action provides an opportunity to move ahead with the implementation of many ICG/ITSU activities, such as the establishment of regional warning systems, enhanced education programmes, inundation mapping for developing countries, and establishment of databases; and recommended that the ICG/ITSU Member States should contribute to its objectives through organizing lectures in schools, distribution of textbooks and children book developed by ICG/ITSU, and circulating information through local media on 1:he effects of tsunamis and measures to be taken for saving lives and property.

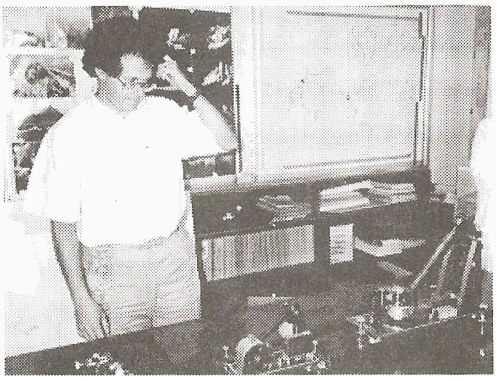
Selected group of ICG/ITSU XV participants, during the visit to the Laboratoire de Geophysique at Papeete, Tahiti, French Polynesia. Left to right are Dennis Sigrist (kneeling), Chip McCreery, Salvador Farreras, Francois Schindele, Eddy Bernard, Hugo Gorziglia, Ariel Vera, Fred Stephenson (kneeling), Fernando Penaranda, and Mario Martinez.

ITSU Master Plan revision. After the ITIC Acting Director reported on the results of the ITSU Master Plan revision, the Group noted that it is necessary, due to many technological developments and scientific findings, to update the Plan after nearly 10 years since it was first published. The Group recommended that an *Editorical Group* headed by the Chairman ICG/ITSU and composed of the Director ITIC, the Director PTWC, a representative of the IUGG Tsunami Commission and an expert from Australia be established to update the Master Plan, circulate a first draft by July 1996 to all ICG/ITSU Member States for comments, and present a new version for adoption at ICG/ITSU XVI Session.

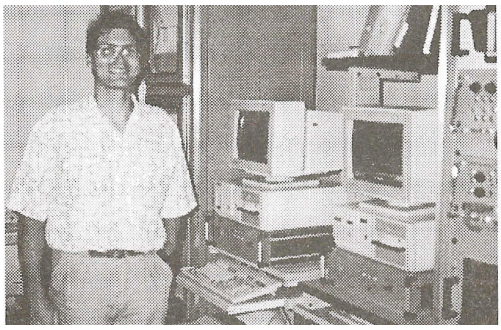
Establishment of New Regional Tsunami Warning Systems.

a) Pacific Ocean. The Chairman ICG/ITSU informed the Group of the efforts made to seek support to the Tsunami Warning System in the South Pacific Project which is in the pipeline of the UNDP projects since 1989, and referred to the decision of the Eighteenth Session of the IOC Assembly requesting that the efforts should continue, the project be updated, and other sources of financial support be investigated. The Delegate of France and the Technical Secretary informed of the plans to approach the European Community Humanitarian Office (ECHO) in order to find out their interest in supporting the project.

The Delegate of Mexico, Dr. Mario Martinez informed of the efforts being made to implement a regional tsunami warning system for Central America and Mexico, and informed that Mexico will soon be in the position to offer inundation numberical modeling technology transfer to other countries in the region. He requested the help of Colombia in contacting other Member States of the region to advertise the idea of a regional warning system. The Delegate of Colombia welcomed the request and offered to contact Ecuador and find their interest to be involved in a project.



Francios Schindele explains how the old seismometers used to work, during a field trip by ICG/ITSU-XV participants to visit the Laboratoire de Geophysique outside Papeete.



Dominique Reymond and the new advanced TREMORS technology he helped develop at the Laboratoire de Geophysique. A few of the ICG/ ITSU participants got to view the system in dramatic action just two days later on July 30 when an M_w=8.1 earthquake occurred near Antofagasta, Chile.

b) Europe. The Delegate of France, Dr. Yves Caristan, speaking on behalf of the Coordinator of the CEC Project on Genesis and Impact of tsunamis on European tsunamis which have affected the shores of Greece, Italy, Portugal, Spain and countries of northern Africa. The main objectives and topics of the GITEC Project, that is being financed by the European Community, include: tsunami generation, tsunami potential, tsunami propagation and end-effects, and tsunami warning and risk mitigation. The Group concurred with the view that the time is ripe to consolidate the cooperation between the European experts and those working in the Pacific, and recommended that the ICG/ITSU and ITIC will establish a more robust and organic relationship among researchers from both groups of nations.

c) Indian Ocean. The Group noted and welcomed the actions taken by Australia and Indonesia to establish a regional warning system in the Indian Ocean and requested the Director of ITIC to keep contact with the Representatives of these countries and investigate possible ways of assistance.

Cooperation with Other International Bodies. Dr. Eddie Bernard, past Chairman of the IUGG Tsunami Commission, reported on the Commission actvities for the past two years, including; a) the publication of a book with selected papers from the Sixteenth IUGG International Tsunami Symposium held in Wakayama, Japan, August 1993, edited by N. Shuto and Y. Tsuchiya, and b) the Seventeenth IUGG General Assembly. The Group recognized that great value of cooperation with the IUGG Tsunami Commission, reiterated its interest to see, as far as possible, the IUGG Tsunami Symposium collocated with the ICG/ ITSU Sessions and Workshops, and applauded Dr. Bernard's efforts in fostering this cooperation during his 8-year term as Chairman of the Commission.

Mr. James Lander provided a briefing on the International Tsunami Measurements Workshop held in Estes Park Colorado, June 1995, and noted that there were a number of Workshop recommendations relevant to ITSU and ITIC, including: coordinating disaster surveys, developing a field survey guide, using models for real-time wave height forecasting, TIME project training, and expert tsunami data base development.

The Group welcomed the kind invitation from Russia to have a joint IOC – Russian Academy of Science Workshop on Tsunami Hazard Mitigation in August 1996 in Russia, recommended that this Workshop be co-sponsored by IOC in the form of travel support for a few Workshop participants, and requested the Director of ITIC to assist the organizers in formulating the programme.

E-mail and Electronic Tsunami Bulletin Board. Cdr. Dennis Sigrist, Acting Director ITIC, presented a report on the status of the electronic Tsunami Bulletin Board (TBB) system that was developed in 1992 by the USA NOAA/PMEL and operated as an experimental e-mail notification system. He noted that the utility of the system has been proven and that the time has come for ITIC to assume responsibility for its continuing operation and maintenance. Cdr. Sigrist was careful to note

that the TBB system requires a robust connection to the Internet, as well as a computer (server) workstation, neither of which existed at ITIC. He informed on proposed enhancements to the TBB that will include a World Wide Web page with access to a broad range of tsunami information at ITIC and other WWW sites in the tsunami community, and reported on a prototype tsunami home page that was developed by researchers at the University of Washington, USA. The Group requested the Member States and IOC to provide financial support for the operation of the TBB and the development of the WWW site at ITIC, and in particular for its purchase of a computer workstation.

Historical Tsunami Database. The Acting Director ITIC reported that there has been limited work on actual maintenance of the ITIC database due to lack of financial and staff resources, and that the existing database format should be modified to include new seismic parameters. The Delegate from the USA noted that the tsunami database maintained at the World Data Center A for Solid Earth Geophysics is probably the most complete Pacific-wide set. The Group agreed that an *ad hoc Working Group* be formed that will review existing tsunami database standards, formulate ways to improve existing data collection and dissemination procedures, and formulate recommendations on the database format and the actual availability of tsunami datasets.

The ICG/ITSU-XV participants enjoyed the entertainment and hospitality provided by the Tahitian people, and were appreciative of France for hosting the meeting in such a lovely setting.

Publications. The ITSU Chairman informed that the children's textbooks and teacher's guide books, previously underdevelopment, have now been published in Spanish by Chile and are being used in their schools. The books have also been translated into English by Canada with the assistance of Chile, Japan and New Zealand, but have not yet been published. The Group requested the Chairman and Member States to continue efforts and the Executive Secretary IOC to secure the necessary funds for the publication of the textbooks. The Acting Director ITIC informed about the ITIC publications completed during the intersessional period: a) an updated ITIC brochure in English, French and Spanish, b) a supplemental teacher's guide to the children's cartoon book on tsunamis, and c) the colorful booklet "*Tsunami – The Great Waves*" describing tsunamis and tsunami safety guidelines. The Technical Secretary IOC requested that a new high-quality brochure be developed to describe the activities of ITSU and ITIC, particularly their efforts in international tsunami hazard mitigation. France agreed to develop an outline of the brochure's sections that could be distributed to Member States for their contribution and comments.

Visiting Experts Programme. The ITIC Visiting Experts Programme resumed in November 1994, after a two-year break, when two scientists from the Republic of Korea and Philippines attended the programme. One immediate positive outcome was the satellite telemetry upgrade to the Legaspi, Philippins tide-gauge that would not otherwise have occurred without the on-site training of the visiting expert. The ITIC Acting Director stressed the importance of continuing the program as it provides significant benefits. Member States were urged to submit names of candidates for consideration every year.

Other training activities. The Delegate of Chile informed the Group that his country, jointly with Mexico, plans to conduct a two-month course related to the TIME Project and usage of the TREMORS in March-April 1996 for up to 8 experts from Spanish speaking countries in Latin America. The course will give an advantage to increase knowledge in modern methods of tsunami modeling and earthquakes and tsunami detection. A modest level of support was requested from IOC.

The Delegate of Colombia announced that a Seminar on tsunami hazard evaluation and mitigation in Latin America is planned for April 1996 at the Observatorio Sismologico del Suroccidente-OSSO, Universidad del Valle. The event shall include presentations of the state-of-the-art and national and sub-regional programmes and projects, and it is aimed at fostering initiatives and promoting regional integration. He invited IOC and Member States to support the Seminar.

The Group recommended IOC to consider support through the IOC/UNESCO Regional Office for both training activities.

National proposals for future projects. Dr. Eddie Bernard, past Chairman of the IUGG Tsunami Commission, on behalf of the Delegate of the USA, proposed the concept of Tsunami Hazard Reduction for the Pacific Nations (THREPAN), using tsunami inundation technologies to identify risk areas and

tsunami detection technology based on real-time offshore surface buoy measurements of tsunamis in the open ocean for forecasting coastal impacts. These technologies will help mitigate the local as well as the distant tsunami hazards. The Group enthusiastically adopted the concept and directed Dr. Bernard to prepare a proposal for the next ITSU Officer's Meeting, for evaluation. Australia and Russia volunteered to help in the preparation of the proposal.

Other businesses. Mr. Mike Blackford, Director PTWC, requested permission (and the Group agreed) to modify the limits of the warning area and the watch area in PTWC warning/watch messages, changing the reference from earthquake origin time to message issuance time. This will give the recipients a better understanding of the amount of time they have before the tsunami arrival to their area. He also requested (and the Group also agreed) that he be able to make additional modifications to the messages during the intersessional period, following a review, comment and acceptance process.

The Delegate of Russia informed the Group of the present state of the national tsunami warning system in the Kuril Islands which were strongly affected by the Shikotan earthquake and tsunami of 4 October 1994. Three of 5 existing regional mareograph stations were totally destroyed, buildings and instruments of seismic stations were seriously damaged and are still unrecovered. This destruction may threaten the effectiveness of the Russian Tsunami Warning System in the Kuril-Kamchatka region and the International TWS in the northwestern Pacific region. Russia will need support from the international community and the ICG/ITSU Members for the complete reconstruction of the System. The Group noted with satisfaction the decision of the Eighteenth Session of the IOC Assembly *"to invite the Executive Secretary IOC and Member States to support Russia in reconstructing the warning system in the tsunami affected area"*, and requested the Executive Secretary IOC to take all necessary actions for implementing the Assembly decision.

Election of Chairman and Vice-Chairman of the ICG/ITSU

The Group praised the energetic, constructive, and most helpful contributions of the present Chairman, Capt. Hugo Gorziglia from Chile, to the activities of the IOC Tsunami Programme, and enthusiastically re-elected him to serve for another term as Chairman of the ICG/ITSU.

The Group expressed his sincere appreciation to Mr. Hiroo Uchiike from Japan for his contribution to the success of the PTWS during his tenure as Vice-Chairman of the ICG/ITSU, and elected Dr. Francois Schindele from France as new Vice-Chairman of the Group, considering his experience and professional knowledge in seismology and his personal qualities.

Date and Place of next ICG/ITSU Sessions

The Delegate of Peru reiterated his country's offer to host the Sixteenth Session of the Group in Lima in the second half of 1997. The Technical Secretary informed that this offer has also been presented by the Peruvian Delegation at the IOC Assembly. The Group accepted the offer with thanks.

The Delegate of the Republic of Korea invited the Group to have the Seventeenth Session at Seoul in 1999. The Group acknowledged this kind invitation and decided to keep this in mind when the issue is discussed at the Sixteenth Session.

List of ITSU National Contacts

The following is a list of the ITSU National Contacts as well as the Chairman and Vice-Chairman of ICG/ITSU, the IOC Secretariat, and the ITIC Director and Associate Director. Every effort has been made to compile accurate information. However, if data change or are found to be in error, please contact ITIC so that correct information can be published in a future newsletter.

Australia
Mr. Peter F. Noar
Bureau of Meteorology
Box 1289 K GPO
Melbourne 3001
Victoria
Australia
Tel: <61> (3) 96 69 40 87
Fax: <61> (3) 96 69 46 95
Email: p.noar@bom.gov.au

Canada
Mr. Fred Stephenson
Manager
Hydrographic Surveys
Canadian Hydrographic Service
Institute of Ocean Sciences
P.O. Box 6000
9860 W. Saanich Rd.
Sidney, B.C. V8L 4B2
Canada
Tel: <1> (604) 363 6349
Fax: <1> (604) 363 6323
Email: stephenson@ios.bc.ca

Chile
Captain Hugo Gorziglia
Director
Servicio Hidrografico y Oceanografico de la Armada (SHOA)
Errazuriz 232
Playa Ancha
Valparaiso
Chile
Tel: <56> (32) 28 26 97
Fax: <56> (32) 28 35 37
Email: shoa@huelen.reuna.cl

China
Mr. Luo Yuru
Director
National Bureau of Oceanography
People's Republic of China
Beijing
China

Colombia
Prof. Hansjergen Meyer
Universidad Del Valle
Observatorio Sismologico-OSSO
A.Aereo 25360
Cali
Colombia
Tel: <57> (2) 339 7222
Fax: <57> (2) 331 3418
Email: osso@osso.univalle.edu.co

Cook Islands
Commissioner Tere Bishop
Chairman
Natural Disaster Management Committee
Ministry of Marine Resources
P.O. Box 85
Rarotonga
Cook Islands
Tel: <682> 28 721
Fax: <682> 29 721

Costa Rica
Ocean. Alejandro B. Gutierrez
Director
International Ocean Institute (IOI)
Universidad Nacional
Apartado 86
Heredia
Costa Rica
Tel: <506> 277 3594
Fax: <506> 260 2546

Democratic People's Republic of Korea
Mr. O. Ryang Pyong
National Oceanographic Commission
State Hydrometeorological Admin (SHMA)
Oesong-dong
Central District
Pyongyang
Korea

Ecuador
Mr. N. Villacis
Director
Instituto Oceanografico de la Armada
Casilla 5940
Guayaquil
Ecuador
Tel: <593> (4) 43 00 33
Fax: <593> (4) 44 36 52
Email: director@inocar.mil.ec

Fiji
Mr. R. A. Rahiman
Director
Mineral Development
Mineral Resources Department
Private Mail Bag
Suva
Fiji

France
Dr. Francois Schindele
Head
Laboratoire de Geophysique Tahiti
Centre Polynesian de Prevention des Tsunamis (CPPT)
B.P. 640
Papeete Tahiti
Polynesie Francaise
Tel: <689> 82 80 25
Fax: <689> 83 50 37
Email: schindel@ldg.bruyeres.cea.fr

Guatemala
Ing. Eddy Hardie Sanchez Benett
Instituto Nacional de Sismologia, Vulcanologia, Meteorologia e Hidrologia
Ministerio de Communicaciones, Transporte y Obras Publicas
7a Avenida 14-57
Zona 13
Guatemala
Tel: <502> (2) 31 91 64
Fax: <502> (2) 31 50 05

Indonesia
Mr. Sunarjo
Head
Geophysical Division
Meteorological & Geophysical Agency
JL. Angkasa I/2
Jakarta 10720
Indonesia
Tel: <62> (21) 424 6474
Fax: <62> (21) 424 6703
Email: suhard@mimo.bppt.go.id

Japan
Mr. Hiromu Yoshida
Director
Earthquake & Tsunami Observation Division
Japan Meteorological Agency
1-3-4 Otemachi
Chiyoda-ku
Tokyo 100
Japan
Tel: <81> (3) 3284 1743
Fax: <81> (3) 3215 2953
Email: bosai@eqvol.kishou.go.jp

Mexico
Dr. Mario Martinez
Director
Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE)
Ensenada, Baja California
KM107 Carretera
Tijuana-Ensenada
Mexico
Tel: <52> (617) 44900
Fax: <52> (617) 44880
Email: mmartine@cicese.mx

New Zealand
Mr. Tom Finnimore
Manager - Response
Ministry of Civil Defense
33 Bowen Street
P.O. Box 5010
Wellington
New Zealand
Tel: <64> (4) 473 7363
Fax: <64> (4) 473 7369

Nicaragua
Ing. Cesar Aviles-Haslam
Director General
Instituto Nicaraguense de Estudios Territoriales (INETER)
Frente a las Oficinas Centrales del INSSBI
Managua
Nicaragua
Tel: <505> (2) 44 7 39
Fax: <505> (2) 49 18 90

Peru
Lt. Cmdr. G. O. Bawden
Chief of the Office
Peruvian Tsunami Warning System
Direccion de Hidrografia y Navegacion de la Marina (HIDRONAV)
Street Gamarra #500
Chicuito-Callao
Peru
Tel: <51> (14) 29 63 04
Fax: <51> (14) 65 29 95

Philippines
Dr. Raymundo S. Punongbayan
Director
Philippine Institute of Volcanology and Seismology
29 Quezon Avenue
Quezon City
Philippines
Tel: <63> (2) 712 61 10
Fax: <63> (2) 712 46 56
Email: tsunami@x5.phivolcs.dost.gov.ph

Republic of Korea
Mr. Sang-jo Kim
Assistant Director
Observation Division
Korea Meteorological Administration
1, Songwol-dong
Chongno-ku
Seoul 110-101
Korea
Tel: <82> (2) 733 0654
Fax: <82> (2) 737 0325

Russian Federation
Dr. Igor P. Kuzminykh
Deputy Chief
Central Design Office
Hydrometeorological Instrument Production Engineering
Obninsk
Russia
Tel: <7> (08439) 2 74 22
Fax: <7> (08439) 4 86 11

Singapore
Mr. Woon Shih Lai
Director
Meteorological Service Singapore
P.O. Box 8
Singapore Changi Airport
Singapore 9181
Republic of Singapore
Tel: <65> 545 7190
Fax: <65> 545 7192
Email: metsin@singnet.com.sg

Thailand
Lt. Sukit Yensung
Meteorology Department
Ministry of Communication
612 Sukumvit
Bangkok 10110
Thailand

U.S.A.
Mr. R. Hagemeyer
Director, Pacific Region
National Weather Service (NWS)
National Oceanic and Atmospheric Administration (NOAA)
737 Bishop Street, Suite 2200
Honolulu, Hawaii 96813-3213
USA
Tel: <1> (808) 532 6416
Fax: <1> (808) 532 5569

United Kingdom - Hong Kong
Mr. Robert Lau
Director
Royal Observatory
134A Nathan Road
Kowloon
Hong Kong
Tel: <852> (2) 926 8221
Fax: <852> (2) 721 5034
Email: metgeos@hk.net

Western Samoa
Superintendent
Apia Observatory
P.O. Box 3020
Apia
Western Samoa

Chairman, ICG/ITSU
Captain Hugo Gorziglia
Director
Servicio Hidrografico y Oceanografico de la Armada (SHOA)
Errazuriz 232
Playa Ancha
Valparaiso
Chile
Tel: <56> (32) 28 27 04
Fax: <56> (32) 28 35 37
Email: shoa@huelen.reuna.cl

Vice-Chairman, ICG/ITSU
Dr. Francois Schindele
Head
Laboratoire de Geophysique Tahiti
Centre Polynesian de Prevention des Tsunamis (CPPT)
B.P. 640
Papeete Tahiti
Polynesie Francaise
Tel: <689> 82 80 25
Fax: <689> 83 50 37
Email: schindel@ldg.bruyeres.cea.fr

IOC Secretariat
Dr. Iouri Oliounine
Senior Assistant Secretary
Head, Ocean Services Unit
UNESCO
1, rue Miollis
75015 Paris
France
Tel: <33> (1) 45 68 39 63
Fax: <33> (1) 40 56 93 16
Email: i.oliounine@unesco.org

ITIC Director
Dr. Charles S. McCreery
Director
International Tsunami Information Center
UNESCO/IOC
737 Bishop Street, Suite 2200
Honolulu, Hawaii 96813-3213
USA
Tel: <1> (808) 532 6422
Fax: <1> (808) 541 5576
Email: itic@ptwc.noaa.gov

ITIC Associate Director
Mr. Salvador Farreras
Associate Director
International Tsunami Information Center
UNESCO/IOC
737 Bishop Street, Suite 2200
Honolulu, Hawaii 96813-3213
USA
Tel: <1> (808) 532 6424
Fax: <1> (808) 541 5576
Email: farreras@ptwc.noaa.gov

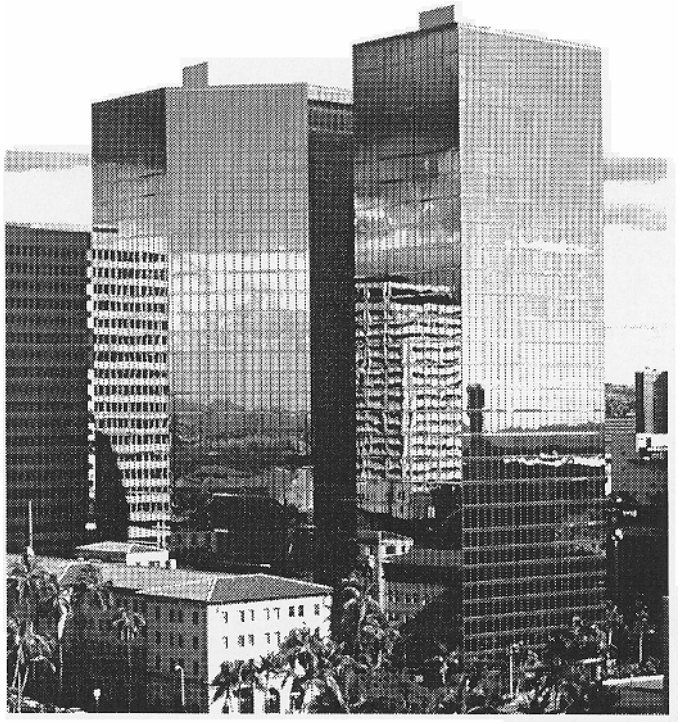
International Tsunami Information Center (ITIC)

ITIC has Moved

On September 18th, the mc office along with its host, the National Weather Service (NWS) Pacific Region Headquarters, moved from its long-time location in the Prince Kuhio Federal Building in downtown Honolulu to an office complex called Grosvenor Center, located just a few blocks away. The move was prompted by the need of another federal agency to expand into the space formerly occupied by the NWS. It provided the opportunity to redesign the office layout, and with support from the NWS to replace many of the old furnishings. The library, which had outgrown its shelves is now adequately housed with room to expand. And a separate office is available for use by the Associate Director. The location of Grosvenor Center in the downtown area is very convenient. Numerous shops, services, and restaurants are within only a short walking distance. Parking for a fee is available in the Center, as well as at numerous private and public lots in the area. The new ITIC address and phone numbers are given below, as well as on the inside front cover of the newsletter.

International Tsunami Warning Center
737 Bishop Street, Suite 2200
Honolulu, Hawaii 96813-3213
USA

Ph: 808-532-6422
Fax: 808-532-5576
E-mail: itic @ptwc.noaa.gov



ITIC is now located on the 22ndfloor of the Grosvenor Center Mauka Tower ("mauka" is a Hawaiian word that refers to something on the mountain side, versus the "makai" or ocean side). The Center is conveniently located in downtown Honolulu, just across the street from the landmark Aloha Tower (from where this photo was taken) and Honolulu Harbor.

New ITIC Director

On September 3rd Dr. Charles S. McCreery, formerly a geophysicist with the Pacific Tsunami Warning Center (PTWC), joined ITIC as the new permanent Director. He replaced Cdr. Dennis Sigrist who had stepped in to serve as Acting Director two-and-a-half years ago.

Dr. McCreery has a background in ocean seismology and acoustics and spent 15 years with the Hawaii Institute of Geophysics before joining PTWC in 1993. He and his wife, Nitaya, live outside Honolulu in Ewa Beach, not far from PTWC.

Following the transition, Cdr. Sigrist moved to Oregon where he built a new home for himself and his family. Although retired from federal service, he is still active in the natural disaster community and has recently taken a position with Oregon

Emergency Management. He can be reached at the following address:

Dennis Sigrist
Oregon Emergency Management
595 Cottage Street N .E.
Salem, Oregon 97310

Ph: 503-378-2911 Ext.237
Fax: 503-588-1378
Email:
dsigrist@oemd02.oem.state.or.us

Salvador Farreras continues in his post as Associate Director through the end off April 1996, sponsored by the government of Mexico and the IOC.

Outgoing ITIC Acting Director Dennis Sigrist, and incoming Director Chip McCreery, pose together with a Micronesian handicraft that had been presented to Dennis by Myron Kerner of the National Weather Service in appreciation of Dennis' service to ITIC and NOAA.

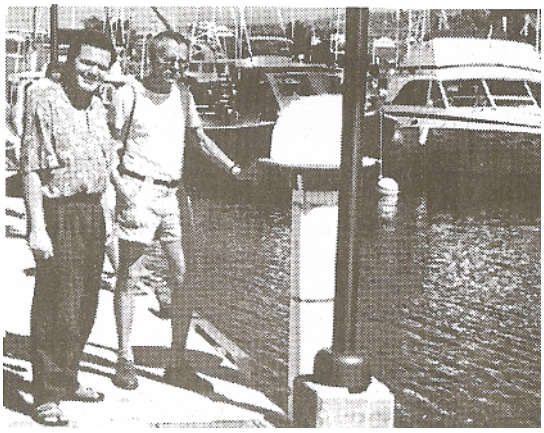
Visiting Experts Programme

The annual IOC/ITIC Visiting Experts Programme (VEP) was held from October 23 to November 17, 1995 in Honolulu. The two candidates chosen to participate in the 1995 VEP were Mr. Lev Rizhokov from the Russian Federation, and Mr. Dante Gutierrez from Chile. Lev is the Leading Specialist of the Arctic, Antarctic, and Marine Department of the Russian Fedaral Service for Hydrometeorology and Environmental Monitoring (ROSHYDROMET). Dante is the Waves and Tsunamis Program Chief for the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA). The VEP was fortunate to have participants of such caliber. Chile and Russia are countries that have both suffered many times from locally generated tsunami, and are source regions of Pacific-wide tsunami. Both countries also have their own regional tsunami warning systems.

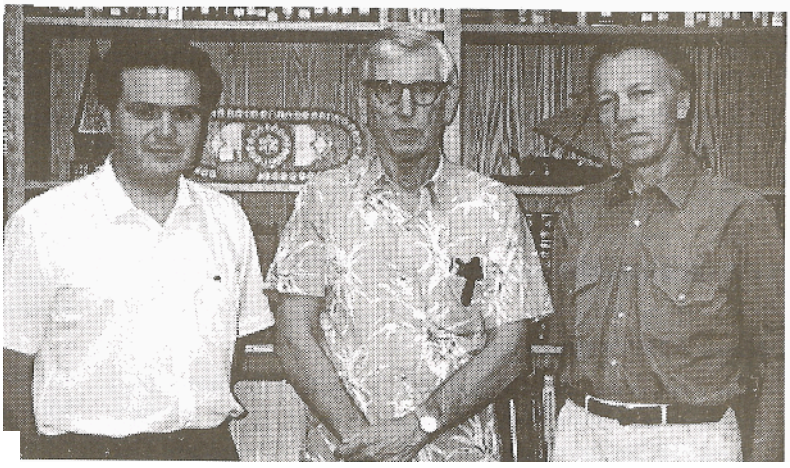
Elements of the training program included:

- Review of the organization, history, and current activities of ITSU.
- Overview of the Pacific Tsunami Warning Center (PTWC) organizational structure under the National Weather Service - its functions and operational procedures, its data collection and processing methods and facilities, and its message generation and communications capabilities.
- Evaluation of the strengths and weaknesses of the Pacific Tsunami Warning System.
- Survey of Hawaii State and County Civil Defense facilities and procedures for tsunami.

Numerous field trips were made to PTWC to meet with Mike Blackford, the Geophysicist in Charge of PTWC, and with other PTWC geophysicists and technicians, to learn about various kinds of data processing and communications equipment at the facility, and to observe demonstrations of warning center operations in a simulated alarm situations. Field trips were made to the respective headquarters of Hawaii State Civil Defense, Oahu County Civil Defense, and Hawaii County Civil Defense (which is said to handle more types of natural disaster than any other county in the U.S.) to discuss their tsunami mitigation plans and activities. A field trip was made to the Hawaii Volcanoes Observatory run by the U.S. Geological



Dante Cutierrez and Lev Rizhkov examine the tidal gauge at Honokohau Harbor on the island of Hawaii. Data from this gauge are transmitted in real time back to the Pacific Tsunami Warning Center in Ewa Beach to aid in the evacuation of locally-generated as well as Pacific-wide tsunami.



Dante Cutierrez from Chile (left) and Lev Rizhkov from Russia (right), the two participants in the 1995 IOC/ITIC Visiting Experts Programme with Richard Hagemeyer (center), the U.S. National Contact and former Chairman of ICG/ITSU.

Survey to learn about their methods for evaluating hazards (including small tsunami) associated with the active volcanoes in Hawaii. Unfortunately, due to the recent U.S. government shutdown, Hawaii Volcanoes National Park was closed, making it impossible to view any of the active lava flows from Kilauea Volcano. A visit was made to the University of Hawaii's Sea Level Center which maintains many tide gauges in unique locations around the Pacific, and shares those data with the warning system. Lastly, field trips were made to several of the remote seismic and water level stations located on the islands of Oahu and Hawaii. ITIC is grateful to all of the staff at the facilities visited for extending their hospitality to the VEP participants.

The four-week program consisted not only of training for the two visitors, but also a liberal exchange of information and ideas between all parties. Dante Gutierrez kindly provided ITIC with digital records from many Chilean tide stations for historical tsunami going as far back as 1960, and including the recent July 30 tsunami. Portions of those data are displayed in an account of that event given previously in this newsletter. Lev Rizhkov focused on the problem of reestablishing tidal stations in the Kuril Islands and hopefully establishing a satellite link for those data to be transmitted back to various warning centers. That work is still ongoing.

Tsunami Videos

The ITIC maintains a library of tsunami videos that are generally available to anyone that requests copies. It is important, however, to note that the videos can be used only for educational purposes; commercial broadcast is not authorized. ITIC has made arrangements with a local video facility to provide duplication at low cost. If you are interested in obtaining copies of either of the following two videos, please phone, e-mail, or fax your request to ITIC. We will validate the request and put you in contact with the vendor for duplication. You will be responsible for dealing with the vendor directly for all charges associated with the duplication and shipping. Please be sure to settle your bills in a timely manner as this will ensure our good relationship with the vendor that provides us this valuable service.

Commercial use of these videos must be approved by the producer or copyright owner. For the Japanese videos this is the NHK national television network. The Hilo Tsunami Museum video, if aired on commercial or public TV, should be shown in its entirety.

The following tsunami and earthquake videos are available from ITIC:

Video #1

- *May 1983 Sea of Japan Tsunami.* Excellent home-video of the tsunami impacting the coastline and harbors. In Japanese, about 50 minutes.

- *July 1993 Sea of Japan Tsunami.* Occurring at night, there is very little video of the tsunami, however, excellent coverage of damage and spectacular runups on Okushiri Island. In Japanese, about 50 minutes.

Video #2

- *Tsunami, How Protect? How Occur?* Distributed by the Japan National Committee for the International Decade of Natural Disaster Reduction at Yokohama in 1994. This excellent presentation includes video of tsunamis in Japan as well as tsunami mitigation activities in Japan. In English, about 30 minutes.

- *Waves and Tsunamis.* Produced by NHK and the Marine Hydrodynamics Div., Port and Harbors Research Institute, Japan, this presentation includes video of tsunamis in Japan, mitigation activities and wave measuring systems. In English, about 40 minutes.

- *Learning from Earthquakes.* Distributed by the Japan National Committee for the International Decade of Natural Disaster Reduction at Yokohama in 1994. Review of major (recent) historic earthquakes in Japan and mitigation activities. In English, about 40 minutes.

- *Hilo Tsunami Museum.* This nine minute video talks about the planned Hilo tsunami museum and includes excellent oral history (interviews) of tsunami survivors in Hawaii.

Reports on Recent Meetings

Tsunami Deposits: Geologic Warnings of Future Inundation

University of Washington, Seattle, USA; May 21-23, 1995

by Joanne Bourgeois

There has been much recent interest in the deposits of tsunamis, from prehistoric earthquakes to asteroid impacts, and in modern analogues from the rash of recent tsunamis around the Pacific. More than 40 scientists met at the University of Washington (UW) to examine various aspects of tsunami-deposit studies, in particular to further the use of these deposits as guides for reducing losses from future tsunamis. This conference was sponsored by the Quaternary Research Center (UW), the National Oceanographic and Atmospheric Administration (NOAA), and the U.S. Geological Survey (USGS), and was co-convened by Brian Atwater (USGS) and Joanne Bourgeois (UW). The group examined field evidence for prehistoric tsunamis on the Pacific coast of Washington and within Puget Sound. This trip was followed by two days of presentations and discussions.

After keynote talks on tsunami-hazard mitigation by Eddie Bernard (NOAA) and on modeling tsunami inundation by Philip Liu (Cornell), talks were grouped to address questions such as: What are the properties of tsunami deposits, and which of these properties best distinguish them from storm deposits? Where are tsunami deposits best preserved? To what degree can we quantify (paleo-) runup from tsunami deposits? and How can tsunami deposits be used to mitigate hazards?

Although eyewitnesses have provided unequivocal evidence that tsunamis erode, transport, and deposit coastal sediment, earth scientists are still in the early stages of characterizing the deposits. At the meeting, deposits from recent and historic events were described from the Philippines (1994 Mindoro event; Arturo Daag, PHIVOLCS); Japan (1993 and earlier events; Yuichi Nishimura, Hokkaido Univ.); Nicaragua (1992 event; J. Bourgeois); Indonesia (1992 Flores event; Alastair Dawson, Coventry Univ.); Alaska (1964 event; Gary Carver, Humboldt State Univ.); Chile (1960 event; J. Bourgeois and B. Atwater); and the North Atlantic (1929 Grand Banks event; Alan Ruffman, Geomarine Associates; 1755 Lisbon event, A. Dawson). In these examples, tsunami deposits tend to be best represented and preserved as thin sheets (typically 10 cm or less) of sand on coastal marshes and in coastal lakes. Coarser, thicker deposits, including transported cobbles and boulders, were documented in some cases.

Eric Wright (Univ. South Florida) and Yuichi Nishimura described examples of modern storm deposits (also described in an unpresented abstract by Martitia Tuttle et al.), prompting discussion of criteria for distinguishing between tsunami and storm deposits. Although no single criterion works everywhere, reliable distinctions can be made in many cases on the basis of association with evidence for coseismic subsidence or uplift, spatial distribution, internal sedimentary structures, and sediment-transport modeling (e.g., as reported by Mary Ann Reinhart, Geoengineers, Inc.). Methods to quantify runup from sediment-transport modeling were also discussed by Hal Mofjeld (NOAA) and David Mohrig (U. Minnesota).

Properties of tsunami deposits were shown to vary with tsunami height and period; local bathymetry and topography; sediment source; vegetation and other roughness elements. Tsunami deposits may be graded or not, laminated or not, typically indicating rapid deposition from suspension. Bed forms are less common, but ripples have been observed; A. Daag described a Gilbert-delta-like tsunami deposit from the Mindoro event. Some deposits exhibit evidence of multiple waves but others don't, even where eyewitnesses have described more than one significant wave. Grain size and sorting commonly reflect source material available; deposits may include displaced and reworked flora and fauna, as reported, e.g., by Eileen Hemphill-Haley (USGS).

Tsunamis sometimes fail to produce widespread onshore deposits, for example in parts of Alaska (1964 event) and Shikotan Island (1994 Kuril Island event). Tsunami deposits were shown to be patchy in a number of cases, and may be easily eroded or otherwise obscured; preservation is most likely in subaqueous and proximal settings.

Prehistoric deposits attributed to tsunamis were described and discussed from the Cascadia subduction zone (Peter Bobrowsky, Geol. Survey Canada; Harvey Kelsey, Humboldt St. Univ.; Ian Hutchinson, Simon Fraser Univ.; and others); the Puget Sound region (B. Atwater; Brian Sherrod, UW; Harry Williams, Univ. N. Texas), and Norway and Scotland (Stein Bondevik, Univ. Bergen). The deposits in Norway and Scotland were credited to the massive Storegga slide complex in the North Sea. Other deposits ascribed to tsunamis from submarine landslides were described from Hawaii by George Moore (U. Oregon) and David Lewis (UW), and disputed by Anthony Jones (Oceanus Flotation Technologies). These Hawaii deposits are much coarser and found at significantly higher altitudes than Storegga deposits. Other searches for possible paleo-tsunami deposits have thus far produced equivocal but some promising results on the Hawaiian Islands (Gerard Fryer, Univ. Hawaii), at Cook Inlet, Alaska (Richard Waitt, U.S.G.S.), and in southern California (Mark Legg, ACTA, Inc.). Although not represented at the meeting, Russian scientists have also found candidates for paleo-tsunami deposits in Kamchatka.

Many of the deposits studied thus far are related to historic events. Prehistoric tsunamis have been assigned ages principally by stratigraphic superposition, radiocarbon dating, and tree-ring analysis of associated buried trees. John Clague (Geol. Survey Canada) described optical dating as a promising new method for dating directly the time of sand-grain deposition. Kenji Satake (U. Michigan) reported that the most recent major prehistoric tsunami at Cascadia may date to 26 January 1700 on the basis of written records of a tsunami in Japan.

Discussion of future directions was preceded by case histories from coastal Oregon, where tsunami-deposit studies have contributed to hazard planning. Paul Visher (Clatsop County), Curt Peterson (Portland St. Univ.) and George Priest (Oregon Dept. of Geology and Mineral Industries) described joint efforts by scientists, public officials, and local citizens in emergency planning and relocation of public facilities. It was clear from these examples, as well as from the following discussion, that studies of tsunami deposits can be combined with numerical modeling of tsunami inundation to improve the delineation of tsunami hazard zones. Participants discussed the criteria needed by modelers (e.g., bathymetry, topography, directional data) and geologists (e.g., velocity fields, spatial distribution of amplitude and runup), in order to couple their studies; there is also a clear need for modem test cases of runup and sediment-transport models. Careful communication with potentially affected communities, including full acknowledgment of the limits of existing knowledge, can allow studies of tsunami deposits, coupled with tsunami modeling and community planning, to reduce future losses of life and property.

International Tsunami Measurements Workshop

Estes Park, Colorado, USA; June 28-29,1995.

This Workshop was held with support from the National Science Foundation, UNESCO's IOC, and NOAA's NGDC. 45 scientist from 10 countries participated. The objective was to develop recommendations which could be implemented to improve the mitigation efforts and the research capability in the tsunami field. The work was accomplished in four working groups identified with the following general topics: 1) International post-tsunami surveys, 2) Applications and status of modeling, 3) Adequacy of present instrumentation and their distribution, and 4) Mitigation efforts. The participants moved freely between groups and frequent presentations of the status of discussions were made.

A total of approximately 30 recommendations were put forth by the respective working groups and accepted by the Workshop participants as a whole. In addition, the three following general recommendations were adopted separately by all the participants: a) Support should continue for the TIME project as a tool to create inundation maps for urban planning, b) Support should continue for the development of the Expert Tsunami Data Base as an information source and training tool, and c) Tsunami Data Centers should be established, initially in Japan, Russia, and the USA, to manage and maintain: bathymetric and topographic data, lists of instruments available and their location, tide gauge and bottom pressure sensor data, documentation and field survey data, inundation maps,

Group photograph at the International Tsunami Measurements Workshop

numerical models available and their documentation, and tsunami literature in general.

A Report including a review of the problems discussed, all the recommendations put forth and approved, and seven selected papers that were distributed at the Workshop, was edited and published by the co-Conveners: James F. Lander and Harry Yeh.

There was wide comment among the participants that the two days were not enough to adequately address all of the questions needing discussion and that another workshop should be held in the future for state-of-the-art presentations and focused on identified unanswered questions. One month later, at ICG/ITSU XV Session, support was recommended, in the form of travel grants for a few participants, for a Russian proposal to hold a workshop at Lake Baikal, Russia, in August 1996 on Tsunami Mitigation and Risk Assessment.

Seventeenth IUGG International Tsunami Symposium

University of Colorado, Boulder, Colorado, USA; July 3-4, 1995

by Jerry Hebenstreit

This Symposium was held during the XXII IUGG General Assembly. It was originally planned to be scheduled jointly with IAPSO and IASPEI, but the decision by IAPSO to disassociate from the General Assembly meant that the Symposium was sponsored solely by IASPEI.

Four separate sessions were held as part of the Symposium. A total of 45 oral papers and approximately 25 posters were presented. Attendance was between 30 and 60, depending on the session. Four topics were discussed: Tsunami Hazard Reduction, Historical and Contemporary Observations of Tsunamis, Physical Processes of Tsunami Generation, and Physical Processes of Tsunami Propagation and Run-up.

Tsunami Hazard Reduction. The papers presented during this session covered a variety of topics. One set of papers described the status and development of plans for tsunami warning and hazard reduction in four regions (Japan, USA, Australia and the SW Pacific, and Russia). A second set of papers described various tools in use or being developed for real-time warning. Techniques presented included underwater cable systems in Japan, noise monitoring for certain types of local tsunamis, and surface radar. A number of papers centered on post-event techniques for hazard analysis and planning, including inverse methods for determining sources, an expert system database for the Pacific, hazard level estimates for the Korean coast and the Black Sea, and a basin-wide scaling law for the Pacific.

Historical and Contemporary Observations. The increased number of significant tsunamis in the past 2-3 years, coupled with rapid strides in worldwide communications, led to the presentation of an unusually large number of papers in this session. For the first time at a Symposium, post-event surveys of a single tsunami were presented by several distinct groups of observers. The recent events described included the October 1994 Shikotan tsunami, the June 1994 East Java tsunami, the 1994 Philippine tsunami, and the July 1993 Hokkaido tsunami. The amount of detail presented is a strong indication that the understanding of near-shore and on-shore processes in actual events is likely to undergo major advances in the near future. Two additional papers shed valuable light on older tsunamis - the 1923 Kamchatka tsunami and several ancient tsunamis recorded in Japanese temple records.

Physical Processes of Tsunami Generation. This session contained studies seeking to understand more fully tsunami generation based on postulated and observed episodes. The postulated mechanisms included volcanoes in Cook Inlet, Alaska, landslides (two papers), and meteor impacts, as well as the more traditional seismic sources. Several additional studies were presented based on observed events such as the 1929 Grand Banks tsunami, the 1992 Nicaraguan tsunami, and the 1994 East Java tsunami.

Physical Processes of Tsunami Propagation and Run-up. The end effects of tsunamis have come under intense study in the last decade as more sophisticated analytical, laboratory, and observational tools have been developed. This session reflected that intensity. Three papers described combined analytical and laboratory work examining run-up on islands with idealized shapes. Four other papers described simulations for tsunamis in the Pacific (1994 Kuril Island and 1993 Hokkaido), the Mediterranean (1627 in Italy), and the Atlantic (1969 and 1975). A number of theoretical papers described various aspects of tsunami propagation, while one paper examined with both model and analytical techniques the impulse force of driftwood caught in tsunami inundation flow.

The technical quality of papers in the 1995 Symposium was uniformly quite high - perhaps higher than in recent memory. The presence of scientists for Asia, North and South America, and Europe produced a high degree of interest and synergy. It seems that tsunami research is a lively topic, especially among researchers interested in fluid flows.

IUGG Tsunami Commission Meeting

University of Colorado, Boulder, Colorado, USA; July 3, 1995

by Jerry Hebenstreit and Eddie Bernard

The meeting opened at 19:00 hours with a Japanese rendition of Dr. Bernard's "Tsunami Song" rendered by Y. Tsuji. Members present were: E. Bernard, R. Braddock, S. Farreras, F. González, V. Gusiakov, G. Hebenstreit, S.-I. Iwasaki, J. Lander, A. Marchuk, H. Miyoshi, J. Preuss, K. Satake, N. Shuto, F. Stephenson, S. Tinti, and Y. Tsuji.

Professor Shuto informed the Commission that the book for

the Wakayama meeting, "Tsunami: Progress in Prediction, Disaster Prevention, and Warning," edited by Yoshito Tsuchiya and Nobuo Shuto has been printed by Kluwer Academic Publishers.

Professor Shuto discussed the TIME project, which is funded by IOC. He stated that tsunami training and software have been transferred to 10 institutions in 9 countries. Yuri Oliouinine (IOC) added that IOC is quite pleased with the progress of this project.

Dr. Hebenstreit informed the Commission that the Proceedings of the Boulder meeting will be edited and assembled in a refereed document to be published by Kluwer Academic Publishers. He hopes to have the volume published by mid-1997.

Dr. Levin (Russia) informed the Commission of the establishment of a formal tsunami research center (TsuCen) in Moscow with the approval and cooperation of various agencies of the Russian government.

Mr. Lander reported on the highly successful tsunami observations workshop held in Estes Park, Colorado, prior to the Tsunami Symposium.

Prof. Tinti informed the Commission that the European Geophysical Society Natural Hazards Working Group has proposed to the EGU that an award (either annual or biannual) be instituted to recognize contributions to the fields of geophysics. If approved, the medal will be named in honor of the late Professor Soloviev. The Commission thanked Prof. Tinti for this gesture of recognition, not only to current researchers, but to one of the finest researcher scientists of an earlier generation.

Dr. Braddock informed the Commission that Australia has volunteered to host the 1997 Tsunami Symposium in Melbourne, Australia. The Symposium will be held concurrently with the IAPSO/IAMAS Symposium. After some discussion the offer was accepted.

The election of new members of the Commission was held. The members voted to add the following individuals to the Commission:

K. Abe (Japan), B.H. Choi (Korea), B. Levin (Russia), H. Matsutomi (Japan), G. Papadopoulos (Greece), E.N. Pelinovsky (Russia), C. Synolakis (U.S.A.), A.C. Yalciner (Turkey) and H. Yeh (U.S.A.)

The election of officers for the coming four-year term was held. Dr. Bernard presented the following slate of candidates: Chair - V. Gusiakov (Russia), Vice Chair - S. Tinti (Italy), Vice Chair - Y. Tsuji (Japan), and Secretary - J. Lander (U.S.A.). No other nominations were received by mail or from the floor. The Commission elected the proposed slate by acclamation.

A brief discussion of the need for developing more avenues for publishing tsunami research in refereed literature was held. It was suggested that the new officers examine this issue.

Dr. Braddock proposed a vote of thanks to Dr. Bernard for his effective and insightful leadership for the past eight years. The motion was approved by acclamation. Dr. Bernard led the English version of the "Tsunami Song."The meeting was adjourned at 20:15 hours.

Coastal Ocean Symposium at IAPSO General Assembly

Hilton Hawaiian Village, Honolulu, Hawaii, USA; August 10, 1995

This symposium focused on circulation and processes in coastal oceans, especially those having connections and interactions with land. Problems related to natural hazards and their mitigation were included. Ten oral papers on tsunamis were programmed for a one-morning session.

Among others, the presentations covered the following tsunami topics: Tsunami and storm surge risk and mitigation in New Zealand, Tsunami and abnormal long wave observations on the Ligurian Coast, Quantification of parameters for tsunami warning and response, Development of a model for the real time evaluation of the tsunami risk, and a Photographic look at the April 1, 1946 tsunami.

The Tsunami Society Business Meeting

Hilton Hawaiian Village, Honolulu, Hawaii, USA; August 10, 1995

The meeting was called to order at noon by the President of the Tsunami Society, Dr. Fred Camfield.

After a call for nominations, the following slate of officers were newly elected or re-elected by acclaim:

President	- Mr. George Curtis
Vice-President	- Prof. Stefano Tinti
Secretary	- Dr. Charles McCreery
Treasurer	- Dr. Augustine Furumoto

A financial report was presented by the Treasurer, followed by a brief but detailed explanation. A short discussion followed.

There being no further business, the meeting was adjourned at approximately 13:00 hours.

Coastal Earthquakes and Tsunamis: Reducing the Risks

Seaside, Oregon, USA; August 29-31, 1995.

by Dennis J. Sigrist

This three-day conference was hosted by Oregon State University, Extension Sea Grant, with supporting funding from the National Oceanic and Atmospheric Administration. The conference brought together a diverse group of 117 participants representing the scientific community, educators, private industry, insurance companies, government (local, state and federal) as well the media. The primary focus of the conference involved discussion, scenarios and mitigation strategies related to a severe megathrust earthquake along the Cascadia Subduc-

tion Zone (CSZ) and resulting tsunami. Field trips to sites along the north Oregon coast presented evidence of prior large earthquakes and tsunamis in the area as well as structures and facilities vulnerable to these natural hazards.

Dennis Sigrist, ITIC's then Acting Director, hosted a session on geologic research that is studying evidence of past earthquakes / tsunamis in the area that have left sand deposits and other physical indicators. The final day of the conference divided the group into smaller Focus Groups to identify effective earthquake and tsunami hazard mitigation strategies. It was recognized by this Focus Groups at the break-out sessions, that pre-event planning and public education must be undertaken to help reduce the loss of life and property damage associated with a CSZ earthquake and resulting tsunami. In fact, the state of Oregon recently passed two new laws that require tsunami education for students in coastal schools and also place restrictions on building critical facilities (hospitals, schools, etc.) in the tsunami inundation zone. Excerpts from the conference were consolidated onto video tape for use in classrooms, meetings and future reference. The IOC/ITSU Pacific Tsunami Warning program was well represented through presentations, videos, posters and educational materials.

International Workshop on Long-Wave Runup Models

Friday Harbor, San Juan Island, Washington, USA; Sept. 12-16, 1995

by Harry Yeh

This was the second in the series of Long-Wave Runup Models workshops begun in Two Harbors, Catalina Island in 1990. The objectives of this second workshop were to review the research progress in tsunami runup and to identify future research directions in tsunami hazard mitigation. Additional objectives were comparisons of numerical, analytical, and physical prediction models with existing laboratory and field data. Just as in the other two tsunami related workshops held in 1995, i.e., the Tsunami-Sediment Deposit Workshop, and the Tsunami Measurement Workshop, the organizers were motivated by six tsunami events of 1992-1994, i.e., the 1992 Nicaragua, the 1992 Flores, Indonesia, the 1993 Okushiri, Japan, the 1994 East Java, Indonesia, the 1994 Shikotan, Russia, the 1994 Mindoro, Philippines and the 1994 Skagway, Alaska tsunamis.

A total of 55 scientists and students participated in the workshop, as follows: one from Australia, two from Brazil, one from Canada, two from England, one from Indonesia, eight from Japan, one from Russia, one from Thailand, and thirty-eight from the United States. Student participation was encouraged, and 21 of the 55 participants were students.

Unlike the 1990 Catalina workshop, the format of this workshop was specifically designed to focus on discussions rather than on formal presentations. To accomplish this goal, four benchmark problems were selected before the workshop so that prediction models could be compared, both qualitatively and quantitatively evaluated and discussed among the participants during the workshop. The workshops organizers provided interested participants with initial and topographic data for the propagation problems and they requested predictions at specific points in specified format. The actual laboratory or physical measurements were only presented during the workshop in the same format, allowing the comparisons of predictions with measurements. During the workshop, seven discussion themes were organized as follows: laboratory, analytical, finite-difference, finite-element, vertical-plane, boundary-integral-element, and marker-and-cell models.

In terms of tsunami runup modeling, significant advances have been made since the Catalina Workshop in 1990, due to the advancement of computational capabilities, but also because of the generation of a large 2-D and 3-D laboratory data set and the field measurements in 1992-1995, all of which have contributed to model calibration.

The workshop report is currently under preparation and the proceedings will appear in a book form from World Scientific Publishing Company in 1996. The workshop was organized by Professors Harry Yeh (University of Washington), Philip Liu (Cornell University), and Costas Synolakis (University of Southern California). The workshop was sponsored by the US National Science Foundation.

Upcoming Meeting Announcements

U.S.A.-Japan Two Great Tsunamis Anniversary: Memorial Service, Conference, Museum Dedication, and Symposium (UJNR Workshop)

Campus Center, University of Hawaii, Hilo, Hawaii, USA; April 1-5, 1996

Cosponsors: The Tsunami Society, Natural Sciences Division of the University of Hawaii at Hilo.

Organizing Committee Co-Chairmen: Jim Lander, University of Colorado, USA, (303)497-6513, jlander@ngdc.noaa.gov; and George Curtis, University of Hawaii, (808) 933-3693, gcurtis@hawaii.edu

Hilo Tsunami Museum, P.O. Box 806, Hilo, Hawaii 96721

Marking the 50th anniversary of the 1946 tsunami at Hilo, Hawaii, U.S.A. which led to the present Pacific-wide tsunami warning system and increased tsunami research, and the Centennial of the great Sanriku earthquake and tsunami in Japan, a Memorial Service and a Conference with invited speakers from both countries and survivors of the 1946 event is planned for April 1. Concurrently, the site of the Hilo Tsunami Museum will be dedicated. The Museum will provide public education programs that will increase tsunami awareness, and will integrate local oral history with scientific information. To achieve its goals, the Museum will have permanent and temporary exhibits, living history "talk sessions", and in-house and outreach educational programs. The Museum, a private non-profit organization, needs financial support. Please contact the address shown above to send your tax deductible donation.

A Symposium on latest developments in the field, including instrumentation, warning and mitigation actions, source mechanisms, case studies, models, and application of lessons learned from past tsunamis to public safety, will be held at the same place on April 2.

On April 3, 4 & 5, an optional field trip to affected sites on Hawaii Island including visits to Hilo Harbor, Laupahoehoe Bay, the Civil Defense Office and the Hawaii Volcano observatory, and an open house and tour to the Pacific Tsunami Warning Center, JIMAR and the National Weather Service office at the University of Hawaii on Oahu are being planned.

For the Symposium, U.S.A. government and academia scientists, and users of tsunami research are being invited to submit papers related to the topics and theme described above. A delegation of scientists from Japan is also being organized. Papers rather than abstracts are encouraged, although both are acceptable. Selected papers will be reviewed and published in a special edition of *Science of Tsunami Hazards*, the international journal of The Tsunami Society. The deadline for either is March 1, 1996.

European Geophysical Society XXI General Assembly

Netherlands Congress Centre, The Hague, The Netherlands; May 6-10, 1996

For general information and pre-registration contact: EGS Office, Postfach 49, Max-Planck-Str. 1, 37189 Katlenburg-Lindau, Germany, Telephone: 49-5556-1440, Fax: 49-5556-4709; e-mail: egs@linax1.mpae.gwdg.de

Session NH5 "Tsunamis Impacting on the European Coasts: Modelling, Observation and Warning" will cover tsunami generation processes by earthquakes and submarine landslides, numerical and laboratory modelling, geological processes associated with tsunamis like erosion and deposition, warning, prevention, and monitoring.

For information on this Session, contact:

Dr. B. Massinon, Convener
Laboratoire de Geophysique
B.P. 12
91680 Bruyeres-le-Chatel
France
e-mail: massinon@ldg.bruyeres.cea.fr

Abstract deadline is December 15, 1995.

Latin American Course on Numerical Simulation and Early Detection of Tsunamis

Valparaiso, Chile; March 11 - May 11, 1996

Jointly organized by: Servicio Hidrografico y Oceanografico de la Armada (SHOA) de Chile, Errazuriz 232 Playa Ancha, Casilla 324, Valparaiso, Chile; and

Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE), Apartado Postal 2732, Ensenada, B.C. 22800, Mexico.

Sponsored by: Intergovernmental Oceanographic Commission of UNESCO

For registration and information contact: Capt. Alejandro Cabezas, Jefe Departamento de Oceanografia, Servicio Hidrografico y Oceanografico de la Armada de Chile, Errazuriz 232 Playa Ancha, Casilla 324, Valparaiso, Chile; Telefono: 56-32-282697, Fax: 56-32-283537; e-mail: shoa@huelen.reuna.cl

A two-months international training course, whose objective is to transfer the tsunami inundation modelling technology of

the TIME project for the benefit of participants from Latin America. The course program aims at developing tsunami inundation maps of coastal communities under risk, for civil protection purposes. Topics will cover: hydrodynamic wave theories and equations, numerical integration algorithms, and application to generation, propagation and coastal flooding by tsunamis. Lectures on the various subjects will be followed every day by extensive practical computer laboratory exercises of application to regions of interest selected by the participants. The last week of lectures will be devoted to explain and demonstrate the usage of the TREMORS system based on a three-component broad-band seismometer for the early determination of seismic moments and evaluation of possible tsunamigenic potential of earthquakes.

Applicants must have a scientific degree (B.Sc. level or equivalent) in geosciences, physics or engineering, and be sponsored by a Latin American institution involved in tsunami warning, prevention or preparedness activities. Capacity is limited, there will be a selection process. Spanish will be the working language of the course.

Deadline to submit applications was November 30, 1995.

7th Pacific Congress on Marine Science and Technology (PACON '96)

Ilikai Hotel, Honolulu, Hawaii, USA; June 16-20, 1996

For registration and information contact: Dr. Narendra K. Saxena, e-mail: saxena@wiliki.eng.hawaii.edu; and/or PACON International, P.O. Box 11568, Honolulu, Hawaii 96828, USA; Telephone: 8O8-956-6163, Fax: 8O8-956-258O

Theme: the role of marine science and technology in the economic development of the Pacific Basin resources. This Congress will bring together scholars and resource people to address key issues concerning the marine technology related to the ocean economic potential of the region from a multi-disciplinary perspective. It will facilitate the exchange of views and ideas between representatives of the Pacific Island nations and of the larger rim countries and thereby strengthen future information exchange and collaborative research linkages.

Session topics include: remote sensing and oceanography satellites, marine applications of GPS, *tsunamis*, marine environmental protection, undersea vehicles and ocean robotics, and effects of hurricanes and typhoons in the coastal areas. An exhibition will be held in conjunction with the technical program.

Abstracts must be received no later than January 15, 1996.

Hazards-96, Sixth International Symposium on Natural and Man-Made Hazards

Toronto, Canada; July 21-26, 1996

Organized by:

The International Society for the Prevention and Mitigation of Natural Hazards (NHS), PO Box 49511, 80 Glen Shields Avenue, Concord, Ontario L4K 4P6, Canada.

For general information contact:

Prof. M.I. El-Sabh, President, Natural Hazards Society, Centre Oceanographique de Rimousqui, 310 Allee des Ursulines, Rimouski, Quebec G5L 3A1, Canada;

Telephone: 418-724-1707, Fax: 418-724-1842; e-mail: mohammed_el_sabh@uqar.uquebec.ca

This is the sixth in the series of Natural Hazards symposia begun in 1982. The objectives of this series are to promote the advancement of hazards sciences, to perceive and explore those aspects that may be similar among some of the various hazards, to review the latest developments in a few selected fields and to outline new directions for future research.

The theme for Hazards-96 is: "Major Natural Disasters in the 90's - What can we learn from them?." Among the topics to be addressed are: Geological hazards (earthquakes, volcanoes, landslides, soil erosion), Meteorological hazards (cyclones, droughts, desertification), Hydrological and marine hazards (*tsunamis*, storm surges, floods, sea level rise), Disaster prevention, mitigation and management, Public education and preparedness, and the IDNDR as a vehicle for action.

Abstracts should be submitted no later than February 29, 1996.

Pan Pacific Hazards '96

Vancouver Trade and Convention Centre, Vancouver, B.C., Canada; July 29- August 2, 1996

For information contact: Program Committee, Pan Pacific Hazards '96 Conference, The University of British Columbia, Disaster Preparedness Resources Centre, 22O6 East Mall, 4th Floor, Vancouver BC V6T 1Z3, Canada; Phone: 6O4-822-5518, Fax: 6O4-822-6164, e-mail: dprc@unixg.ubc.ca

A Conference on Earthquakes, Volcanoes, and *Tsunamis*. The following areas will be covered in bridging research/technical, emergency management, and practical application aspects of earthquakes, volcanoes and *tsunamis*: disaster preparedness, public education and awareness, risk assessment, prediction and forecasting natural events, monitoring and warning systems, communication technologies and networks, disaster response and recovery, and hazard mitigation, among others.

The purpose of this Conference is interdisciplinary, so in addition to technical sessions within specialty areas, participants will be asked to listen to issues and concerns raised by others as well as contributing to the search for answers. The Conference will go beyond conventional discussion of response stories and risk analysis to explore strategies for preparedness and mitigation. To enhance interdisciplinary information sharing, it will include: workshops, poster sessions, plenary sessions, panel discussions, technical exhibits, video viewing, technical tours, and public forums.

Deadline for abstracts submission is November 1, 1995.

Coastal Zone Canada '96

Rimouski, Quebec, Canada; August 12-17, 1996

Sponsors: Groupe de Recherche en Environnement Cotier (Universite du Quebec a Rimouski), Coastal Zone Canada Association, IAPSO, and others.

For information and registration contact the Conference Chair: Prof. Mohammed I. El-Sabh, CZC'96 Conference Secretariat, GREC, Centre Oceanographique de Rimouski, 310 Allee des Ursulines, Rimouski, Quebec G5L 3A1, Canada; Telephone: 418-724-1707, Fax: 418-724-1842; e-mail: mohammed_el_sabh@uqar.uquebec.ca

This International Conference is the second in the continuing inter-disciplinary series begun in 1994 in Halifax, Nova Scotia.

The objective and theme of this meeting is to review current knowledge, provide a forum, and frame recommendations to integrate management and sustainable development in coastal zones. Session topics include: environmental quality, pollution impacts, and coastal oceanography; climate change, sea level rise, and *natural disaster impacts;* conservation and protection of the coastal zone; and management and development of coastal zone resources.

A major trade show and exhibition is planned to allow private companies and public organizations to meet with attendees and discuss innovative technologies, approaches and business opportunities.

Paper or poster presentations are encouraged. Proposals for round-table sessions are also invited.

Abstract deadline is February 1, 1996.

International Workshop on Tsunami Mitigation and Risk Assessment

Petropavlosk-Kamchatskiy, Russia; August 19-23, 1996

Sponsors: IUGG Tsunami Commission, Intergovernmental Oceanographic Commission of UNESCO, Russian Foundation for Basic Research, and others.

Co-Conveners: Viacheslav K. Gusiakov, Computing Center, Pr. Lavrentiva 6, Novosibirsk 630090, Russia, Telephone: 7-3832-324892, Fax: 7-3832-324259, e-mail: slava@comcen.nsk.su; and Boris W. Levin, Russian Foundation for Basic Research, Leninskiy Prospect 32a, Moscow 117334, Russia, Fax: 7-095-938-1931, e-mail: levin@rfbr.ru

Main Objective: Evaluation of the state-of-the-art of the problem of the long-term estimation of tsunami risk (tsunami-zoning). The final product of the workshop will be recommendations on the tsunami-zoning strategy which can be used as a guide for scientists and practitioners to improve the quality and reliability of tsunami risk estimates for coastal areas with different types of seismo-tectonics and different levels of completeness of historical data. Format: Round-table discussions with 30 minutes introductory presentations on each particular topic.

Topics: paleotsunami research, historical catalogs and data bases, seismo-tectonics of tsunami, numerical models of tsunami behavior, methods of calculation of tsunami risk, mitigation and countermeasures.

The workshop will be followed by a 1-day field trip to the Pacific coast of Kamchatka to look at geological traces and sites of manifestation of 1952 and 1737 tsunamis.

Deadline for registration is May 1, 1996.

Natural Disaster Reduction '96

Brisbane, Queensland, Australia; September 29 - October 2, 1996

For information contact: Ms. Shauna Kelly, Managing Director, AE Conventions, Pty Ltd., Engineering House, 11 National Circuit, Barton Act 26OO, Australia; Phone: 61-6-27O6572, Fax: 61-6-2732918

Aims of the Symposium are: To review both theoretical and practical knowledge of the nature, impact, and mitigation of natural disasters; To provide a forum for government, academic, and business community members, to exchange their experiences and knowledge on natural disasters; To generate state-of-the-art information products to illustrate the scientific and societal response to the threat from natural disasters; and To frame recommendations arising from the deliberations of the Symposium.

Themes for the Symposium are: case studies (bushfires, droughts, cyclones, earthquakes, floods, storms, *tsunamis*, and biological hazards); management/mitigation/recovery (contribution of advanced technology to natural disaster mitigation, and role of the IDNDR and other international programs); social and community issues (role of education in community defense against natural disasters, social and psychological impacts, insuring against disasters, and influence of the media on the perception and mitigation of disasters); and environmentally specific implications (global climate change influence in natural disasters occurrence, linkages between land degradation and natural disasters, and global vulnerability to meteorite impacts).

Deadline for abstracts: December 1, 1995.

Second Caribbean Conference on Natural Hazards and Disasters

Kingston, Jamaica; October 9-12, 1996

Organized by: Department of Geology, University of the West Indies.

For further information, please contact: Dr. Barbara Cardy, Coordinator, 2nd Caribbean Conference on Natural Hazards and Disasters; Department of Geology, University of West Indies; Mona, Kingston 7, Jamaica, W.I.; Telephones: 809-927-2781, 809-927-2728, and 809-927-2253, Fax: 809-927-2156; e-mail: bcarby@unwimona.edu.jm

This Conference, which follows the first one held in Trinidad in 1993, will present papers and posters on all aspects of natural hazards, disasters and their management. The major aim of the Conference is the review of current research on and management of natural hazards. A network of organizations involved in the field will also be set up.

Publications

Report of the International Tsunami Measurements Workshop

Lander J.F. and H. Yeh (Co-Convener editors), 1995. Estes Park, Colorado, U.S.A., 102 p.

The International Tsunami Measurements Workshop was held in Estes Park, Colorado, U.S.A. on June 28-29, 1995, with support from the National Science Foundation, UNESCO's IOC, and NOAA's NGDC. Forty-five scientists from 10 countries participated. The work was accomplished in four working groups identified with the following general topics: 1) International post-tsunami surveys, 2) Applications and status of modeling, 3) Adequacy of present instrumentation and their distribution, and 4) Mitigation efforts.

This Report gives an overall description of the above topics and contains the separate reports of each working group with their recommendations that were put forth and accepted by the Workshop participants as a whole. A review of the problems associated and questions arising from the collection and distribution of tsunami data are presented in the Introduction of the Report. Also included as Appendices are seven selected papers covering the most prominent aspects discussed, that were distributed at the Workshop.

A limited supply of this report in hard copy is available from James F. Lander, University of Colorado, CIRES, Campus Box 449, Boulder, Colorado 80309, USA. It will also be available on the World Wide Web by the end of February 1996 at http://www.ngdc.noaa.gov/seg/segd.html (select "activities" and look for "hazards" section).

Tsunami: Progress in Prediction, Disaster Prevention and Warning

Tsuchiya Y. and N. Shuto (editors), 1995. Kluwer Academic Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands, 336 p. Order within North America to: Kluwer Academic Publishers, 101 Philip Drive, Norwell, MA 02016, USA.

The Sixteenth IUGG International Tsunami Symposium was held in Wakayama, Japan from August 23 to 27, 1993. This book is a selection of 21 papers from seven countries, selected and rigorously scrutinized through a review process, out of the 78 presentations given at the Symposium.

These scientific contributions are grouped and presented under three areas of research: a) Tsunami generation, propagation and inundation: their prediction and simulation; b) Tsunami disasters: their prevention and mitigation; and c) Tsunami observations and warning systems, and plans for improvement.

Perspectives on Tsunami Hazard Reduction

J. Hebenstreit (editor), late 1996. Kluwer Academic Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands, (in process)

The Seventeenth IUGG International Tsunami Symposium was held on July 3-4 1995, in Boulder Colorado, during the XXII IUGG General Assembly. Four separate sessions were held as part of the Symposium, with a total of 45 oral papers and 25 posters from scientists of 18 countries being represented.

This Proceedings book will include a selection of contributions covering the most prominent aspects of current tsunami research. It will examine three phases of hazard reduction: observations, physics, and planning. The Editor is presently selecting the papers that will undergo peer review for their acceptance. The Publisher would like to receive a camera-ready original in May 1996, so as to be able to have the volume available for distribution by late summer of 1996.

Tsunamis 1992-1994: Their Generation, Dynamics and Hazard

Satake K. and F. Imamura (editors), 1995. Birkhauser Verlag, P.O. Box 133, CH-4010 Basel, Switzerland, 430 p. Order within North America to: Birkhauser, 675 Massachusetts Ave., Cambridge, MA 02139, USA, Telephone: 800-777-4643, Fax: 617-876-1272. List price: US$ 42.50 plus US$ 3.00 for shipping and handling.

This book is not a proceedings volume of any particular meeting, but a collection of 26 papers specifically submitted for this publication. They cover various aspects of eight recent tsunamis (1992 Nicaragua, Cape Mendocino, and Flores Island; 1993 Hokkaido Nansei-Oki and Guam; and, 1994 Mindoro Island and Shikotan), as well as theoretical and physical modeling of the arrival of a tsunami at a circular island. Topics deal with: field survey data and results, seismological analysis, numerical modeling of generation, propagation and coastal behavior, and tsunami deposits. The content was previously published as topical issue 144 (3 & 4) of *Pure and Applied Geophysics.*

Pacific All-Hazards Conference Proceedings

R.C. Price, President of the Pacific Caucus (editor), 1995. Hawaii State Civil Defense, Honolulu, Hawaii, 14 p. plus 14 App.

The Pacific All-Hazards Conference was held in Honolulu, Hawaii, U.S.A. on June 7-9, 1995. The Conference was organized as a series of formal presentations on the main topics given by representatives of the Pacific Caucus member states and by authorities of civil defense, warning systems and emergency management agencies, followed by short discussions. The sessions covered: hazards common to the Pacific, Pacific insular states disaster mitigation strategies and preparedness, El Niño Southern Oscillation, hazard insurance programs, the Pacific Tsunami Warning System, the Earth Alert Emergency Warning System, and the Pacific Disaster Center.

This Report contains short summaries of all the main presentations followed by 14 papers covering the most prominent aspects as presented by the speakers. Also included at the beginning of the Report are a description of the Pacific Region Emergency Management Caucus (or Pacific Caucus), its goals and operational procedures, and a summary of the welcome speeches to the Conference.

Internet/World Wide Web

Tsunami! - World Wide Web Site

from a tsunami bulletin board posting by Ben Cook

An on-line, interactive, tsunami-information resource is now accessible at the following URL:

http://tsunami.ce.washington.edu/tsunami/counter.acgi?view

This World-Wide Web (WWW) site was developed at the University of Washington with collaborative support from the global tsunami research community. The resources available at this site include the following multimedia-supported topics: Explanations of the physics of tsunami propagation and inundation; case studies of significant historical tsunamis; an overview of the Tsunami Warning System; hazard mitigation and prevention information; recent tsunami-event documentation (at present, limited to the 1994 East Java event); and links to other tsunami-related WWW sites.

"Tsunami!" is a work in progress. It is a virtual, or living software document, with dynamic content and structure. It is hoped that this site will serve as a prototype for a more extensive and complete site that could be developed collaboratively by the tsunami research community.

Ben Cook developed this site for his Master's project in the Department of Civil Engineering, University of Washington, assisted by members of the tsunami research community who provided various tsunami-related literature, images, computer-generated animation, and video, and under the guidance of Dr. Catherine Petroff (e-mail: cpetroff@u.washington.edu), his Master's advisor. She will be maintaining the site and continuing its development. They encourage all members of the tsunami community to explore this Internet resource and send constructive comments and suggestions for future development.

Tsunami Survey Photographs

This World-Wide Web (WWW) site was developed by Dr. Costas Synolakis of the University of Southern California. It is accesible at the following URL:

http://www.usc.edu/dept/tsunamis/

The color photographs presented are from the reconnaissance surveys of the following 1992-1995 tsunami events:

12 December 1992	Ms = 7.5	Flores, Indonesia Tsunami
04 June 1994	Ms = 7.2	East Java Indonesia Tsunami
12 October 1994	Ms = 8.2	Kuril Islands Tsunami
15 November 1994	Ms = 7.0	Mindoro, Philippines Tsunami
09 October 1995	Ms = 7.3	Manzanillo , Mexico Tsunami

Very soon it will include maps to identify locations where the photographs were taken and descriptions of the event and the damage. Dr. Synolakis is working to upgrade the site and will post notices on the Internet as new material is added. Comments and suggestions on improving this tsunami survey photo page site are welcome. Visitors to the home page may download any of the images for scientific journal use, as long as they acknowledge the relevant journal publication where the photos are described, and the home page. The WWW site also lists related publications available by order.

PMEL Home Page: Tsunami Section

The U.S. National Oceanic and Atmospheric Administration's Pacific Marine Environmental Laboratory (PMEL) announced its World Wide Web Home Page. It is located at URL:

http://www.pmel.noaa.gov/

One section describes the Tsunami Project currently in development at the PMEL, including: objectives, field work, modeling and analysis, and reports published. Information is also

given on other activities related with tsunamis in which PMEL is engaged - like organizing Tsunami Workshops.

The FY 94 PMEL Summary Report is also available and can be accessed at URL:

http://www.pmel.noaa.gov/annual-reports/fy94/

or directly from the Home Page.

Science of Tsunami Hazards

from a tsunami bulletin board posting by Antonio Baptista

The International Journal of The Tsunami Society, *Science of Tsunami Hazards*, is now on-line at the following URL:

http://www.ccalmr.ogi.edu/STH

The WWW page of the journal contains a list and abstracts of papers published in current and past issues, besides information of general interest (conference announcements, links to tsunami sites, information on the Tsunami Society, etc.). Only selected issues are listed at this time, but the list will become comprehensive over time. Authors can help speed the process by submitting electronic versions of their past abstracts (no full papers at this time, please) according to the "instructions to authors" given at the site. In the future, special issues of the journal will have full papers available through the web, and ideas for such special issues are welcome. Aspects of the design of the WWW page of the journal will likely evolve over the next few months.

Comments and suggestions for this web site should be sent to Antonio Baptista at:

baptista@ccalmr.ogi.edu

Warning Center Activities

Centre Polynésien de Prévention des Tsunamis

New Mo Threshold for Tahauku Bay at Hiva Oa

based on information provided by Francois Schindele of LDG/CPPT

The Centre Polynésien de Prévention des Tsunamis (CPPT) has redefined its threshold for issuing tsunami warnings for Tahauku Bay at Hiva Oa in the Marquesas Islands. This change was necessitated by two recent tsunami that produced unexpectedly large waves in the bay. The July 30 tsunami from Chile produced a 3m wave that sunk two small boats, damaged others, and ran inland 250 meters. That same tsunami measured only 15 cm at Papeéte. Then, on October 9 a tsunami from Manzanillo, Mexico produced a wave of 1 meter amplitude at Tahauku, although it was only 7 cm at Papeete. On the other hand, the December 3 tsunami from the southern Kuril Islands was also 7 cm at Papeéte, but was unobserved at Tahauku. Based on these data, a new warning level was formulated especially for that bay: Mo > 8.0×10^{20} N-m for tsunamis coming from the eastern Pacific, and Mo > 5.0×10^{21} N-m for those coming from the western Pacific.

Pacific Tsunami Warning Center

Submarine Eruption Prompts TIB

A specially formatted Tsunami Information Bulletin (TIB) was issued by PTWC on October 25th to advise recipients of the potential for generation of a local tsunami by an undersea volcano located in the Commonwealth of the Northern Marianas Islands (CNMI). The volcano, named "Ruby", located about 25 miles northwest of Saipan, had been in eruption for at least two weeks based on reports from local fishermen who had noticed unusual ocean activity in the area above the undersea cone. Then, on October 23rd, fishermen reported that they could hear explosions in the water. After consultations with the Hawaii Volcanoes Observatory and with PTWC, the governement of CNMI issued a Tsunami Alert to residents of nearby communities, and an evacuation plan was put in place. The aforementioned TIB from PTWC was issued shortly thereafter. Fortunately, no tsunami materialized.

Communications Plan Update

The Communications Plan (Comm Plan) for the Tsunami Warning System (TWS) is the operations manual for participants in the TWS. It provides a general overview of the nature of tsunamis and a brief history of the warning service. It lists the tide and seismograph stations which participate in the service, the preferred methods of communication between the stations and the tsunami warning centers, the criteria for reporting, and gives examples of tsunami bulletin formats and content.

All countries that may be affected by tsunami generated in the area covered by the TWS are listed section by section in the Comm Plan. These sections detail the methods by which various tsunami bulletins are sent and received. Sample bulletins and criteria under which they are issued are also included.

The long-delayed twelfth edition of the Comm Plan is now in final preparation before going to the printers. It will be automatically sent to all listed participants in the TWS and is also will be available on request from PTWC.

PTWC Renovations Update

The Pacific Tsunami Warning Center has been undergoing a modernization process over the past few years as part of the wider modernization of the U.S. National Weather Service. Planned and ongoing improvements include: 1) a new phone system with more incoming lines, voice mail, and many helpful features available in modern phone systems, 2) new uninterruptable power supply for all critical electronic equipment, 3) new signal processing electronics with better monitoring and troubleshooting capabilities, 4) the interconnection of computers and peripherals via a LAN, and 5) connection of the PTWC LAN to other National Weather Service facilities as well as to the Internet. Many improvements to the physical plant have also taken place or are underway including: 1) a new layout of the main office and operations areas, 2) replacement of older office furnishings with modular furniture designed to accommodate computers and other office electronic equipment, 3) new roofs for the main office, electronics facility, and on-site houses, 4) new air conditioning system for the main office, and 5) a sewer system to replace aging septic tanks. A majority of these improvements should be completed by summer.

Summary of Pacific Basin Earthquakes

with Surface Wave or Moment Magnitudes Greater than or Equal to 6.5
(data provided by PTWC, ATWC, JMA AND NEIC, June 1995 through December 1995)

Event	Date	Location	Time UTC	Lat.	Long.	Depth Km.	Ms	Mw	Action	Issued UTC
95-28	Jun 24	New Ireland, PNG	0658Z	4.0S	153.9E	386	6.2*	6.8		
95-29	Jun 29	Vanuatu Islands	1224Z	19.5S	169.1E	144	6.2*	6.7		
95-30	Jul 3	Kermedec Islands	1950Z	29.1S	177.7E	33	7.3	7.2	PTWC/TIB	2051Z
95-31	Jul 12	Vanuatu-Hunter Islands	1547Z	23.3S	170.8E	33	6.6	6.4	PTWC/TIB	1644Z
95-32	July 28	Tonga Islands	1429Z	21.1S	175.5W	100	6.1*	6.5		
95-33	Jul 30	Northern Chile	0511Z	23.4S	70.4W	47	7.8	7.5	PTWC/RWW	0638Z
95-34	Aug 14	New Britain, PNG	0437Z	4.8S	151.4E	127	6.3*	6.9		
95-35	Aug 16	Solomon Islands	1027Z	5.6S	153.9E	45	7.8	7.4	PTWC/RWW	1119Z
95-36	Aug 16	Solomon Islands	1624Z	5.3S	153.8E	27	6.8	6.6	PTWC/TIB	1719Z
95-37	Aug 16	Solomon Islands	2310Z	5.7S	154.1E	37	7.2	6.9	PTWC/TIB	2358Z
95-38	Aug 17	Solomon Islands	0016Z	6.1S	154.5E	55	6.5	6.4		
95-39	Aug 17	Solomon Islands	1001Z	5.0S	153.3E	24	6.5	6.4		
95-40	Aug 19	Colombia	2144Z	5.1N	75.7W	125	6.2*	6.5		
95-41	Aug 23	Mariana Islands	0706Z	18.8N	145.2E	597	6.2*	7.0		
95-42	Sep 8	South Pacific Ocean	0115Z	56.2S	122.3W	10	6.5	6.3		
95-43	Sep 14	Guerrero, Mexico	1404Z	16.8N	98.6W	21	7.2	7.5	PTWC/TIB	1452Z
94-44	Sep 23	Near Coast of Peru	2232Z	10.5S	78.6W	70	5.9*	6.5		
95-45	Oct 3	Ecuador-Peru Border	0151Z	2.8S	79.9W	27	7.0	6.8	PTWC/TIB	0243Z
95-46	Oct 9	Jalisco, Mexico	1536Z	19.2N	104.2W	33	7.3	7.6	PTWC/TIB	1637Z
95-47	Oct 18	Ryukyu Islands	1037Z	27.9N	130.4E	27	6.9	6.9	PTWC/TIB	1125Z
95-48	Oct 19	Ryukyu Islands	0242Z	28.1N	130.5E	31	6.9	6.6	PTWC/TIB	0326Z
95-49	Oct 21	Chiapas, Mexico	0239Z	16.9N	93.5W	161	6.3*	7.3		
95-50	Nov 1	Northern Chile	0035Z	28.9S	71.4W	20	6.6	6.6	PTWC/TIB	0139Z
95-51	Dec 1	Off Coast of Mexico	0520Z	10.1N	104.0W	10	6.2	6.5		
95-52	Dec 2	Southern Kuril Islands	1713Z	44.5N	149.3E	19	6.6	6.6	PTWC/TIB	1800Z
95-53	Dec 3	Southern Kuril Islands	1801Z	44.6N	149.4E	33	8.0	7.8	PTWC/RWW	1847Z

** indicates mb for the case of deeper focus earthquakes*

MEMBER STATES OF THE

INTERNATIONAL COORDINATION GROUP FOR THE TSUNAMI WARNING SYSTEM IN THE PACIFIC