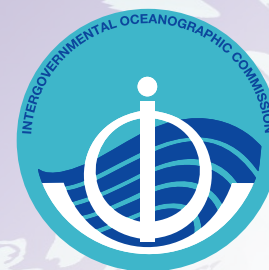




# TSUNAMI NEWSLETTER



## International Tsunami Information Center

### TSUNAMI MAPS DEVELOPED FOR ESMERALDAS, ECUADOR

Patricia Arreaga Vargas

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Tsunami inundation maps have been produced for Esmeraldas, Ecuador by personnel from the Oceanographic Institute of the Navy (INOCAR) of Ecuador, with funding assistance from ITIC and UNESCO/IOC for a training course at the Center of Scientific Research and Graduate School of Ensenada, Mexico (CICESE). The course took place from February 3 to March 3, 2003, under the guidance of Professor Modesto Ortiz (Figure 1). The training course was based on the Tsunami Inundation Modeling for Exchange (TIME) programme of Tohoku University.

The training covered the use of TIME, and other specialized software, the acquisition of bathymetric and topographic data and selection and generation of grids at



Figure 1. During February, 2003, Professor Ortiz (left) assisted Mrs. Arreaga (right) in computing tsunami inundation maps for Ecuador using the TIME program.

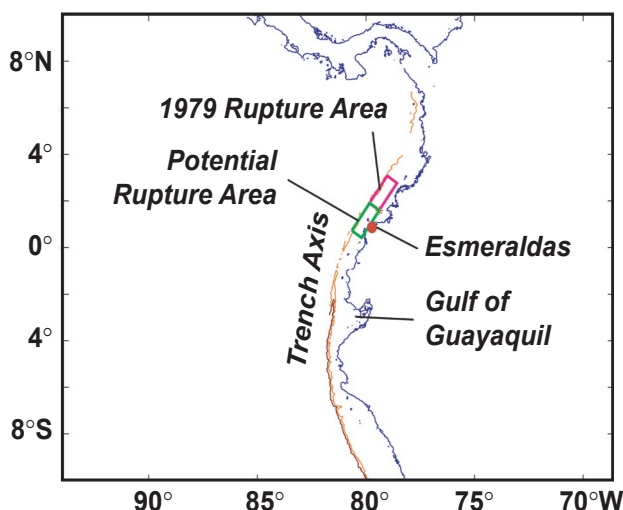


Figure 2. Potential tsunami hazard for the city of Esmeraldas resulting from a subduction-type earthquake similar in magnitude to the 12 December 1979 (Mw 8.0), Colombia earthquake that occurred just off the coast of Esmeraldas.

resolutions

suitable for running the modelling programme, the identification of possible tsunami source areas based on the historic record of regional tsunamigenic earthquakes, and the collection and digitization of actual tsunami event mareograms for validation with the theoretical tsunami modelling results. During her month-long stay, Arreaga computed inundation maps for two areas, Esmeraldas, and the Galapagos Islands.

For Esmeraldas, predicted tsunami inundation models were calculated and calibrated against the 12 December 1979 Colombia earthquake and tsunami (Figure 2). As expected, results of the simulated tsunamis showed the most destructive tsunamis to Esmeraldas to be those that are generated directly off the coast of Esmeraldas (Figure 3). Among the most vulnerable places in Esmeraldas are Las Palmas and Capitanía de Puerto; this is in spite of the protection offered by structures built up to protect the harbor. Both banks of the Esmeraldas River were also found to be highly vulnerable to tsunami flooding. As a final step, the

## CHILE NATIONAL TSUNAMI WARNING SYSTEM

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### Background

On May 21, 1960, at 06:01 local time, a strong earthquake occurred in the area of Concepción, Central Chile, causing serious damage to several cities in the region and a minor tsunami. At 09:00 local time, a small change at the Valparaíso tide gauge was detected. Several waves with amplitudes of 20-30 cm and periods of 20-25 minutes were recorded.

The Hydrographic Office (now the Hydrographic and Oceanographic Service of the Chilean Navy, SHOA), contacted the Honolulu Magnetic Observatory (now the Richard H. Hagemeyer Pacific Tsunami Warning Center, PTWC), reporting this unusual activity. PTWC had initiated a watch at 06:54 (Chilean local time) after recording the earthquake on their seismographs, but the watch was cancelled at 20:19 (Chilean time) after confirming that no big tsunami had been recorded at other tide stations along the Chilean coast from Valparaíso to the north. SHOA, however, maintained a permanent watch.

On the next day, May 22nd, at 15:10 (Chilean time), a second strong earthquake occurred, this time affecting several provinces in southern Chile between Concepción and Chiloé (37°S – 43°S). This earthquake, however, generated a big tsunami that produced extensive and severe damage along the coast. The first report of the tsunami indicated tsunami waves 3-4 meters in height, and several other confusing reports from other ports reported tsunami waves of 10 meters or more. At 16:30 (Chilean time), SHOA sent a cable to PTWC reporting on tsunami activity. The Valparaíso tide gauge began recording tsunami waves at 16:13 (Chilean time) with an initial rise of 74 cm in 16 minutes.

In Honolulu, the seismic alarms had started ringing at 15:38 (Chilean time), and a Tsunami Watch Bulletin was issued by the PTWC five minutes before the cable from SHOA arrived. Almost 9 hours later, at 00:47, May 23 (Chilean time), a tsunami warning was issued by PTWC. At 06:54 (Chilean time), the tsunami waves hit Hawaii causing serious damage and 61 deaths in Hilo. The tsunami also caused damage and killed people in other countries around the Pacific Rim.

As a result, the authorities in Chile realized the importance of having a system to handle the earthquake and tsunami wave information in a proper and timely manner when large earthquakes occur. A few years later, the importance was reinforced with the occurrence of the Alaska earthquake and tsunami on March 27, 1964, and on July 30th of that year, SHOA commenced operation of its own National Tsunami Warning System, and on January 11, 1966, SHOA was designated as the official Chile representative to the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU).

### Present Operations

Since then, significant improvements have been made to address tsunami risk in three general areas: (1) improvement in seismic and tide data acquisition, (2) heightened public awareness of the tsunami threat and (3) improvement in communications.

- 1.1. Seismic data acquisition: Approximately 60 seismic stations are run by different universities around the country. Most of them are linked via radio telemetry, the Internet, or modem to a central analysis office where earthquake location and magnitude can be retrieved. However, since this is a university system, it does not operate after



Figure 1. TREMORS station, Valparaíso, Chile.



## CHILE NATIONAL TSUNAMI WARNING SYSTEM, *continued*

working hours. Recognizing the need for a prompt and reliable source of seismic data, SHOA received funds in 1995 to install a TREMORS broad band station inland from Valparaíso (Figure 1), that would provide estimates of the epicenter and seismic moment in real time. Additionally, a computer continuously receives hypocentral information from earthquakes around the globe from different sources.

- 1.2. Tide data acquisition: The old mechanical and bubbler gauges, some of them operating since 1942, started being replaced in 1985 with satellite data collection platforms (DCP, Figure 2), with help from the U.S. National Weather Service, Pacific Region, and especially the support of the late NWS/PR Director Richard Hagemeyer. Data from these platforms are received in near-real time (delays up to a one-hour) at SHOA. A new project is under way to get sea level information from these DCP's in real time through the Navy's communications system. Presently, there are 18 satellite sea level stations operating along the Chilean coast. During 2003, a DART System buoy will be deployed off the northern coast of Chile in order to improve the early tsunami warning capability in both Chile and the Pacific (Figure 3).
- 2.1. Education efforts: Proper knowledge of the tsunami facts can save lives. After earthquakes occurring close to coastal cities, there may not be enough time to give residents an ample tsunami warning. By providing the public with good tsunami safety and preparedness information, the public will know what to do in order to be minimize losses due to a tsunami's impact. Since 1992, SHOA has been publishing educational textbooks on earthquakes and tsunamis with the support of the IOC. In addition, several tsunami pamphlets for the general public have been printed in Spanish, English, and French. Currently, Dr. Rodrigo Nunez serves as the Associate Director of ITIC, and SHOA maintains the ITIC Chile web site (<http://www.shoa.cl/oceano/itic/frontpage.html>).
- 2.2. Tsunami inundation maps: The project, *Processing Tsunami Inundation Maps for the Chilean Coast*, which follows techniques of the TIME Modeling Project, has been funded since 1996. Twenty six maps were published before 2003, and three more are slated for production in 2003. These maps are given to the local authorities to aid them in developing their own community tsunami response procedures.
- 3.1. Communications within the system: Improved communications with PTWC and the U.S. West Coast/Alaska Tsunami Warning Center have been implemented through the use of an e-mail address dedicated exclusively to receiving tsunami messages. Also, since 1999, regular tsunami test exercises are performed with the Peruvian Direccion de Hidrografia y Navegacion de la Marina de Guerra. To ensure greater redundancy, in 1998, Chile installed a terminal of the U.S. operated communications system *Emergency Managers Weather Information Network* (EMWIN), which provides various emergency management data, including tsunami watches and warnings from PTWC through the GOES satellite system.
- 3.2. Communications with the public: The National Emergency Office of the Ministry of Interior (ONEMI) is responsible for disseminating Tsunami Watches and Warnings to the general public and the media. SHOA and ONEMI are linked by VHF and HF radios, in addition to the common communication systems. ONEMI and SHOA also work on a 24 hours basis monitoring any and all emergencies occurring in the country through these radio links.



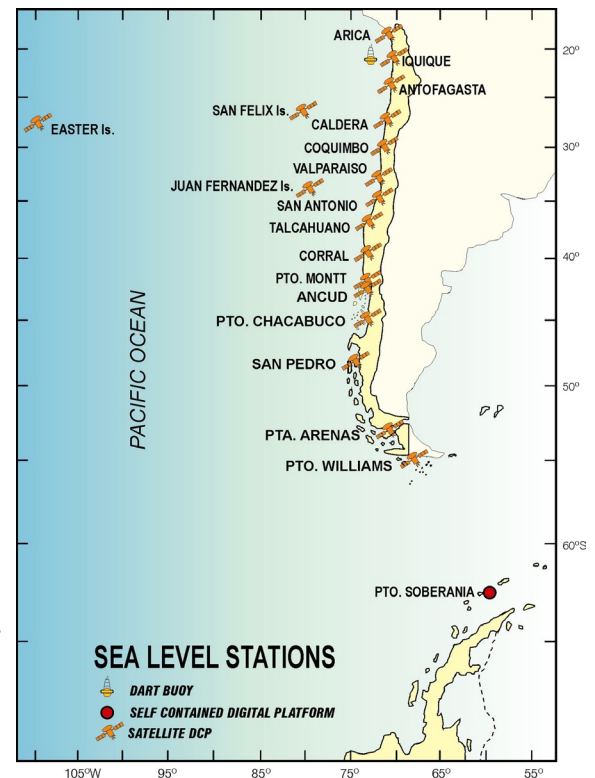
Figure 2. Chile sea level station on wharf showing Data Collection Platform (DCP) with pole-mounted GOES antennae and solar power panel.

## CHILE WARNING SYSTEM, *continued*

### Future Directions

Strong tsunamigenic earthquakes are known to recur along the Chilean subduction zone, and several source areas where tsunamis will most likely be generated have been identified by scientists. Because of this high tsunami hazard, SHOA is committed to focusing as much of its human and financial resources as needed to keep the Chile National Tsunami Warning System in operation and to continuously work to reduce its tsunami response and dissemination times.

Figure 3. Locations of sea level stations used by the Chile National Tsunami Warning System. All data are telemetered back to the operations center through the GOES satellite.



## THE TSUNAMI SOCIETY ISSUES POSITION PAPER ON MEGA-TSUNAMI HAZARD

*The Tsunami Society Media Committee*

*George Curtis, University of Hawai'i at Hilo (Chair); Dr. Tad Murty, Baird and Associates, Canada, Dr. Laura Kong, ITIC; Dr. George Pararas-Carayannis, Honolulu, HI; Dr. Charles L. Mader, U.S. Los Alamos National Laboratory*

In response to recent media reports erroneously suggesting that volcano flank collapses will generate catastrophic ocean-wide tsunamis, The Tsunami Society convened a committee of private, university, and government scientists to comment on misleading information that had been released to the public about this hazard. The following is summary:

Last year, the Discovery Channel replayed a program alleging potential destruction in the near future of Atlantic coastal areas by tsunami waves generated by volcanic collapse in the Canary Islands. Other reports have involved a smaller but similar catastrophe from Kilauea volcano on the island of Hawai'i. The occurrences have been labeled as "mega tsunamis." These reports, however, are unfounded and sensationalist. In particular, the following is a set of facts about the claims in these reports:

- While the active volcano of Cumbre Vieja on Las Palma is expected to erupt again, it will not send a large part of the island into the ocean, though small landslides may occur. The Discovery program does not bring out in the interviews that such volcanic collapses are extremely rare events, separated in geologic time by thousands or even millions of years.
- No such event - a mega tsunami - has occurred in either the Atlantic or Pacific oceans in recorded history.
- The colossal collapses of Krakatau or Santorin (the two most similar known happenings) generated catastrophic waves in the immediate area but hazardous waves did not propagate to distant shores. Carefully performed numerical and experimental model experiments on such events and of the postulated Las Palma event verify that the relatively short waves from these small, though intense, occurrences do not travel as do tsunami waves from a major earthquake.
- The U.S.G.S. Hawaiian Volcano Observatory, situated on Kilauea volcano, near the current eruption, states that there is no likelihood of that part of the island breaking off into the ocean.

The complete position paper and additional reading, can be viewed at <http://www.sthjourn.org/media.htm>.

## SUMMARY OF EARTHQUAKES IN THE PACIFIC Occurring February-March 2003

*With surface wave or moment magnitude ( $M_w$ ) greater than or equal to 6.5 and a depth no greater than 100 km, or an event for which a Tsunami Information Bulletin (TIB) or Regional Watch Warning (RWW) was issued. Epicenter and  $M_w$  from USGS National Earthquake Information Center (NEIC, G); preliminary  $M_s$  from PTWC (P) at time of action;  $M_w$  and depth from Harvard (H).*

| DATE     | LOCATION                      | TIME (UTC) | LAT      | LONG      | DEPTH (km) | $M_w$     | $M_s$ | PTWC ACTION | ACTION TIME (UTC) | Damaging Tsunami ? |
|----------|-------------------------------|------------|----------|-----------|------------|-----------|-------|-------------|-------------------|--------------------|
| Febr. 19 | Unimak Island Region          | 03:33      | 53.758 N | 164.612 W | 32         | 6.6 (G,H) | 6.5   | TIB         | 03:58             | NO                 |
| March 17 | Rat Islands, Aleutian Islands | 16:36      | 51.40 N  | 177.72 E  | 29         | 7.0 (G,H) | 6.9   | TIB         | 16:44             | NO                 |

### ITIC NEWS

*ITIC Associate Director Captain Rodrigo Nuñez (left) met with Dr. Fumihiko Imamura (right) from Tohoku University, during a visit to Servicio Hidrográfico y Oceanográfico de la Armada (SHOA) on November 14, 2002. Imamura was in Valparaíso, Chile with a group students from the Disaster Reduction and Human Renovation Institution (DRI) of Tohoku University, Sendai, Japan.*



### PTWC NEWS

#### Legaspi, Philippines Tide Station Repaired

The PTWC Legaspi, Philippines tide station was repaired and upgraded by PTWC Senior Electronics Technician Richard Nygard with assistance from University of Manila Philippines Institute of Volcanology (PHILVOLCS) technical staff, Eton Olavere and Mel Lasala, during a three and a half-day visit in March, 2003. The station, located in Albay Gulf in southeast Luzon Island, provides the earliest sea level readings from Philippine Trench earthquakes. During the visit, besides the general service maintenance to the system, the Data Collection Platform and cabling were replaced, new system programming installed, the pressure sensor cleaned and a second new pressure sensor added. JMA and PTWC were contacted during the visit to coordinate system communications and data quality. Many thanks to PHILVOLCS Director Dr. Raymundo Punongbayon, and Dr. Bart Bautista, who arranged for their staff to provide technical help and transportation to Legaspi to accomplish tsunami/tide system work.



*From left to right, Mel Lasala (PHILVOLCS), Rich Nygard (PTWC), and Eton Olavere (PHILVOLCS), in front of Legaspi tide station. The GOES satellite antennae and solar cell are mounted on a pole adjacent to the cement station house. The 2460-m high Mayon Volcano, an active stratovolcano that last erupted in July, 2001, looms in the background.*



## PTWC NEWS, *continued*

### Local Tsunami Warning Response Exercise Conducted in Hawai'i

*Brian Yanagi, Hawai'i State Civil Defense Tsunami Program Manager*

The first statewide urgent local tsunami warning response exercise in Hawai'i was successfully conducted on April 1, 2003, coincident with the monthly test of the State's siren warning system. PTWC duty personnel began the drill by reading an "Urgent Local Tsunami Warning" message on the Hawai'i Area Warning Announcement System (HAWAS) (Figure 1). A worst-case scenario was chosen in which a major Kona coast earthquake (western coast of the island Hawai'i) generated a destructive local tsunami that then swept through the island chain in about 45 minutes. The exercise served to test and validate the following:

1. Rapid communications procedures used to activate sirens and the Emergency Alert System;
2. Coastal inland and vertical building evacuation procedures;
3. Reviews of emergency response checklists and procedures;
4. Kickoff to Hawai'i April Tsunami Awareness Month.



*Figure 1. PTWC Geophysicist-in-Charge Dr. Chip McCreery initiates the Hawai'i Local Tsunami Warning Exercise by reading an "Urgent Local Tsunami Warning" message on HAWAS. This statewide telephone hotline provides voice communications to state and county emergency agencies. Local television and press media covered the tsunami exercise.*



*Figure 2. SCD Tsunami response team members monitor warning communications from PTWC during the exercise. From left, Plans and Operations Officer Alden Kang, Telecommunications Officer George Burnett, and Planner Eddie Chung-Hoon.*

Many participating agencies conducted "in house" and behind-the-scenes training and exercise sessions on April 1 (Figure 2). Normal public activities were not disrupted during the exercise. Participating agencies included PTWC, National Weather Service Honolulu Weather Forecast Office, International Tsunami Information Center, State Civil Defense (SCD), O'ahu Civil Defense Agency, Maui Civil Defense Agency, Kaua'i Civil Defense Agency, Hawai'i County Civil Defense Agency, County, State Warning Points, and the State and County Tsunami Science Advisors. Other agencies included the Department of Education, American Red Cross, Hawai'i Tourism Authority, Pacific Tsunami Museum and the Civil Air Patrol.

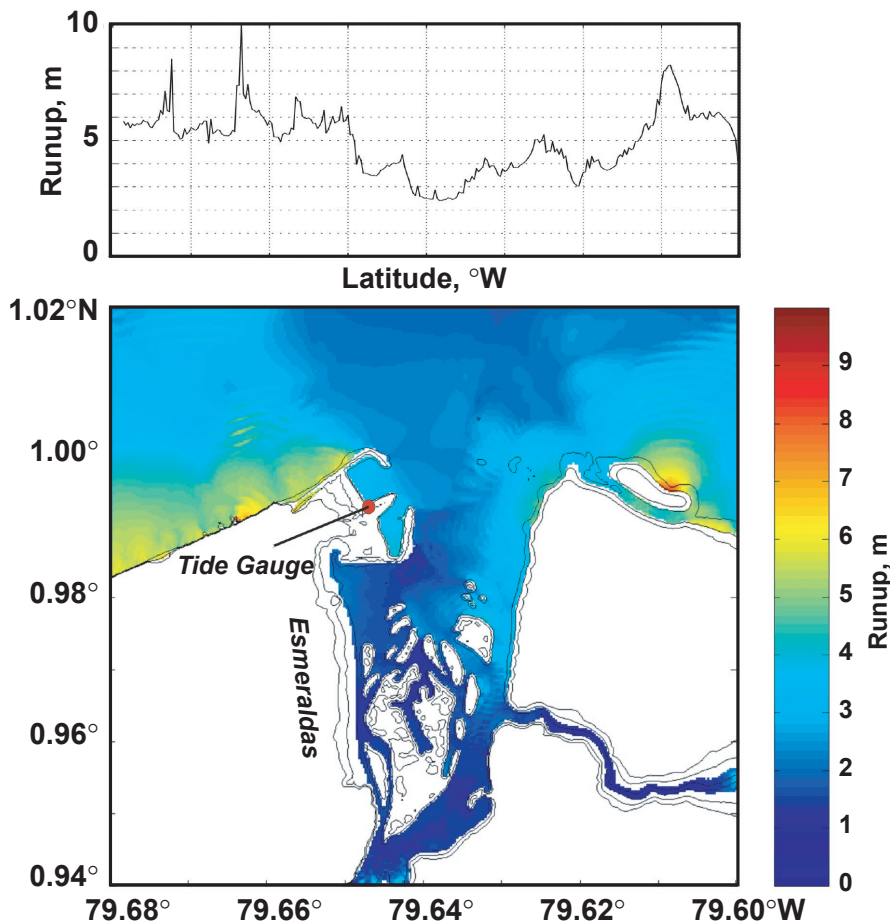
For the past two years, State Civil Defense has also exercised its internal procedures for the case of a distant tsunami warning resulting from a major earthquake and tsunami originating in the Aleutian Islands. For each exercise, PTWC prepares a scenario, timeline, and issues appropriate tsunami warning and sea-level observation messages. The SCD plans to initiate periodic future exercises and expand agency participation to sharpen its emergency planning and response skills, as agencies must remain vigilant to effectively respond to tsunamis, Hawai'i's #1 natural disaster killer.

## UPCOMING CONFERENCES

- April 30-May 4** (Wednesday-Sunday) **Seismological Society of America Annual Meeting**, San Juan, Puerto Rico. This meeting commemorates the 100th Anniversary of the University of Puerto Rico along with 100 years of seismic instrumentation in Puerto Rico. More can be learned about the conference by visiting the Web site: <http://civil.uprm.edu/ssa-2003/>. This year's meeting also includes a special technical session, **Seismological Tools for the Advancement of Tsunami Modeling and Warning**. The co-convenors of this session are Professor Aurelio Mercado (amercado@uprm.edu) and Dr. Eric Geist (egeist@usgs.gov). Registration is available online through April 23rd and can be accessed at [https://mail.seismosoc.org/ssa03\\_Reg/](https://mail.seismosoc.org/ssa03_Reg/). The venue for the meeting is the Caribe Hilton in Old San Juan (<http://www.caribehilton.com/>).
- May 5-7** (Monday-Wednesday), **Public Safety and Risk Management Conference**. Fiji. (Outrigger Reef). Sponsored by SOPAC (South Pacific Applied Geoscience Commission). The purpose of the conference is the promotion of disaster reduction policy/legislation development, research, training, scientific knowledge and technology transfer to reduce community vulnerability from natural-, environmental- technological- and human- induced disasters. For more information, visit: <http://www.sopac.org.fj/Secretariat/Programmes/CRI/Conference.html>, or contact Vive Vuruyak (vive@sopac.org) or Tel: 679 338 1377.
- June 29-July 2**, (Sunday-Wednesday), **PACON 2003**, Hotel Splendor Kaohsiung, Kaohsiung, Taiwan. Ocean Capital Year, The Sixth Regional Symposium of the Pacific Congress on Marine Science and Technology (PACON). PACON is an international, non-profit professional marine science and technology society dedicated to the sharing of scientific and technical information among those interested in the future of the world's oceans, with a Pacific focus. The technical sessions will revolve around 3 areas of concern: Ocean Science and Technology, Coastal Science and Technology, and Marine Resource Management & Development. Details are available at <http://www.hawaii.edu/pacon/>.
- July 9-10** (Wednesday-Thursday) **JSS7: Tsunamis: Their Science, Engineering and Hazard Mitigation**, IASPEI-led inter-association symposium at **IUGG 2003** (30 June-11 July) Sapporo, Japan. A meeting on the status of the Historical Tsunami Database (HTDB) will be held tentatively on either July 8 or 9, the exact date is still pending. A field trip to Okushiri Island will follow the symposium on July 11-13. Deadline for abstract submission was January 30, 2003. Lead convener for this symposium is Dr. Viacheslav (Slava) Gusiakov (gvk@OMZG.SSCC.RU) and co-conveners are Dr. Kenji Satake and Dr. Efim Pelinovsky. For more about IUGG 2003, visit: <http://www.jamstec.go.jp/jamstec-e/iugg/index.html>.
- August 26-29** (Tuesday-Friday) **International Seminar/Workshop on Tsunami, In Memoriam 120 Years of Krakatau Eruption--Tsunami and Lesson Learned from Large Tsunami**, Jakarta and Anyer. The Meteorological and Geophysical Agency (BMG) of Indonesia, along with the Indonesian Department of Marine Affairs and Fishery (DKP); are organizing the meeting in cooperation with ICG/ITSU, IUGG Tsunami Commission and several related institutions in Indonesia. A Krakatau complex tour is planned for August 29. Paper submission or registration can be made through Fauzi Rades, Coordinator of National Earthquake Center MGA (fauzi@bmg.go.id) or Gregar Prasetya, Marine and Fisheries Agency BRKP (gegar@lycos.com). For more information, visit: <http://www.bmg.go.id/krakatau/>.
- September 25-26** (Thursday-Friday) **Tsunamis in the South Pacific--Research towards Preparedness and Mitigation** Organized jointly by the IUGG Tsunami Commission (IUGG/TC) and the International Co-ordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU), in co-operation with the Institute of Geological & Nuclear Sciences and the National Institute of Water and Atmospheric Research (New Zealand), in Wellington, New Zealand in conjunction with ITSU-XIX. Convened by Viacheslav Gusiakov (gvk@omzg.sccc.ru), François Schindelé (schindel@ldg.bruyeres.cea.fr), Gaye Downes (tsunami\_conference\_nz2003@gns.cri.nz), and Roy Walters (r.walters@niwa.cri.nz).
- The objectives of the Wellington workshop are: (1) to review the situation with tsunami observations and preparedness in the South West and Central Pacific area, (2) to analyse the regional features of tsunami generation, propagation and impact from both local and remote sources, (3) to exchange national experiences on the development of mitigation measures, (4) to formulate recommendations on the actions required for tsunami disaster reduction. Deadline for Registration and Abstract submission is June 30, 2003. For more details visit: <http://ioc.unesco.org/itsu/calendar.php>.



## Tsunami Maps for Esmeraldas, Ecuador, *continued*



inundation results will be overlaid onto local Esmeraldas maps which show the locations of roads and structures and uses of land (vertical resolution 1 meter). This will make it possible to evaluate where and how safe evacuations can be made. The production of tsunami hazard maps will help to identify areas susceptible to tsunami flooding so that planners can keep people and critical facilities out of the area of flooding. At the same time, however, Arreaga recognizes that an effective tsunami mitigation programme must contain an educational component stressing tsunami awareness, as well as early regional tsunami warning systems to alert coastal residents that danger is imminent.

Figure 3. Top. Computed maximum tsunami run-up height along the Ecuadorian coastline, produced by the potential earthquake indicated in Figure 2. Bottom. Inundation map for Esmeraldas, showing maximum computed water level (color scale in meters) at every grid point in the numerical model. The city of Esmeraldas is located along the river, 3 to 10 meters above mean sea level. Contours of 0.5, and 10 meters above mean sea level are indicated on the map.

Located in Honolulu, the International Tsunami Information Center (ITIC) was established on November 12, 1965, by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). In 1968, the IOC formed the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU).

The present 25 Member States are: Australia, Canada, Chile, China, Colombia, the Cook Islands, Costa Rica, the Democratic People's Republic of Korea, Ecuador, Fiji, France, Guatemala, Indonesia, Japan, Mexico, New Zealand, Nicaragua, Peru, the Philippines, the Republic of Korea, Samoa, Singapore, Thailand, the Russian Federation, and the United States of America.

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