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TSUNAMI NEWSLETTER

International Tsunami Information Centre

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LONG–TIME IUGG–TSUNAMI COMMITTEE OFFICER PASSES AWAY

Professor Kinjiro Kajiura (78) passed away of lung cancer on June 23, 2004 in the Kanto-Chuo Kyosai Hospital, Setagaya-ku, Tokyo, near his home.

He is well known to the tsunami community for both his pivotal writings on tsunami and his involvement in the IUGG Tsunami Committee. He graduated from the Department of Geophysics, Faculty of Sciences, the University of Tokyo in 1948. In 1952, he was appointed as a research associate in the department from which he had graduated. For five years, starting in 1955, he was a research scientist in the Department of Oceanography and Meteorology of A & M College of Texas (now Texas A & M University), in the USA. In May 1958, he received the degree of Doctor of Philosophy by presenting the thesis, “Response of a boundless two-layer ocean to atmospheric disturbances”. After he returned to Japan, he was appointed Associate Professor of Earthquake Research Institute (ERI) of the University of Tokyo and was promoted to Professor in 1965. He was the Director of ERI from August of 1977 to July of 1979. He retired from ERI on March 31, 1986.

His achievements were remarkable in various aspects of physical oceanography, particularly the mechanical features of ocean waves, internal waves, and boundary layers. His studies of the generation and propagation of tsunamis are recognized as lasting contributions to tsunami research and are cited by many scientists around the world. In the field of tsunami, he applied Green functions to tsunami propagation problems, and discussed several theoretical aspects, such as the leading wave of tsunamis, and the directivity of radiation of tsunami waves from a source region. He also carried out field research, and published detailed reports on the 1964 Alaska, the 1968 Tokachi-Oki, and the 1983 Japan Sea tsunamis. He had held the post of Vice-Chairman of the Tsunami Committee of the IUGG since 1983.

We Japanese tsunami scientists call him “Tensai-Kajiura (Genius Kajiura)”, because his studies were difficult to understand and one would wonder why he had introduced particular ideas. But then, after carefully rereading his work, we eventually understood what he was saying and were impressed with his amazing acumen. Still now, we have many things we want to ask him directly. But now, Professor Kinjiro Kajiura has gone. We deeply hope for his happiness in the other world. He is survived by his wife, Mrs. Masako Kajiura.

(Based on a tribute posted by Dr. Yoshinobu Tsuji, Department of Disaster Mitigation Sciences, ERI, University of Tokyo, tsuji@eri.u-tokyo.ac.jp, to the Tsunami Bulletin Board on June 23, 2004. Photo courtesy of ERI, from a volume of Kajiura-san’s work published upon his retirement by the ERI, Department of Tsunami and Storm Surge, 1986.)

37th IOC EXECUTIVE COUNCIL SESSION, 23-29 JUNE 2004, PARIS, FRANCE: ICG/ITSU XIX SUMMARY REPORT

The summary report was presented by the Chairman of the International Co-ordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU), François Schindelé, who informed the Council on the intersessional activities of the ICG/ITSU. The long-established and successful IOC programme has continued to evolve in terms of the technology applied and of the geographical coverage.

During the intersessional period 2001–2003, at the international level, new procedures were implemented and revised criteria were adopted for issuing warnings, watches and cancellations. International tsunami signs and symbols were drafted, the *Tsunami Glossary* in French, English and Spanish was published, and high-quality bi-monthly newsletters were issued. The development of the ITIC and ITSU websites was completed and the ITSU Training Programme (ITP), continued, (formerly the Visiting Experts Programme). At the national level, activities continued to focus on the further strengthening of national tsunami warning and mitigation systems.

At ITSU-XIX in Wellington, New Zealand, Member States agreed to increase the duration of the ITSU Training Programme in Hawaii, add an ITP international component, consider expert missions to Member States, decrease the frequency of the *Tsunami Newsletter*, complete the submission of ITSU signs to the ISO, restructure the IOC/ITSU and ITIC websites, and make modifications to the *ITSU Master Plan* conclusions.

The ICG/ITSU adopted its work plan for 2004–2005, which will focus on the support of the International Tsunami Information Centre (ITIC), the Global Tsunami Data Base (GTDB) and the new Integrated Tsunami Data Base (ITDB), the Tsunami Information Kit, the newly established Working Groups on a Comprehensive Tsunami Hazard Reduction Programme (TROIKA), on the Central American Pacific Coast Tsunami Warning System (CAPC-TWS), and on the Tsunami Warning System in the Southwest Pacific and Indian Ocean (SWP-TWS). The evaluation of the Tsunami Programme, requested by the Assembly at its 21st Session, will be carried out by a small group of experts nominated by Member States, and will complete its draft evaluation in time for consideration by the Assembly at its 23rd Session (June 2005) and in final form for the XXth Session of ICG/ITSU. ITSU-XX and a related workshop will be hosted by Chile in October 2005. The ICG/ITSU will also initiate and strengthen co-operation with JCOMM, the Circum-Pacific Council, GLOSS, ISDR, and CEPREDENAC.

The Chairman presented the ITSU Tsunami Hazard Reduction Strategy, formerly called TROIKA, which is based upon three elements: assessment, mitigation and warning guidance. The consideration of all elements by all involved stakeholders ensures the development and implementation of a meaningful hazard mitigation programme aimed at empowering local communities.

The Chairman again stressed the insufficiency of resources allocated for ITSU in terms of staff and budget, which thereby jeopardizes the Tsunami Warning System's efficiency and effectiveness. He urged Member States to consider this issue when allocating resources.

Council delegates made numerous announcements to the Council. The delegate of Japan informed the Executive Council of the sad passing away on 24 June 2004 of Professor K. Kajiura who, since 1983, had held the post of Vice-Chairman of the Tsunami Committee of the International Union of Geodesy and Geophysics (IUGG). Prof. Kajiura had a long and distinguished career in physical oceanography. (*See p. 1*).

In other matters, the Philippines, the Russian Federation and Japan informed the Executive Council of the establishment or renewal of their national tsunami warning systems in the western Pacific, thereby demonstrating their countries' continued strong commitment to tsunami warning and mitigation. Japan further informed the Executive Council of the development of the Northwest Pacific Tsunami Information Centre in 2004.

Strong support of the ITSU Programme was expressed by the Representative of the International Ocean Institute (IOI), who co-sponsored by the 2002 tsunami workshop in Kamchatka along with ITSU; he expressed his organization's interest in continued collaboration, with special attention to risk assessment, awareness and social issues. Strong support was also expressed by the representative of the International Hydrographic Organization (IHO), who noted that the improvement of ocean bathymetry and especially coastal bathymetry data sets will be of great relevance to the ITSU programme for improving tsunami modelling impacts of coastal communities. The IHO Representative called for closer collaboration between his organization and IOC's ITSU programme in this regard.

After hearing the ITSU report and discussions, the Executive Council instructed the ICG/ITSU to identify specific bathymetric needs and priorities that could improve the tsunami programme, and to make this

IOC-EC, *continued*

information available to IHO for consideration by the appropriate IHO regional hydrographic commissions. The Executive Council called for close collaboration between ITSU, GLOSS and JCOMM, for example, and invited the Chairpersons of relevant IOC and other programmes to attend ITSU Sessions and identify joint activities that will further the aims of ITSU.

Finally, the Executive Council expressed its strong appreciation of and support for the ITSU programme, as one of the IOC programme that specifically protects human life and property, thus having substantial societal importance and therefore direct relevance to GEO. The Council noted with appreciation the establishment of working groups on a Central America Pacific Coast Tsunami Warning System and on a Tsunami Warning System in the South-west Pacific and Indian Ocean, and encouraged Member States bordering other ocean basins to consider similar initiatives. The Executive Council adopted Resolution EC-XXXVII.4.

IOC Executive Council Resolution EC-XXXVII.4

THE INTERNATIONAL CO-ORDINATION GROUP FOR THE TSUNAMI WARNING SYSTEM IN THE PACIFIC

The Executive Council,

Recalling that the IOC Tsunami Programme is a high priority programme of the Commission,

Appreciating:

(i) the support of Chile, France, New Zealand, Republic of Korea and USA to the ITIC Tsunami Programme in 2002–2003 through Trust Fund and in-kind contributions,

(ii) the support of the USA in hosting and co-funding the operation of the International Tsunami Information Centre (ITIC) in Hawaii, and of Chile for providing support to the ITIC Associate Director,

(iii) the establishment of the North Western Pacific Tsunami Information Centre by Japan in 2004,

Considering the Summary Report, Resolution and Recommendations of the 19th Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific (ITSU-XIX), held in Wellington, New Zealand, from 29 September to 2 October 2003, and the progress achieved by the ICG in the implementation of the ITSU Programme at the national and international levels,

Welcoming the studies in support of the development of sub-regional tsunami warning systems for the Central American Pacific Coast and for the Southwest Pacific and Indian Ocean, and the possible development of a comprehensive tsunami hazard-reduction programme,

Endorses the Summary Report and Resolution and **adopts** the Recommendations of ITSU-XIX;

Strongly encourages Member States to contribute actively to the further development and maintenance of the Tsunami Programme, either through financial contributions to the IOC Trust Fund, staff support or in-kind contributions;

Instructs the IOC Executive Secretary to take action to strengthen the IOC Secretariat support for the ITSU Programme.

Financial implications: US$ 82,500 from Regular Programme Budget (2004–2005)
- US$58,500 from ITSU
- US$24,000 from Regions

US$ 59,000 from extra-budgetary resources to be identified (2004–2005)

Total amount: US$141,500

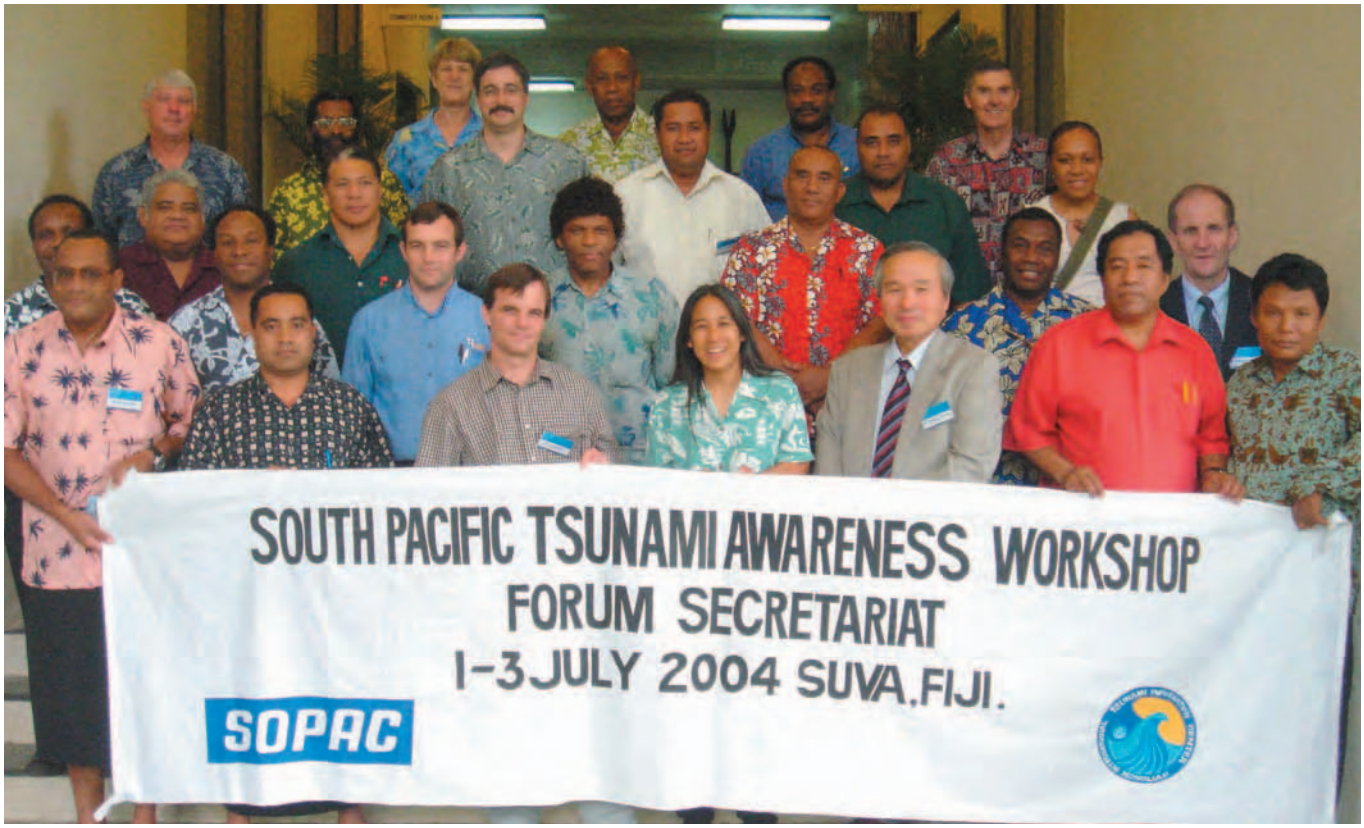
DEVELOPING PACIFIC ISLANDS REGIONAL STRATEGIES TO REDUCE TSUNAMI RISKS: South Pacific Tsunami Awareness Workshop, July 1-3, 2004, Suva, Fiji Islands

Laura Kong, Director, International Tsunami Information Centre, laura.kong@noaa.gov, and Atu Kaloumaira, South Pacific Applied Geoscience Commission Community Risk Programme (SOPAC CRP), atu@sopac.org, Co-convenors, South Pacific Tsunami Awareness Workshop.

The UNESCO/Intergovernmental Oceanographic Commission and its International Tsunami Information Centre and the South Pacific Applied Geoscience Commission Community Risk Programme co-convened the South Pacific Tsunami Awareness Workshop (SPTAW), July 1-3, 2004 at the Forum Secretariat in Suva, Fiji Islands. Funding was provided by SOPAC, UNESCO/IOC-ICG/ITSU, and the RANET Project (NOAA/NWS International Activities).

The SPTAW brought together National Disaster Managers and Technical Experts from agencies responsible for earthquake and tsunami monitoring and emergency response from American Samoa, Cook Islands, Fiji Islands, Papua New Guinea, Samoa, Solomon Islands, Tonga, and Vanuatu. The first two days were used to conduct the ITP-International training programme in tsunami risk reduction. Resource speakers included experts from the ITIC (Dr. Laura Kong), PTWC (Dr. Stuart Weinstein), Japan (Dr. Masahiro Yamamoto, Japan Meteorological Agency), Russia (Global Tsunami Database Project, Dr. Slava Gusiakov), USA (Washington State Emergency Management, George Crawford), New Zealand (IGNS, Gaye Downes), Australia (Geoscience Australia, Dr. Phil Cummins, Emergency Management Australia. Matthew Smith), Indonesia (Meteorological and Geophysical Agency, Dr. Masturyono), and the Pacific Disaster Center (PDC, Stan Goosby). Topics included warning guidance, hazard and risk assessment, and education, preparedness and land-use mitigation. On the third day, regional and national mitigation priorities and short- and long-term mitigation activities were identified through facilitated group discussions.

The workshop stressed the importance of involving all stakeholders from very beginning so that the mitigation products and tsunami services that are developed fit the user and customer's needs. This is



SPTAW participants on Day 3, from left to right: Row 1: Lasarusa Vuetibau (Fiji), Rennie Vaimo'unga (Tonga), Phil Cummins (Australia), Laura Kong (ITIC), Masahiro Yamamoto (Japan), Mulipola Ausetalia Titimaea (Samoa), Masturyono (Indonesia). Row 2: Wilfred Lus (Papua New Guinea), Chalapan Kaluwin (South Pacific Sea Level and Climate Monitoring Project, SPSLCMNetwork), Matthew Smith (Australia), Stanley Goosby (PDC), Toafa Vaiagae (Am. Samoa), Charley Douglas (Vanuatu), Slava Gusiakov (Russia). Row 3: Akapo Akapo (Am. Samoa), Maliu Takai (Tonga), Stuart Weinstein (PTWC), Malaefatu Leavasa (Samoa), Loti Yates (Solomon Islands), Kata Duaibe (SOPAC). Row 4: George Crawford (USA), Atu Kaloumaira (SOPAC), Gaye Downes (New Zealand),Asaeli Malewa (Fiji), Lawrence Anton (Papua New Guinea), Alan Mearnes (SOPAC).

SPTAW, *continued*

often a very difficult task to coordinate, and a slow process at first because everyone must first attain a baseline amount of knowledge. SPTAW's aim was to provide a comprehensive, but concise overview of all aspects of tsunami mitigation.

To facilitate a better assessment on the level of awareness and understanding of the tsunami hazard, a user Questionnaire was distributed prior to the workshop. Country responses identified as foremost of the many issues at stake, the inadequacies of their national response systems, communication systems and education and awareness programmes to the tsunami hazard. Presently, the Pacific Tsunami Warning Center provides international tsunami warnings to the Pacific for large earthquakes greater than magnitude 7.5 and tsunami information bulletins for earthquakes greater than magnitude 6.5, but is not able to monitor the regional seismicity occurring at lower magnitudes. Historical tsunami data for the region indicate that destructive tsunamis have been generated by smaller earthquakes measuring as low as magnitude M5.8 (1930, Bismarck Sea, 10 fatalities). The events in Pentecost Island (1999 – 10 deaths) and Aitape (1998 – 2200+ deaths) are sharp reminders of the tragic and destructive effects of local tsunamis. Countries currently receive international tsunami warnings but do not have the emergency response capacity and communications infrastructure to adequately warn their coastal communities making them extremely vulnerable. Furthermore, it was noted that in general the island countries have very little understanding of regional and local tsunamis, and hence none of the countries felt that they were well prepared.

Each country made presentations on their tsunami hazards and mitigation programme. Shown is Lasarusa Vuetibau of Fiji.

During this first consultation, disaster managers and technical experts discussed regional strategies and action plans to address the disparity across the region, and made recommendations on Objectives, Outcomes, and Activities in the themes of Tsunami Hazard and Risk Identification, and Preparedness for Effective Response. A number of critical activities and processes for facilitating their implementation were identified. In all, SOPAC was asked to play a major coordinating role for the region. Two key priorities were the establishment of a *Tsunami Working Group* and the conduct of a feasibility study for *Regional Tsunami Warning Services.* Improvement of the regional tsunami event database was also identified as a key to better understanding the tsunami hazard. The SPTAW's Strategic Recommendations are printed at the end of this article.

South Pacific country representatives were provided with a comprehensive introduction tsunamis and the mitigation of the tsunami hazard. Top: From left to right, Cummins (Australia), Smith (Australia), Lus and Anton (Papua New Guinea), Vuetibau (Fiji), Masturyono (Indonesia), Vaimo'unga (Tonga). Bottom: From left to right, Vaimo'unga and Takai (Tonga), Job Esau (Vanuatu), Bobby Kelly (Solomon Islands), Titimaea, Leavasa, Filomena Nelson (partially hidden) (Samoa), and Yamamoto (Japan).

SPTAW, *continued*

ITIC and SOPAC will continue to work collaboratively on tsunami mitigation activities leading to the next SOPAC National Disaster Managers meeting hosted by Papua New Guinea in June, 2005. Goals include regionalized tsunami awareness materials and guidance, national response plans, and the feasibility study for regional tsunami warning services. To gain greater support and bring the recommendations forward to the SOPAC General Council for action, the SOPAC CRP and ITIC will make SPTAW presentations and convene a tsunami working group at the SOPAC STAR (Science, Technology and Resources Network) meeting September 17-24, 2004, in Fiji. Additionally, Australia and the South Pacific Sea Level Network have collaborated to put together a proposal for a pilot tsunami warning service. Consultation at STAR is an important step towards identifying the operational requirements for a Regional Tsunami Warning Service, and moreover, to align the tsunami mitigation programmes with the regional strategy and framework on disaster reduction that SOPAC is developing for presentation to the 2nd World Conference on Disaster Reduction in Kobe, Japan, in January 2005.

PTWC Geophysicist Dr. Stuart Weinstein discusses the transmission of international tsunami warnings to Samoa with ITSU National Contact Titimaea.

After the meeting, ITIC Director Dr. Laura Kong and GTDB Project Leader Dr. Slava Gusiakov met with SOPAC CRP Manager Alan Mearns to discuss strategies for incorporating the SPTAW recommendations in the 2005 CRP activities. They also met with Lasarusa Vitibeau, Senior Seismologist with the Fiji Mineral Resources Department to discuss assistance in the printing of awareness materials, the acquisition of local data and updating of the Fiji portion of the GTDB, and the earthquake seismicity, seismic crustal structure, and complex tectonics of the Fiji region. The ITIC also produced a short awareness video using existing photographs and a movie clip filmed on location describing the local term for tsunami (loka); the digital video clip was made as a demonstration to show that a modern digital camera and inexpensive software can be used to quickly create awareness announcements and/or to document oral histories of tsunami events.

USA Emergency Manager George Crawford briefed attendees on the U.S. National Tsunami Hazard Mitigation Program, and stressed the importance of a community-based approach as the way to best achieve rapid buy-in for new programs and policies.

Topics highlighted by the resource speakers included the following:

- ITSU Tsunami Hazard Reduction Strategy, as developed by the ICG/ITSU TROIKA Working Group. The comprehensive global strategy involving assessment, mitigation and warning guidance activities was also presented at the IOC Executive Council in June 2004.
- The value of the GTDB for the documenting and illustrating a locale's tsunami hazard. Dr. Gusiakov also demonstrated the newly-available ITDB application, which includes a travel time calculator and display module. The PC software is freely available, and can be obtained by contacting Dr. Gusiakov (gvk@sscc.ru) or the ITIC (itic.tsunami@noaa.gov). He also asked participants to work with him to improve the quality of the database by adding locally-derived information (the current database is compiled only from internationally-available sources, which may not have the most accurate information).
- Operational Tsunami Warning Systems, data and message communication infrastructures, and the roles, responsibilities, and needs of the stakeholders who receive the tsunami warnings, including non-governmental organizations and other social science perspectives. Information on new siren/voice alert system technology (All-Hazards Alert Broadcasting, AHAB) currently being installed by U.S.A. coastal communities generated great interest, with technical and cost information already requested by Fiji, Am. Samoa, Puerto Rico, Tonga, and Guam. Further inquiries can be made to George Crawford (g.crawford@emd.wa.gov), or ITIC.
- Numerical modeling concepts, assumptions, and data requirements related to the construction of inundation and evacuation maps, and the idea of a web-based scenario database of numerical models available for shared cooperative use and further detailed modeling for planning and local forecasting. The NOAA/Pacific Marine

SPTAW, *continued*

THEME 1. TSUNAMI HAZARD AND RISK IDENTIFICATION		
Objective	**Expected Outcomes**	**Activities to achieve objective**
1. To establish a regional Tsunami Warning System (TWS) in order to provide early warning for regional earthquakes under PTWC magnitude threshold Basic components of the TWS:· • Data observation network (seismic and water level stations to monitor seismicity and sea levels)· • Data transmission and receiving systems for TWS evaluation, and data sharing amongst nations· • Data processing system at center for acquiring, archiving, and tsunamigenic evaluation (operating 24h/7d)· • Dissemination of warnings	**Expected within 2 yrs**: Technical proposal for the creation of a Southwest and Central Pacific TWS. Coordinated by the TWG-SP **> 2 yrs:** Establishment of a Regional TWS capable of responding to Pacific needsAll South Pacific countries become members of ICG/ITSU Clearinghouse for distribution of information/data	**< 2 yrs:** Conduct Feasibility Study with existing observational data and communication infrastructures **> 2 yrs:** SP countries establish networks and infrastructure for early warning system in the region SOPAC with support of ITIC to liase with countries in encouraging ICG/ITSU membership. PDC in coordination with SOPAC and ITIC to establish clearinghouse for distribution of information/data
2: To identify areas at risk and to develop hazard mitigation plan for each of these areas.	**Expected within 2 yrs**: Historical earthquake and tsunami database for region based on international guidelines that would support early warning and tsunami risk management (Member countries of WG, GTDB Project, NZ, Australia, ITIC, PDC) **> 2 yrs** Production of maps/inventories on vulnerable sites/areas of the region National/Regional Reports on Tsunami risk assessment and management for the region.Incorporate Tsunami Risk Assessment to National Disaster Mgmt Plans (Member govts with international support)	**< 2 yrs** SP countries with support of SOPAC and GTDB Project, ITIC and PDC to collect data on historical seismicity, tsunami, and volcanic events. economics, population, critical infrastructure and lifelines, and other environmental hazards **> 2 yrs** SP countries with support of SOPAC to assess potential tsunami impact and undertake modeling for at-risk areas

THEME 2. PREPAREDNESS FOR EFFECTVE RESPONSE		
Objective	**Expected Outcomes**	**Activities to achieve objective**
1. Develop framework for effective response system for preparedness and emergency response to tsunamis	1.1 Guidelines available for developing plans	1.1.1 Conduct user questionnaire surveys 1.1.2 Develop guidelines for developing plans
	1.2 A timely response to tsunamis	1.2.1 Develop national tsunami response plans
	1.3 Tsunami-ready community	1.3.1 Develop partnership for acquiring educational material 1.3.2 Development of education programme and target key stakeholders (e.g. community, politicians, first responders). 1.3.3 Incorporation of training in formal and informal education 1.3.4 Develop national education strategy (tsunami)
2. Develop regional and national capacity (technical and management)	2.1 Provision of accurate and timely information	2.1.1 Raise tsunami awareness at national and community levels 2.1.2 Conduct table top exercises 2.1.3 Conduct an assessment on current capability of communication network 2.1.4 Communication / Media 2.1.5 Networking with national and regional partnership

SPTAW, *continued*

Environmental Laboratory is working with the Institute of Geological and Nuclear Science to implement a community model pilot between the USA and New Zealand. Further inquiries can be made to Vasily Titov (Vasily.Titov@noaa.gov), or Gaye Downes (G.Downes@gns.cri.nz).

Additional information on the SPTAW, including the Workshop Summary Report, Strategic Recommendations, Participant List, and photographs can be found on the ITSU (www.ioc.unesco.org/itsu) and SOPAC (www.sopac.org) web sites.

On Day 3, participants broke into two groups (Technical Hazard and Risk Assessment, and Preparedness and Response) to discuss the priorities and identify mitigation activities. Shown is the technical group.

ITSU XIX INTERSESSIONAL WORKING GROUP ON THE SOUTHWEST PACIFIC AND INDIAN OCEAN TSUNAMI WARNING SYSTEM (SWPIO TWS)

The 2nd meeting of the SWPIO TWS Working Group was convened on July 3, 2004, in Suva, Fiji, to discuss the outcomes of the SPTAW meeting, and the progress on actions since ITSU-XIX in Wellington, New Zealand. The meeting was attended by Dr. Phil Cummins, Australia, Gaye Downes, New Zealand, Dr. Slava Gusiakov, Russia, Dr. Laura Kong, ITIC, Dr. Masturyono, Indonesia, Lasarusa Vuetibau, Fiji, Dr. Stuart Weinstein, PTWC, Dr. Masahiro Yamamoto, Japan. During this period, the National Delegate from Indonesia was changed from Ibnu Purwana to Dr. Masturyono. Dr. Masturyono heads the Geophysical Instrumentation and Calibration Division of the Indonesia Meteorological and Geophysical Agency.

The following Terms of Reference were discussed and actions reported on:

1. Based on SPTAW discussions and interest from for regional tsunami warning services, it was agreed that the SWPIO TWS should be split into two separate Working Groups, one to focus on the Indian Ocean and related seas between Indonesia, Papua New Guinea, and Australia (SWPIO TWS) and the second on the South Pacific Ocean encompassing from Indonesia and Papua New Guinea to the Cook Islands in the east and New Zealand and Australia northward to the equator (South Pacific TWS). The SP TWS WG would be proposed for formation at ITSU XX in October, 2005. During the current intersessional period, however, the existing working group would continue to work together as a proponent for both regional TWS efforts.
2. SWPIO TWS Terms of Reference for the collection and assessment of capacities, requirements and interest in tsunami warning services were met by the activities of the SPTAW. Users Questionnaire asking for information on existing tsunami warning instrumentation, communications, and emergency responses, and tsunami awareness and other mitigation efforts distributed prior to meeting, and participants gave oral presentations on their activities and/or hazards.
3. Japan reported that the Japan Meteorological Agency (JMA, masahiro.yamamoto-a@met.kishou.go.jp) has obtained funding to begin to implement its North and West Pacific Regional Tsunami Warning System in 2005. The area of service has been proposed to include the Pacific Ocean coasts of the Philippines and extending southward to Indonesia and Papua New Guinea. A planning technical meeting with PTWC and ITIC will take place in October 2004, and an official kick-off ceremony and technical meeting is planned for March 2005. JMA will work with PTWC to establish clear protocols for the issuance of regional warnings that are coordinated with the international or Pacific-wide warnings that PTWC issues.
4. During the SPTAW, Dr. Cummins (Phil.Cummins@ga.gov.au) made a proposal on the conduct of a feasibility study to document the existing data and communication networks and determine the requirements for the establishment of a regional tsunami warning system for the Southwest Pacific. The proposal generated much interest with the SPTAW recommending the formation of a South Pacific Working Group and endorsing a proposal to investigate the feasibility for tsunami warning services. The SPTAW Strategic Recommendations are being presented at the SOPAC STAR meeting, where a STAR Working Group will be co-convened by Dr. Laura Kong and Atu Kaloumaira to receive further input and formulate Recommendations that will be put forth by the STAR Chair to the SOPAC General Council for acceptance. Once accepted, they can then become officially part of the SOPAC Work Programme and receive funding if a high priority.

PACIFIC TSUNAMI WARNING CENTER: SEA LEVEL DATA FOR MEASURING PACIFIC-RIM-GENERATED TSUNAMIS

Charles S. McCreery, Geophysicist-in-Charge, Richard H. Hagemeyer Pacific Tsunami Warning Center, Ewa Beach, HI USA, Charles.Mccreery@noaa.gov

This is the second in a series of articles describing the current state of operations of the Richard H. Hagemeyer Pacific Tsunami Warning Center (PTWC). The first dealt with seismic data and analysis capabilities for Pacific Rim earthquakes, and the following deals with sea level data used for detecting and evaluating tsunami waves from such events.

Initially, the tsunami warnings of PTWC and of the West Coast/Alaska Tsunami Warning Center (WC/ATWC) are based only on seismic parameters. Earthquakes that occur very near or under the sea, that are not too deep inside the earth, and that are of a sufficient magnitude have the potential to generate a tsunami. However, it is necessary to wait until a potential tsunami reaches the nearest sea level gauge to confirm or deny its existence and begin to evaluate its character. Since the 1980's, the Centers have received coastal sea level data via satellite from stations around the Pacific for this purpose (*Fig. 1*). These gauges currently number about a hundred and are operated by PTWC, WC/ATWC, and various other organizations of the U.S., Japan, Russia, Chile, France, and Australia often for a variety of purposes other than just tsunami detection and evaluation. Most transmit their data via satellite back to the warning centers on an hourly schedule with sample rates that range from one sample every two minutes to one sample every six minutes. Gauges of the U.S. National Ocean Service also have an internal as well as a dial-in tsunami trigger to initiate more frequent transmissions at a one-minute sample rate should a tsunami be passing the gauge.

While these coastal data are more accurate and reliable than the telex messages PTWC used to receive during an event from trained observers around the Pacific, they have significant shortcomings when being applied to the problem of tsunami forecasting. They are typically located in the shallow protected water of harbors and bays to provide easy access for installation and maintenance, to provide security, and to ensure relatively benign ocean conditions for instrument longevity. But in these environments, tsunami waves coming in from the deep ocean are highly modified in non-linear ways as they shoal and interact with the coast, severely limiting the predictive usefulness of the signals. Their character, including their amplitude, period, and duration are more often a result of the local bathymetry than they are a measure of the deep ocean tsunami waves. In addition, since such gauges must be fixed to land (e.g., a pier), vast portions of the northern and eastern Pacific are not instrumented because there are no islands on which to site a gauge. Tsunamis from some of the most dangerous tsunamigenic zones stretching from northern Japan to Kamchatka to the Aleutian Islands

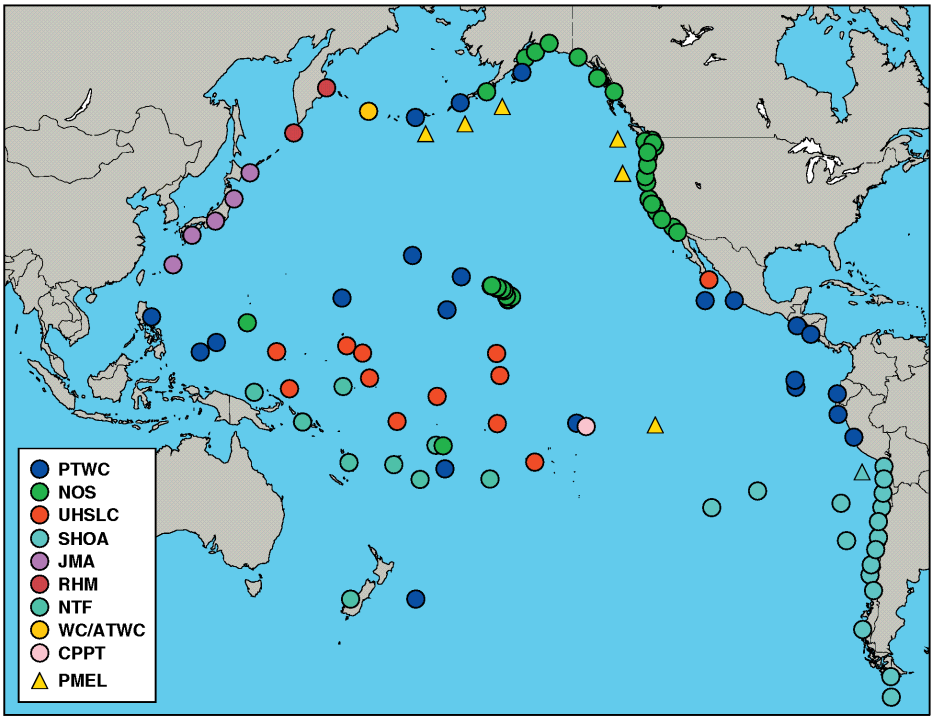


Figure 1. Sea level gauges used by PTWC to detect and evaluate tsunami waves propagating across the Pacific Basin. The circles are coastal gauges are operated by a variety of U.S. and international agencies including PTWC, WC/ATWC, the U.S. National Ocean Service (NOS), the University of Hawaii Sea Level Center (UHSLC), the Servicio Hidrográfico y Oceanográphico de la Armada de Chile (SHOA), the Japan Meteorological Agency (JMA), the Russian Federal Service for Hydrometeorology and Environment Monitoring (RHM), Australia's National Tidal Facility (NTF), and the Centre Polynesien de Prevention des Tsunamis (CPPT). The triangles are deep-ocean DART tsunameters developed by the Pacific Marine Environmental Laboratory (PMEL). Some locations have gauges operated by more than one organization although only one color is shown. For example WC/ATWC operates several co-located gauges in Alaska and the Aleutians although only one is indicated. Six DARTs (yellow) are operated by the U.S. National Data Buoy Center and one DART (light blue) by SHOA.

PTWC CAPABILITIES, *continued*

as well as along the Pacific coast of South America must travel for many hours before they reach the nearest strategically located coastal gauge seaward of the source.

To address both of these shortcomings, NOAA's Pacific Marine Environmental Laboratory developed a gauge for measuring tsunamis in the deep ocean and sending their data back to the warning centers in near real time. These DART (Deep-ocean Assessment and Reporting of Tsunamis) tsunameters (*Bernard et al., 2001 and Gonzalez et al. in press*) accurately measure the tsunami by the pressure it exerts on the deep ocean floor as it passes (*Fig. 2*). In contrast to wind-generated waves, tsunami waves have wavelengths much greater than the depth of the ocean. Consequently, as they pass in the deep ocean they can be viewed locally as a slow rising and falling of the entire sea level rather than just a ruffling of the ocean's surface. On the ocean floor this creates a corresponding slow increase and decrease in pressure due to the increase and decrease in the weight of the overlying water. The DART tsunameter measures this pressure signal with an accuracy better than 100 Pa, the equivalent of one centimeter of sea level change. Since a destructive tsunami may measure only a few centimeters in the deep ocean, this kind of accuracy is required. The recorded signals are sent from the bottom pressure recorder to a nearby ocean-surface buoy using an acoustic modem. From the buoy, the data are sent via a satellite link back to the warning centers. To help conserve battery power satellite transmissions occur only once an hour with only one sample every 15 minutes during benign periods. The data from these transmissions show the regular rise and fall of the tides and indicate the instrument is working properly. However, when a tsunami passes, an onboard algorithm detects the anomaly and initiates transmissions every few minutes with data sampled at a much higher rate to accurately record the higher frequency tsunami waveforms. The DART tsunameters have also been triggered by seismic signals from large nearby events. These signals can be distinguished from the tsunami by their earlier arrival time and much higher frequency content. A prototype gauge is now being tested that will allow the Centers to trigger the more frequent and higher data rate transmissions directly, rather than depending upon the onboard algorithm.

Since the DART tsunameters are sited in deep water, they can accurately record the character of tsunami waves as they propagate unaltered in the deep open ocean. In addition, they can and have been sited strategically, directly between tsunamigenic zones and populated coastlines. At the time of this writing seven DART gauges have been deployed for warning operations (*Fig. 1*), with at least four more planned

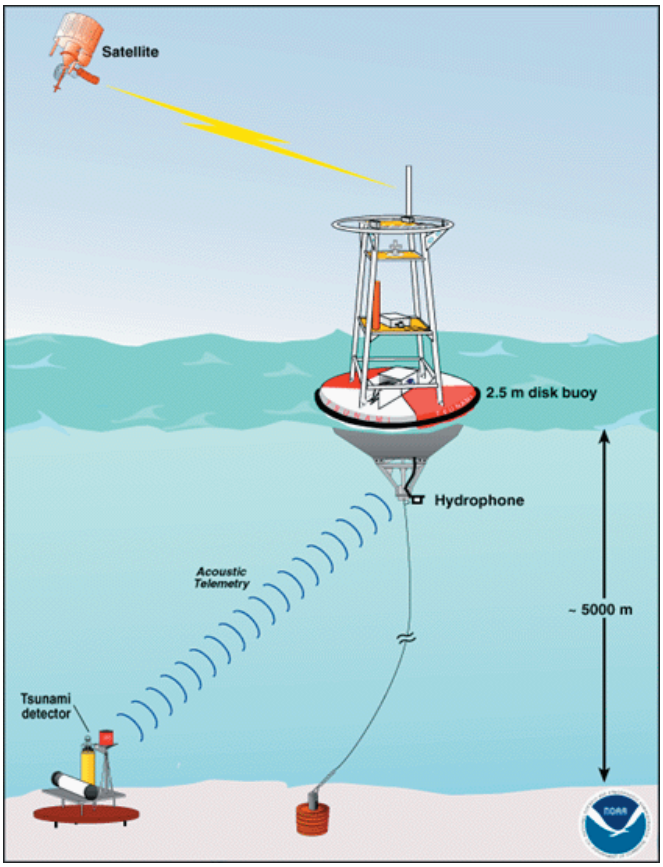


Figure 2. DART tsunameters are now used in a few strategic locations in the deep ocean to measure tsunami waves unaltered by shoaling and reflections at a coast. The tsunameters sense the pressure induced on the ocean bottom by passing tsunami waves, transmit these data by acoustic modem to an ocean-surface buoy moored nearby, and from the buoy the data are sent via satellite to the warning centers.

for deployment in the next three years. Three are off the Alaska Peninsula and Aleutian Islands and in a position to provide timely measurements of tsunami waves propagating towards Hawaii and the U.S. West Coast from tsunami sources in that region. Two more are off the coast of Washington and Oregon. They will provide timely measurements of tsunamis generated along the Cascadia subduction zone and also measure tsunami waves propagating towards Washington and Oregon from other areas of the Pacific. The sixth gauge is deployed just south of the equator in the eastern Pacific to provide readings of tsunamis generated in South America as they head towards Hawaii and the West Coast. A seventh gauge was recently deployed off the coast of northern Chile by the Hydrographic Service of the Chilean Navy (SHOA) to detect and measure tsunamis generated to the north of Chile, and a second gauge is planned. The ultimate utility of the DART tsunameter data won't be realized, however, until it can be interpreted using numerical tsunami simulations to provide comprehensive and accurate forecasts. This work is underway and will be described in detail in a future article.

PTWC CAPABILITIES, *continued*

In addition to receiving data from the DART gauges, PTWC and WC/ATWC have enhanced their sea level capabilities by utilizing their Earthworm systems and dedicated CREST circuits (described in the previous article) to exchange real time regional sea level data. This provides PTWC with real time data from eight Alaska-Aleutian coastal sea level stations and WC/ATWC with real time data from seven Hawaii stations. In the case of an Aleutian earthquake, when PTWC's tsunami evaluation must be made in an hour or less to give Hawaii Civil Defense adequate time to carry out an evacuation, having those data available in real time is extremely beneficial.

References

E.N. Bernard, F.I. González, C. Meinig, and H.B. Milburn, (2001): Early detection and real-time reporting of deep-ocean tsunamis in *Review of the U.S. National Tsunami Hazard Mitigation Program*, *Seattle, WA, 7 August 2001,* p. 85-96.

F.I. González, E.N. Bernard, C. Meinig, M.C. Eble, H.O. Mofjeld, and S. Stalin (in press): The NTHMP Tsunameter Network. in *Developing Tsunami Resistant Communities: The National Tsunami Hazard Mitigation Program,* edited by E.N. Bernard, Elsevier Publishing Company, Amsterdam.

PTWC Staff, from left to right: Geophysicist Barry Hirshorn, GIC Dr. Chip McCreery, Geophysicist Dr. Robert Cessaro, Geophysicist Dr. Stuart Weinstein, Senior Electronics Technician Rich Nygard, Oceanographer Dr. Dave Burwell, and Administrative Assistant Marilyn Ramos. Missing, Electronics Technician Lynn Kaisan.

NEW INITIATIVE: THE INTERNATIONAL TSUNAMI DIGITAL LIBRARY, FACILITATING ONLINE ACCESS TO TSUNAMI INFORMATION

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Relevant and useful information on tsunamis can be difficult to find. Field data and information on lessons learned are buried inside reports maintained by many organizations, in different formats, and representing distinct interests and perspectives. Historical accounts, photographs, eyewitness interviews, etc. are dispersed in libraries, news archives, agency files, and private collections. The International Tsunami Digital Library (ITDL) is a collaborative effort to develop a shared repository for tsunami resources.

Unlike a physical library, this digital library will not exist anywhere in its entirety. Instead, the ITDL will provide a "portal" (integrated web-based environment) for searching, browsing, and viewing materials that actually reside on websites around the world. A user chooses from questions that other people (including tsunami experts) have posed, or types in a new question. Like other web search engines, the portal searches for relevant websites and displays a list of results. It also applies recent advances in artificial intelligence to classify the results so that each user receives personalized guidance, suggestions of other queries to try, and information about how to reference the materials for papers, etc.

A prototype has already been developed at Oregon State University (USA) by the Northwest Alliance for Computational Science and Engineering, Hatfield Marine Science Center, and Valley Library. Collaborators at Gunma University (Japan) have been digitizing historical newspaper accounts, while ITIC has begun digitizing historical photos. The ITDL partners invite all *Tsunami Newsletter* readers to contribute. Please contact us at *diglib@tsunami.orst.edu* if:

- you have materials on a website and would like to partner with us to make them easier to access
- you have materials such as facsimiles of reports, photos, historical documents, videos, audio recordings, drawings, and maps that are already in digital format, even if they're not currently on the web
- you have materials that you would be willing to scan or otherwise digitize if we can mount them on a website
- you simply want to point us to web materials that you think are particularly useful.

PTWC NEWS: NEW ZEALAND SEA LEVEL GAUGES REPAIRED

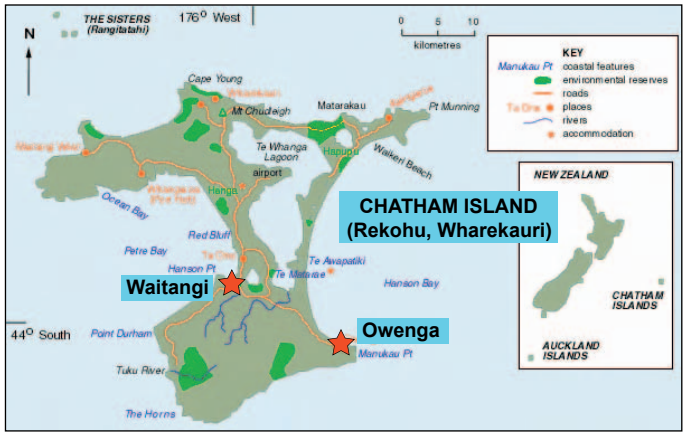

Figure 1. Chatham Island, New Zealand. Locations of stations visited by PTWC in April 2004.

Figure 2. Owenga Wharf, Chatham Island, New Zealand station. The sensor package is located at the distal end of the pier.

Figure 3. From left to right, John Lovell and Tom Roche of New Zealand CDEM, and Rich Nygard of PTWC in front of the Owenga data collection and transmission electronics.

Tsunami/tide system station installation and maintenance were performed on Chatham Island, New Zealand (Figure 1) by PTWC with the assistance of New Zealand Ministry of Civil Defence and Emergency Management (CDEM) in April 2004. In Owenga on the northeast facing coast of Chatham Island, a new tsunami/tide system was established (Figures 2 and 3). The Druck sensor package is located at the end of a long pier that juts out into the ocean, with the data collection and transmission electronics located 100-m landward. Maintenance was performed at Waitangi, on the west-facing coast of Chatham Island (Figures 4 and 5), where a new Data Collection Platform (DCP) and encoder assembly were installed. In Waitangi, the Vaisala 555 DCP, GPS timing, and GOES satellite transmission electronics are located in a warehouse situated over the Druck sensor package in a sheltered harbor in southern Waitangi Bay. New Zealand logistics were arranged by CDEM Advisor John Titmus and Readiness Manager Mike O'Leary. Chatham Island local logistics support was provided by the Counsel Manager Owen Pickles and Counsel Member Nigel Ryan.

Figure 4. Waitangi, Chatham Island, New Zealand station. Arrow shows the location of the sensor package beneath the building where the DCP is housed.

Figure 5. Stilling well holding the Druck sensor and 436B encoder assembly.

PTWC NEWS: RUSSIAN SEA LEVEL GAUGE REINSTALLED

The tsunami/tide system at Severo Kurilsk, Russia was re-established by the PTWC with the assistance of the Yuzhno-Sakhalinsk Tsunami Center (YSTC) and the Kamchatka Hydromet (KH) in August, 2004. The station, which provides critical information on tsunamis generated in the Kuril and Kamchatka region, was originally installed in 1999, but had not been working for several years. The station, consisting of Druck pressure sensor, Vaisala 555 DCP, GPS timing system, GMS antenna, 12-volt battery, and two 30-watt solar panels, was relocated to a more sheltered area in the harbor wharf (*Figure 1*). The sensor is located about 200-m from the building housing the DCP and satellite telemetry equipment. PTWC Senior Electronics Technician Rich Nygard carried out the work. YSTC Chief Tanya Ivelskaya and Engineer Victor Usov provided logistics and technical fieldwork, with local support arranged by KH Chief Michael Ishonin (*Figure 2*). During his stay, Nygard also discussed the needed repairs to the station at Ust Kamchatsk. As the sensor was broken, he left two pressure sensors and other necessary equipment with KH technical personnel for their use in fixing the stations. Prior to the visit, Nygard visited the West Coast/Alaska Tsunami Warning Center to learn about their seismic network's upgrades and the new radar tide installation system planned for Shemya, Alaska.

Figure 1. Severo Kurilsk installation. Arrows show the locations of the sensor at the wharf and the electronics/ telemetry system.

Figure 2. From left to right, Victor Usov, YSTC; Rich Nygard, PTWC; Yury Evtodiev, former KH Chief; Tanya Ivelskaya, YSTC Chief; Michael Ishonin, KH Chief; and Valery Rivkin, KH Deputy Chief.

ITIC NEWS: ITIC ASSOCIATE DIRECTOR VISITS HONOLULU

ITIC Associate Director Emilio Lorca (Servicio Hidrográfico y Oceanográphico de la Armada de Chile) met with ITIC staff in Honolulu July 12-17, 2004. During the week, he worked with ITIC Director Dr. Laura Kong to arrange the participation of Colombia in the ITP-Hawaii 2004, assess the progress on ITSU-XIX Action items, and plan the content of the ITP-International Training planned for Central America in late 2004. He also helped ITIC Technical Information Specialist Linda Sjogren, determine the status of some Spanish language materials and discussed with ITIC Webmaster Tammy Kaitoku the Spanish translation of the web site. At the end of the week, Lorca toured the PTWC where GIC Dr. Chip McCreery briefed him on PTWC's operations and future improvements in wave forecasting.

ITIC Director, Kong, and Associate Director, Lorca, during their recent meeting in Honolulu.

SUMMARY OF EARTHQUAKES IN THE PACIFIC
Occuring April-July 2004

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, M_S, and M_W from USGS National Earthquake Information Center (NEIC, G); M_W and centroid depth from Harvard (H); M_W from PTWC (P) at action time.

DATE	TIME (UTC)	LOCATION	LATITUDE	LONGITUDE	DEPTH (km)	M_W	M_S	PTWC ACTION	ACTION TIME (UTC)	Tsuami ? Damaging ?
May 3	04:37	Near Coast of Central Chile	37.695 S	73.406 W	21	6.8 (P) 6.6 (G, H)	6.5	TIB	04:54	No No
June 10	15:20	Kamchatka Peninsula, Russia	55.682 N	160.003 E	188	6.9 (G,H,P)	6.8	TIB	15:35	No No
June 28	09:50	Queen Charlotte Islands Region	54.800 N	134.250 W	20	7.0 (P) 6.8 (G,H)	6.8	TIB	10:00	No No
July 15	04:27	Fiji Region	17.656 S	178.750 W	566	7.1 (H) 7.0 (G,P)	N/A	TIB	04:43	No No
July 25	14:35	Southern Sumatera, Indonesia	2.427 S	103.981 E	582	7.3 (G,H) 7.1 (P)	N/A	TIB	14:52	No No
July 28	03:56	Irian Jaya Region, Indonesia	0.443 S	133.091 E	13	6.6 (P) 6.5 (H) 6.4 (G)	6.3	TIB	04:12	No No

Located in Honolulu, the International Tsunami Information Centre (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 26 Member States are: Australia, Canada, Chile, China, Colombia, the Cook Islands, Costa Rica, the Democratic People's Republic of Korea, Ecuador, El Salvador, Fiji, France, Guatemala, Indonesia, Japan, Mexico, New Zealand, Nicaragua, Peru, Philippines, the Republic of Korea, Samoa, Singapore, Thailand, the Russian Federation, and the United States of America.

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