

Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System



TSUNAMI NEWSLETTER



International Tsunami Information Centre

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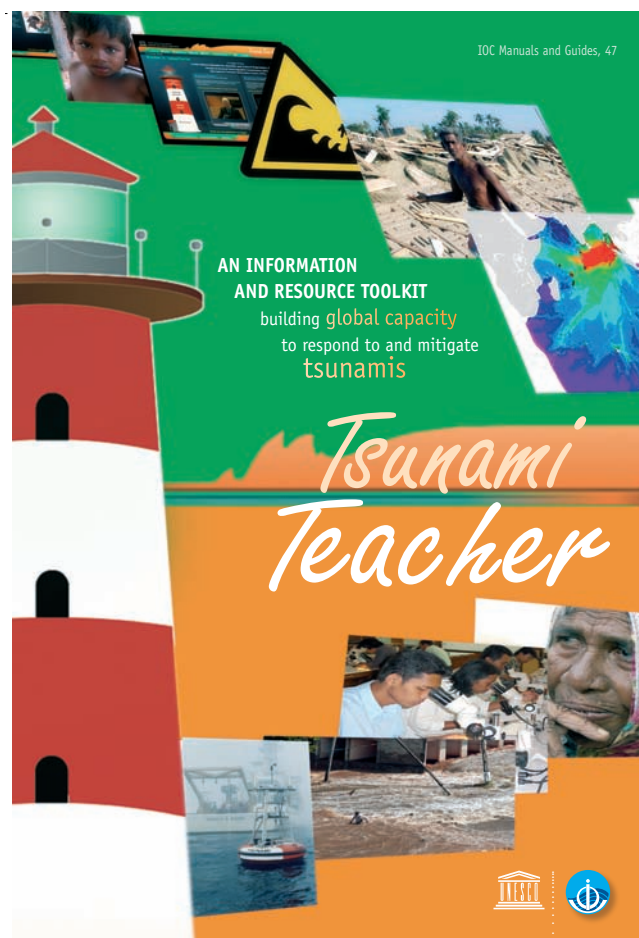
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TsunamiTeacher Launched

Guided and compiled by the IOC's ITIC, Tsunami Teacher is an information and resource toolkit that brings together a wealth of new and existing information on tsunamis into a single, reliable resource that can be adapted to local conditions through its customizable training modules for different audiences.

Training modules target the public and private sectors, including the Media, educators, governments, non-governmental organizations, businesses, and community groups. Within the government sector, a large amount of training material has been assembled on earthquake and tsunami science and research, tsunami events, and the building of tsunami warning and mitigation systems. These topics include hazard and risk assessment, operational warning and dissemination systems, tsunami emergency response, alerting, and preparedness, environmental, engineering mitigation and policy, and educational outreach. Examples and guidelines are included as resources for decision-makers.

TsunamiTeacher is supported both as a dynamic, electronic, on-line resource that will be continually reviewed, updated, and added to by experts, and as an off-line DVD which will run on either PC or Macintosh platforms. The base language is English, with future translations planned into Bahasa Indonesia, Bengali, French, Spanish, and Thai. For more details or to download the program visit <http://tsunamiwave.info>.



SUMMARY OF EARTHQUAKES

Occurring July-September 2006

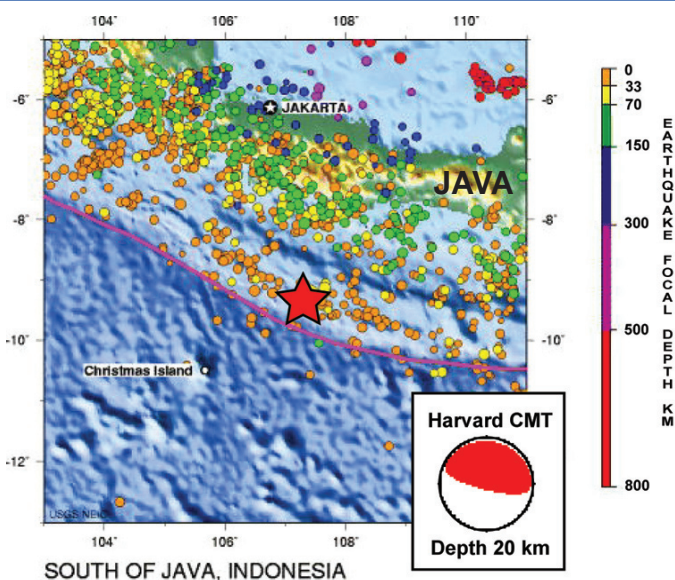
With surface wave or moment magnitude (M_w) greater than or equal to 6.5 and a depth no greater than 100 km, or an event for which a PTWC Tsunami Information Bulletin (TIB), PTWC Regional Watch Warning (RWW), and/or JMA Tsunami Watch Information (TWI) were issued. Epicenter, depth, and M_w from USGS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

DATE	TIME (UTC)	LOCATION	EPICENTER	DEPTH (km)	M_w	PTWC (P), JMA (J) ACTION	ACTION TIME	TSUNAMI? DAMAGING?	Maximum height and place
17 July	08:19	South of Java, Indonesia	9.254° S 107.411° E	6	7.7 (H) 7.2 (G, P)	(P) TIB 001 (P) TIB 002 (J) TWI 001 (J) TWI 002 (J) TWI 003 (J) TWI 004	08:36 11:08 08:46 11:43 12:25 18:50	Yes Yes	4.6 m Widarapayung Java
7 Aug	22:19	Vanuatu	15.777° S 167.799° E	27	7.0 (P) 6.8 (G,H)	TIB	22:32	No	
20 Aug	03:42	Scotia Sea	61.029° S 34.365° W	27	7.1 (P) 7.0 (G,H)	TIB	03:59	No	
1 Sept	10:19	Bougainville Region, Papua New Guinea	6.759° S 155.512° E	38	6.9 (P) 6.8 (G) 6.7 (H)	TIB	10:35	No	
10 Sept	14:56	Gulf of Mexico	26.319° N 86.606° W	14	6.0 (P001) 5.8 (G,H, P002)	TIB 001 TIB 002	15:05 15:10	No	
28 Sept	06:22	Samoa Islands	16.613° S 172.035° W	28	7.0 (P002) 6.9 (H, P001) 6.7 (G)	TIB 001 TIB 002	06:38 07:19	Yes No	16 cm Pago Pago

SOUTH OF JAVA, 17 July 2006, 08:19 UTC, $M_w=7.7$

At 08:19 (15:19 local time) on 17 July 2006 an earthquake of magnitude 7.7 occurred in the Indian Ocean, approximately 355 km south of Jakarta and about 200 km south of Java, Indonesia, triggering a local tsunami which hit a 300 km stretch of coast along southern Java. Summaries of surveys follow in the next section.

This was a 'slow earthquake', meaning that the rupture occurred more slowly and took longer than in a normal earthquake. Slow earthquakes usually occur at very shallow depths and produce greater displacements than normal earthquakes. As a consequence, they are more likely to significantly displace the seabed and generate tsunamis. In addition, the magnitude of slow earthquakes may be underestimated by traditional magnitude calculations because the energy they radiate is deficient in high frequencies due to the slower rupture speed. Further, the strongest energy release of the earthquake may occur minutes after the initial rupture and thus not be captured by the initial magnitude calculation. This event was also called a 'tsunami earthquake,' which is an earthquake that generates a tsunami much larger than expected given



Historical seismicity (from 1990-present) of area south of Java from National Earthquake Information Center (NEIC). The pink line indicates the Java Trench. The red star indicates the present earthquake. the earthquake magnitude. 'Tsunami earthquakes' are often caused by 'slow earthquakes'.

According to a ReliefWeb report, (<http://www.>

reliefweb.int/rw/dbc.nsf/doc108?OpenForm&emid=TS-2006-000087-IDN&rc=3) on 19 July, Indonesian Vice President Jusuf Kalla announced that the death toll had reached

525 with 273 people missing. Most damage centred on the town of Pangandaran. More than 50,000 people were evacuated.

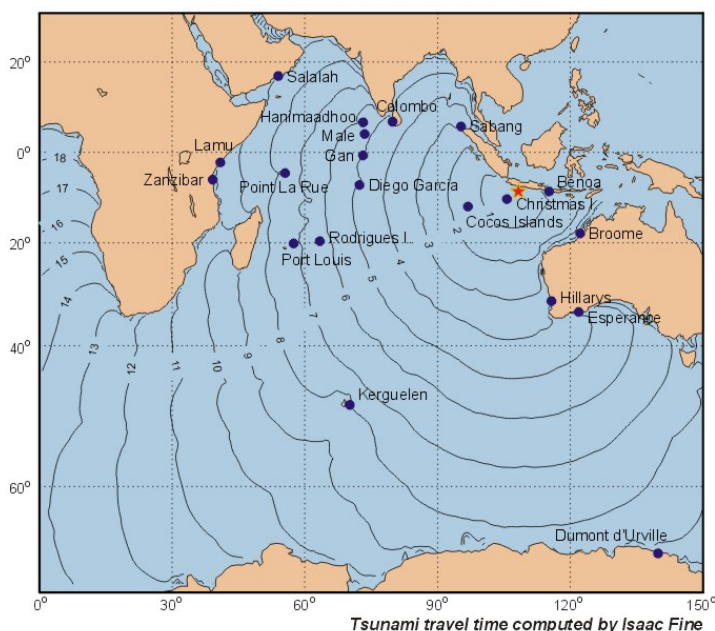
Timeline: 17 July 2006, Java, Indonesia Earthquake and Tsunami

Compiled by IOC ITIC

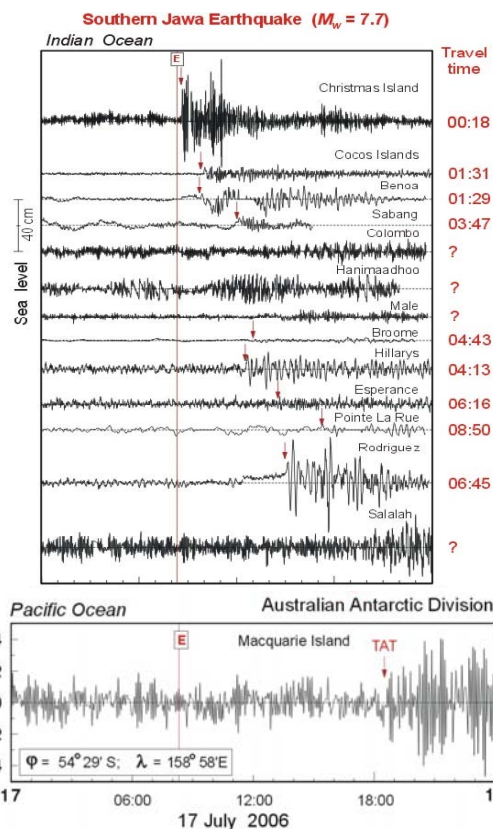
(<http://ioc3.unesco.org/itic/contents.php?id=355>)

UTC	Elapsed Time*	Action
0819		Earthquake occurs (USGS and Harvard CMT: 9.28S, 107.38E, 34 km, Mw7.7)
0821	0:02	Indonesia Meteorological and Geophysical Agency (BMG) calls start being received.
0824	0:05	BMG SMS alert reporting automatic solution using 8 stations, ML6.8 .
0825	0:06	BMG Mb5.5 => large difference in M implies non-typical earthquake PTWC Seismic Alarm triggers alerting PTWC staff.
0826	0:07	BMG press inquiry on phone and issued to media - caution for tsunami Japan Meteorological Agency (JMA) Operations trigger for distant earthquake
0827	0:08	BMG unsuccessful to contact local government official in the coastal area by telephone due to unavailability of communication contact points at the said areas. SMS message sent to list of about 400 available addresses, though list did not contain many Java coastal addresses.
0829	0:10	NEIC Short Period Alarm
0831	0:12	PTWC Observatory Message with preliminary epicenter (9.3°S, 107.3°E), magnitude (Mwp 7.3) and <i>P</i> -wave arrival times disseminated to other observatories (e.g., JMA, WC/ATWC)
0832	0:13	JMA receives PTWC Observatory Message.
0833	0:14	WC/ATWC calls to PTWC (determines that WC/ATWC does not need to issue a bulletin since the earthquake is not in the Pacific Ocean).
0836	0:17	PTWC Bulletin #1 - Indian Ocean Local Tsunami Watch Message disseminated via GTS, email, fax, putting Indonesia and Australia in a watch, M 7.2; providing estimated tsunami arrival times for tsunami forecast points at Christmas Island, Australis (0836), Cilacap, Indonesia (0900). NEIC —Initial automatic solution, Mwp 7.2
0838	00:19	JMA receives PTWC Bulletin #1.
0839	00:20	PTWC confirms with Emergency Management Australia (EMA) by telephone.
0840	00:21	Tsunami arrival, Pangandaran , According to the witness accounts, the sea level went down at first due to the tsunami wave. The wave came twice: first wave was 3m, and second wave was 5m. According to witness accounts, in the whole Pangandran, the tsunami wave came into 500m inland from the shoreline. The earthquake continued for 3 minutes.
0841	00:22	NEIC Mw 7.2 from Body Wave Moment Tensor.

*All times are UTC. *Italicized times are best estimates.*



Calculated Tsunami Travel Times for Indian Ocean Sea level stations (black dots) recording the tsunami of 17 July 2006. Epicenter shown by red star. Sea Level data are shown on the following page. Travel time plot and sea level data plots posted to the ITIC Tsunami Bulletin Board (TBB) by Dr. Alexander Rabinovich, Institute of Ocean Science, Sydney, Canada, 2 Aug 2006.



Courtesy Institute of Ocean Science, Canada; Bureau of Meteorology, Australia, and Pacific Tsunami Warning Center.

Java Timeline, *continued*

<u>UTC</u>	<u>Elapsed Time*</u>	<u>Action</u>
0843	00:24	PTWC attempts to confirm with Indonesia BMG by Telephone (no answer, 10 attempts in 12 minutes to three phone numbers).
0846	00:27	JMA Bulletin #1 – Indian Ocean Local Tsunami Watch disseminated via GTS and email, providing estimated tsunami travel times of 1 hour or less to Indonesia Indian Coast of Sumatra, Jawa, and south coasts of Lesser Sunda Islands, and Australia Cocos Islands. JMA receives NEIC Bulletin.
0849	00:30	JMA Fax Message of JMA Bulletin #1
0849-0859	00:30-00:40	Tsunami arrival, Parang Endok DIY: 3-4 waves, Receding wave 50-100m, No shaking, only heard explosions before tsunami. Tsunami arrival, Suwuk–Kebumen: Receding wave >100m, 3 waves, 2nd biggest; Weak shaking, heard explosions before tsunami.
0900	00:31	BMG checks email from PTWC, JMA.
0904	00:45	Tsunami arrival, Ayah – Kebumen: 4-5 waves, first wave the biggest; No shaking or slight shaking; Explosions heard twice before wave coming.
0909	00:50	Tsunami wave arrival, Bunton – Cilacap: High waves (- 5m) but breaking into 1-1.5m small waves, 2 waves, 1st biggest; Explosions not heard before arrival.
0914	00:55	Tsunami wave arrival, Cikembulan 1 – Ciamis: Some explosions before arrival.
0923	01:04	NEIC reviewed solution – took longer than usual because of recent staffing changes as well as complexity due to the ‘slow’ nature of the earthquake rupture. For most global earthquakes, reviewed solution available within 20-30 min (for May Tonga earthquake, it was about 20 min).
0930	01:11	PTWC report from Australia Bureau of Meteorology, 0.6m amplitude tsunami on Christmas Island gauge near epicenter.
0945	01:26	PTWC call from CNN – they report 6-ft tsunami in Indonesia.
1030	02:11	PTWC and JMA receive first sea level readings from Benoa, Indonesia (which were transmitting every 15 min) show 0.04m amplitude tsunami at 0951 (1:32 after earthquake).
1108	02:49	PTWC Bulletin #2 - Local Tsunami Watch Follow-Up Message disseminated indicating media reports of a damaging tsunami in Indonesia and that a threat of a widespread tsunami was not probable; reported an observed 0.04m tsunami at Benoa.
1110	02:51	JMA receives PTWC Bulletin #2.
1143	03:24	JMA Bulletin #2 – Indian Ocean Local Tsunami Watch, reporting Benoa, Indonesia observed maximum tsunami of 0.2m at 1944 JST.
1225	04:06	JMA Bulletin #3 – Indian Ocean Local Tsunami Watch, correcting maximum tsunami arrival time
1432	06:13	Harvard CMT Mw 7.7.
1457	06:38	JMA receives USGS M7.7.
1850	10:31	JMA Bulletin #4 – Final Bulletin, Indian Ocean Local Tsunami Watch, reporting Rodrigues Island, Mauritius maximum tsunami of 0.4m at 1750.

*All times are UTC. *Italicized times are best estimates.*

EVENT NOTES:

1. By current protocols, PTWC and JMA are providing an interim service and only issue Tsunami Watch bulletins to the Indian Ocean Region. Warnings are issued by each national authority. Currently, only a single initial Watch bulletin is issued unless other information becomes available.
2. At the time, there was no dissemination system established from BMG to any local government or authorities other than the limited lists of SMS and email. In response to the event, BMG (as of 17 August 2006) made improvements to its TWC operations including:

In response to the event, Indonesia BMG has made improvements to its TWC operations:

1. Additional telephone lines are now available
2. Dedicated communication links from BMG through:
 - a. Police communication networks, from Police Headquarter to district level,
 - b. Dept of Internal Affairs network to Governor offices to district level,
 - c. Media centers of Radio and TV broadcasting services.

Points of Contact: BMG: Prih Harjadi, Fauzi, Suhardjono; PTWC: Charles McCreery; JMA: Osamu Kamigaichi; USGS: Stuart Sipkin; Germany: Joachim Saul; IOC: Laura Kong and Masahiro Yamamoto.

References:

BMG, Germany, JMA, PTWC, USGS NEIC, 29 July 2006, *BMG Technical meeting, Bali.*

BPDP–BPPT & ITS (Widjo Kongko, Suranto, Chaeroni, Aprijanto, Zikra, Sujantoko), *Rapid Survey on Java Tsunami 17 July 2006, presented ICG/IOTWS-III, WG4, 29 July 2006.*

BMG–ERI/UTokyo, Japan–Korea Institute of Earthquake Information, *Field survey of the tsunami inundated heights due to the Java Tsunami*

Java Timeline, continued

(2006/07/17) along the coast on the Indian Ocean in Java Island, http://www.eri.u-tokyo.ac.jp/tsunami/javasurvey/index_e.htm.

Fachrizal, Sugeng Pribadi, and Iwan Hermawan, 2006, *Laporan Survey Gempabumidan Tsunami Selatan Jawa Barat 17 Juli 2006*, Badan Meteorologidan Geofisika, p.77.

ITIC communications: Post-Tsunami Survey, Nusa Kambangan, ~August 5-10, 2006, University of Crete, Georgia Institute of Technology, personal communication by H. Fritz to L. Kong, 14 Aug 2006.

Tsunami Bulletin Board postings: Sea level data; posted by Dr. Alexander Rabinovich, Institute of Ocean Science, Sydney, Canada, 25 July, 2 Aug 2006; Post-Tsunami Survey 4-11 Aug 2006, BMG-U/Tokyo, Korea Institute of Earthquake Information, posted by Y. Namegaya, 13 Aug 2006; Post-Tsunami Survey 20-21 July 2006, Kyoto University, posted by J. Mori, 27 Jul 2006.

17 July 2006—Post-Tsunami Surveys

On the following pages, we report on the southern Java post tsunami surveys conducted in July and August 2006. Survey teams came from Australia, Crete, Indonesia, Japan, Korea, New Zealand and the United States of America. In general, people either did not feel, or only slightly felt the earthquake. It was also noted that walls perpendicular to wave direction are often knocked down, while walls parallel to wave direction remained intact.

**NZ Post-Tsunami Survey 30 July-4 August,
Institute of Geological and Nuclear
Sciences, LTD, (GNS Science) New Zealand
and others**

A joint New Zealand reconnaissance team conducted a post-tsunami survey of the damaged areas of the port city of Cilacap and the resort town of Pandangaran to acquire data for calibrating models developed in New Zealand relating casualty rates to inundation and damage levels. The main tasks were to collect (a) run-up (water depth) and inundation (horizontal extent) along multiple transects, (b) building, infrastructure and vegetation damage levels for various water depths (run-ups), and (c) data on casualty rates. One of the aims of the study was to determine the rates of deaths and injuries as functions of water depth and type of building. Although it is known that: (a) people did not know exactly where they were at the time of tsunami; (b) most buildings were not uniform in type, and (c) water depths changed rapidly over small distances, it was nevertheless possible to obtain some conclusions by making reasonable assumptions based on the locations of people and rates of building occupancy. These assumptions included that:

1. All deaths and injuries occurred in or near totally or badly damaged buildings;
2. Water depths could be assigned to the heavy-to-total damaged buildings based on the water depth ground profile transects;
3. Occupancy rates for a 4 pm Monday earthquake were according to Table 5-2 of the report (p. 31);
4. For every three persons indoors, there was one additional person outdoors and nearby.

The resulting plot of death and injury rates a function of

water depth (Figure 1) shows that death rate increases with observed water depth. Collection and comparison of the slope of the linear correlation with other tsunami studies will help to establish whether the results of this study are universal.

Village	Occu- pant [*]	Dead+ Missing	Injured	Death Rate	Injury Rate	Water Depth (m)
Ds. Pangandaran	792	41	5	0.05	0.006	2.75
Ds. Pananjung	709	32	19	0.05	0.03	4.0
Ds. Wonoharja	668	74	34	0.11	0.05	3.5
Ds. Cikembula	322	52	5	0.16	0.02	3.5
Ds. Ciliang	312	18	106	0.06	0.34	2.3
CIAMIS DISTRICT	4586	428	332	0.09	0.07	c.3

^{*}in or around heavily damaged or destroyed buildings

Table 1. Data compiled in the study by village and district as a whole. The water depth for the Ciamis District is an assumed average. [p. 32 of the study].

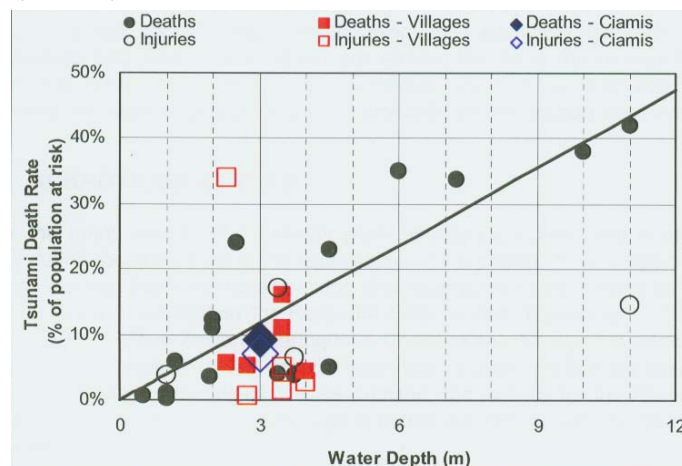


Figure 1. Effect of water depth on death rates (solid symbols) and injury rates (open symbols) due to tsunami. Squares are results for individual villages, trapezoids are approximate overall results for the Ciamis District (the assumed water depth average), and circles are data from other tsunamis. The black line is a best fit to the pre-Java death rate data. [p. 32 of the study]

Reference:

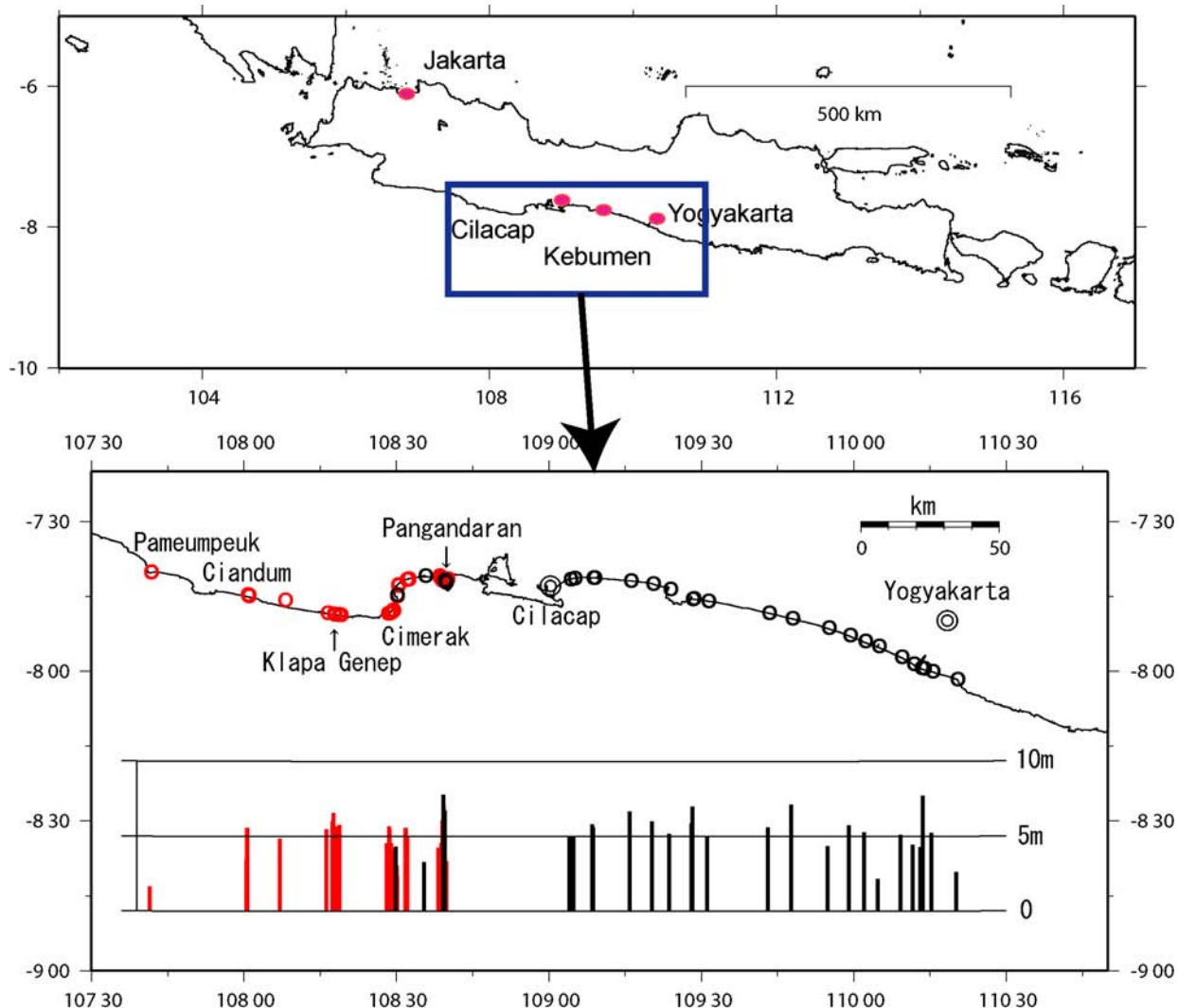
Cousins, W. J.; Power, W.L.; Palmer, N.G.; Reese, S.; Tejakusuma, I.; Nugrahadi, S., *South Java Tsunami of 17th July 2006, Reconnaissance Report, GNS Science Report 2006/33, 42 p.*

Java, *continued***Post-Tsunami Survey, 4-11 August 2006,
BMG, U/Tokyo, Kitvalley**

A survey was conducted by Badan Meteorologi-dan Geofisika (BMG), Indonesia, Earthquake Research Institute-University of Tokyo (ERI), Japan, and Korea Institute of Earthquake Information, Korea. Tsunami run up measurements, following mean sea-level corrections, are depicted in the southern Java maps below. Detailed post-tsunami survey information can be accessed at: http://www.eri.u-tokyo.ac.jp/tsunami/java-survey/index_e.htm

Reference:

Fachrizal, Sugeng Pribadi, and Iwan Hermawan, 2006, *Laporan Survey Gempabumidan Tsunami Selatan Jawa Barat 17 Juli 2006*, Badan Meteorologidan Geofisika, p.77.



Map of southern Java coast impacted by tsunami, showing area where post-tsunami survey was conducted. Red color indicates tsunami run up measured by BMG team, black color indicates tsunami run up measured by BMG team, ERI and Kitvalley.

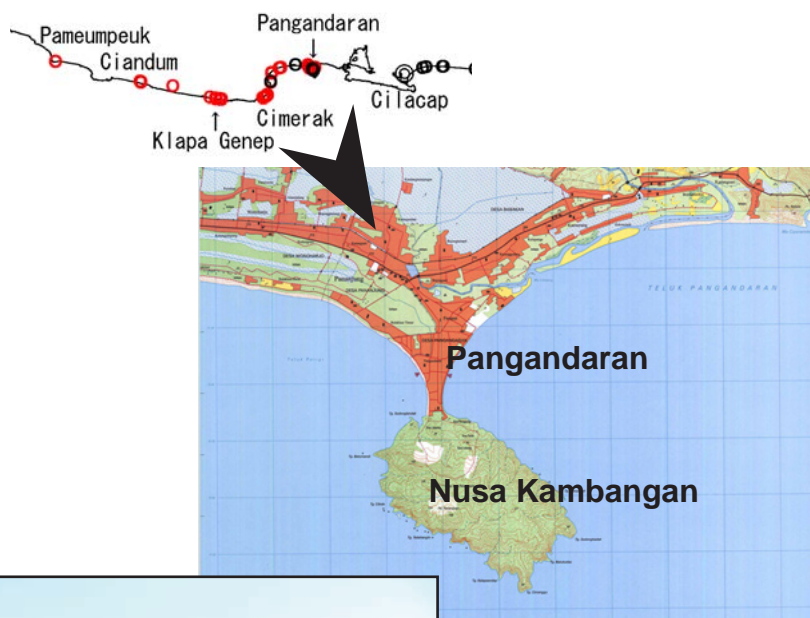
Java, *continued*



Two maps showing measurements taken in a post-tsunami survey led by Indonesian government agencies.

Post-Tsunami Survey, Nusa Kambangan, 5-10 August, 2006, University of Crete, and Georgia Institute of Technology, USA

An international team surveyed Nusa Kambangan and reported up to 20 m runups on this sparsely populated island.



Tsunami inundation in Nusa Kambangan Island, South Java. Note person in center right of photo (inside red circle) provides runup scale perspective.



Vegetative debris along uninhabited coast of Nusa Kambangan Island.



Batu Hiu damage in the Pangandaran area.



Marsawah village in the Pangandaran area. One building is left standing while all the rest in this area have been completely destroyed. Seventy people were killed in this area.

Post-Tsunami Survey 20-21 July 2006, Kyoto University, posted by J. Mori

From the report on 24 July 2006:

On 20-21 July, we inspected the damage area of the tsunami caused by the earthquake (M7.7) offshore of Java on 17 July. There was severe damage and over 200 people killed in the Pangandaran area. The largest tsunamis probably occurred in the Bulakbenda area about 20 km to the southwest of Pangandaran. Throughout the region, we saw no damage due to earthquake shaking, and people felt the earthquake only very slightly.

Reference: <http://www.eqh.dpri.kyoto-u.ac.jp/~mori/java/java-tsunami.html>

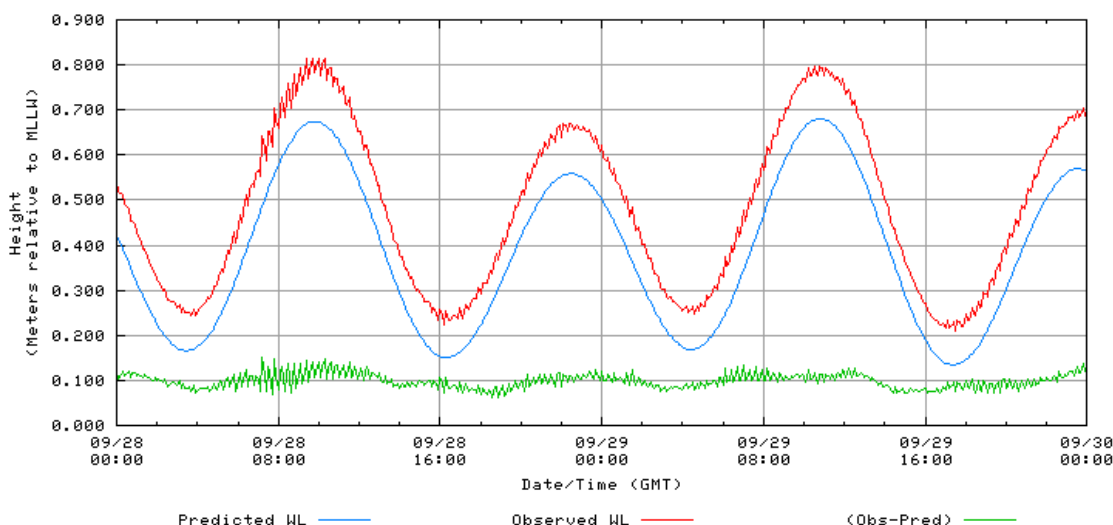


Damage in Pangandaran.

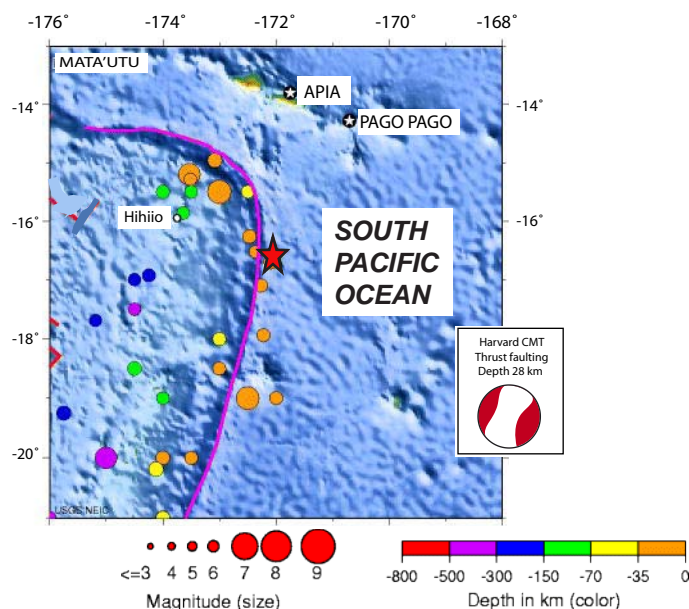
Samoa Islands, 28 September 2006, 06:22 UTC, $M_W=6.9$

An earthquake of magnitude 6.9 (Harvard) occurred on 27 September at 1922 local time (0622 UTC), 290 km southwest of Pago Pago with a location of 16.6° S and 172° W. There were no reports of damage. The

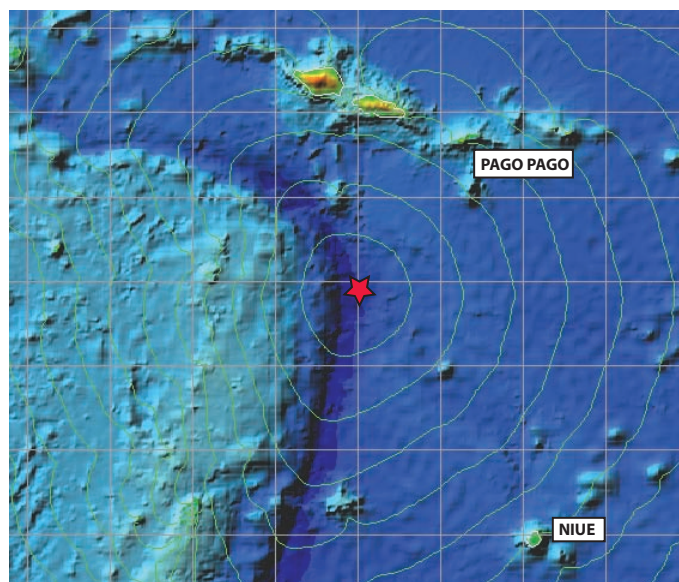
largest local tsunami sea level measurement was made at Pago Pago harbour where a 16 cm wave height was recorded.



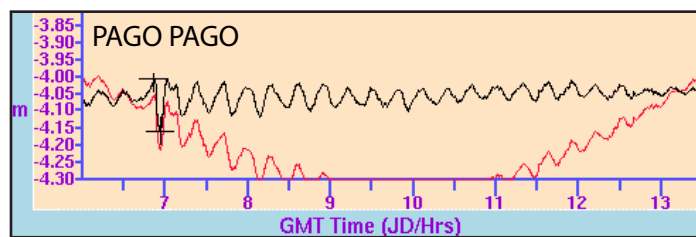
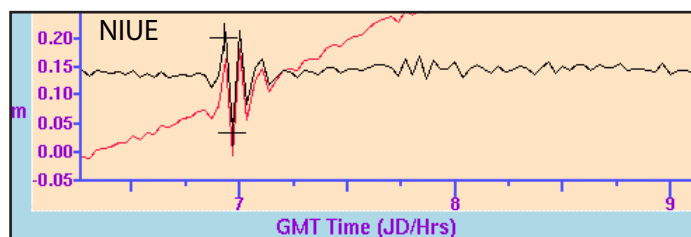
Tide gauge record from Pago Pago showing predicted and observed water levels for 28-29 September 2006. Courtesy of the U.S. National Ocean Service (NOS) web-site for tide records: http://tidesandcurrents.noaa.gov/data_menu.shtml?stn=1770000%20Pago%20Pago,%20%20&type=Historic%20Tide%20Data

Samoa, *continued*

Historical seismicity (1990-present) of area along the Tonga Trench (pink line) from National Earthquake Information Center (NEIC). The current earthquake indicated by the red star.



Tsunami travel time map showing the earthquake source (red star) and distance of wave travel in 5 minute increments.



Water level records provided by Pacific Tsunami Warning Center (PTWC) showing data from the Niue and Pago Pago gauges. The black lines indicate corrected measurements, while the red lines are the observed data.

IOC NEWS

ICG/IOTWS III, Bali, Indonesia, 31 July - 2 August 2006

The Third Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS) was held in Bali, Indonesia from 31 July to 2 August 2006 under the chairmanship of Dr. P.S. Goel, Secretary to the Government of India, Department of Ocean Development. It was attended by over 140 participants from twenty ICG/IOTWS Member States and other organizations. The Executive Secretary of the Intergovernmental Oceanographic Commission (IOC), Dr. Patricio Bernal, gave

the opening address and expressed his condolences to the families of the victims of the 17 July 2006 Java tsunami.

Bernal noted an interim IOTWS has been put in place, comprised of 26 new tide gauges, 25 additional seismic stations and 4 deep ocean DART buoys. The data are transmitted in real time to the PTWC and JMA, which both provide tsunami alert bulletins to the Indian Ocean Member States, until a fully-fledged system in the region is established. However, he emphasized that the process is far from fully running, and that there is an urgent need to especially have the community

ICG/IOTWS III, *continued*

preparedness “downstream” part of the “end to end” Tsunami Warning System (TWS) system set up and strengthened under the authority of participating nations.

Dr. Goel also read a message from former U.S. President, Bill Clinton, UN Tsunami Special Envoy, encouraging the development of a Tsunami Warning System down to ‘the last mile’ in the wake of the Java tsunami. Clinton addressed the recently established Indian Ocean Consortium Partners of 7 international agencies (UNDP, IOC, UNEP, WMO, OCHA, IFRA and the

WG5 Establishment of a system of interoperable operational centres—Chair: Mr. Geoff Crane, Australia, and

WG6 Mitigation, preparedness and response—Chair: Mr. Michel Vielle, Seychelles.

In addition to reports from the preexisting working groups, presentations were made by the IOC (Tsunami Unit (Head and IOTWS Secretariat), on Exercise Pacific Wave ‘06 (PTWS Vice-Chair), Capacity Building and Tsunami Teacher (ITIC), and other UN agencies (ISDR, UNESCAP, UNDP and WMO). National progress re-



Participants of the ICG/IOTWSIII in Bali, Indonesia, 31 July -2 August, 2006.

World Bank) and facilitated by the UN-ISDR to assist Indian Ocean Member States with the implementation of their national TWS. By the end of the session, Working Group 6 was approved to address the community “downstream” process. The present six ICG/IOTWS Working Groups (WG) are as follows:

- WG1 Seismic measurements, data collection, and exchange—Chair: Dr. Prih Harjadi, Indonesia,
- WG2 Sea level data collection and exchange, including deep-sea tsunami detection instruments—Chair: Dr. Premkumar, India,
- WG3 Risk Assessment—Chair: Professor Sam Hettiarachchi, Sri Lanka,
- WG4 Tsunami hazard identification and characterisation, including modelling, prediction and scenario development—Chair: Professor Charitha Pattiaratchi, Sri Lanka,

ports were given by 14 Indian Ocean countries. Other presentations were made by NHK on broadcast training and NHK’s role during disasters.

Supporting documents for the meeting can be found at the IOTWS III Website: <http://ioc3.unesco.org/icg-iii/1-20august-20presentations.htm>.

Indonesia Tsunami Drill Stakeholder Orientation, Patra Bali Hotel, Indonesia, 4 August 2006

Noting that the Indonesia Tsunami Warning System should issue appropriate tsunami warnings in a timely manner to the right addresses; and considering the system should be capable of transmitting the warning to the public in a timely and appropriate manner; the Indonesia Roundtable (IOC, 25 May 2006) made a recommendation to conduct a tsunami drill at one of

Indonesia stakeholders, *continued*

three locations at their 17 May 2006 meeting in Jakarta. The Indonesian drill sites recommended, by priority, were Bali, Banten, or NTT. The tsunami drill would be held on 26 December 2006, the second anniversary of the 2004 Indian Ocean tsunami. The Indonesia Roundtable consisted of Indonesia government and non-government agencies, and universities involved with the detection and threat evaluation of earthquakes and tsunamis, dissemination of warnings to provincial, district and community levels, and the conduct of education, outreach, and other preparedness measures to reduce the impact of tsunamis on life and property.

In response to this recommendation, a Bali Tsunami Drill Stakeholder Orientation meeting was convened on 4 August, following the conclusion of the ICG /IOTWS III meeting in Bali. The orientation was sponsored by the UN Development Programme (UNDP) Regional Centre in Bangkok, and coordinated with UNESCO IOC ITIC, a number of other UN agencies, and the Indone-

sia Meteorological and Geophysical Agency (BMG). A total of 44 participants attended the meeting, including Bali based government and non-government organizations. Presentations on Indonesia tsunami warning and mitigation systems were conducted by various agencies including BMG, Pacific Tsunami Warning Center, ITIC, and the Indonesian Institute of Sciences (LIPI).

Follow up activities included the subsequent designation of the RISTEK technology organization as the lead Indonesian national agency in charge of coordination of the 26 December 2006 Bali tsunami drill with various stakeholder groups at the national, provincial, and district levels. Moreover, UNDP subsequently sponsored the IOC ITIC to coordinate the delivery of technical expertise in tsunami exercises; and the development of Standard Operating Procedures (SOP) for "upstream" Tsunami Warning Centre operations and "downstream" Emergency Response; and also establishing 24/7 communication links from the "upstream" to the "downstream" processes.

ICG/PTWS NEWS

Developing Pacific Islands Regional Strategies to Reduce Tsunami Risks: North Pacific Tsunami Awareness Workshop, Guam, 22-24 August 2006

Pacific Island Countries (PIC) are located within some of the most geologically active parts of the world. On the whole, PIC's are amongst the most vulnerable countries in the world to multiple natural hazards, including local, regional, and teletsunamis.

An inaugural western North Pacific Tsunami Awareness Workshop (NPTAW) was convened in Guam on August 2006, through a collaborative effort between U.S. NOAA, South Pacific Applied Geoscience Commission (SOPAC), and ITIC. Over 50 participants represented PIC's and territories of Guam, American Samoa, Commonwealth of Northern Mariana Islands, Federated States of Micronesia, Republic of Palau, and the Republic of Marshall Islands. Participants from Australia, Fiji, Japan and USA also attended.

The aims of the workshop were to present an overview of current efforts for improving the management of tsunami risks specifically targeting new initiatives on early warning systems for the North Pacific. The workshop goal was to enhance the effectiveness of the Pacific Tsunami Warning System for the Northern Pacific through education, outreach and problem solving. The workshop had these six objectives to assist achieving the goals:

- a. *Clarify current knowledge of the behaviour of local, regional and distant tsunami waves on and around the Pacific islands.*
- b. *Distinguish the risk of experiencing destructive and non-destructive tsunamis during an event.*
- c. *Develop a strategy to improve research and modelling in the behaviour of local, regional and distant tsunami waves on and around Pacific islands (including those surrounded by coral reefs).*
- d. *Address methods to improve dissemination of tsunami information to and for the Pacific islands.*
- e. *Address the appropriate response of emergency personnel to tsunami information on Pacific islands.*
- f. *Infuse international tsunami warning strategies into western Northern Pacific.*

The results of a SOPAC – PIC survey were discussed. It was established that all countries received tsunami messages from the Pacific Tsunami Warning Center through the NOAA.

The survey revealed the following key information:

- *No country has a system to monitor and warn for local tsunamis,*
- *No country except American Samoa has a paging notification system, siren or public alarm system.*

Guam workshop, *continued*

- *Not all countries have "higher ground or inland."*
- *No country has bathymetry maps, but Majuro coastal recently has been mapped by SOPAC.*
- *There is little or no country research on the history of tsunami risks.*
- *Only Guam and American Samoa have seismic stations.*
- *Many have sea level gauges but Yap's was recently destroyed.*
- *Many except Pohnpei have satellite communication backup capabilities*
- *Most countries have plans for local earthquake and tsunami response, but only American Samoa and Guam have inundation modeling and evacuation maps*
- *Only Guam has active research on earthquakes and tsunamis. Further only a few countries have cooperation with their neighbours on tsunami researches.*

Much work needs to be done based on the survey, foremost of these being;

- *to find practical suggestions for community response and evacuation plans for low relief and narrow atoll islands,*
- *to encourage much wider participation in Exercise Pacific Wave,*
- *to encourage countries to initiate historical tsunami risk studies.*

SOPAC had been seeking to conduct a NPTAW over the past two years as a follow up to past PIC workshops including the SOPAC/IOC-ITIC South Pacific Tsunami Awareness Workshop (SPTAW) in Suva, Fiji from 1-3 July 2004, (see *Tsunami Newsletter*, XXXVI:3 (April-July 2004), p 4-8), and the SOPAC sponsored Regional Planning Meeting on Enhancing Early Warning Systems for the PIC's from 5-6 September 2004 in Fiji, driven in the wake of the December 2004 Indian Ocean Tsunami. A Planning Meeting outcome was a "Draft Strategy for Enhancing Early Warning for Pacific Island Countries" over a two year period. SOPAC solicited input from NPTAW PIC stakeholders to move this strategy forward as truly owned by the region. Moreover, a SOPAC Science Technology and Resources Network (STAR) –Tsunami Working Group considered the SPTAW recommendations in Fiji on 17–24 September 2004.

The NPTAW group developed numerous findings and action lines, which were added to the SPTAW's Draft Strategy for Enhancing Early Warning Systems.



Participants of the inaugural western North Pacific Awareness Workshop (NPTAW) in Guam, August 2006.

This document then truly became regional in nature for use by many Pacific Island Countries. Additionally, the NPTAW group also developed an action plan for strengthening the Pacific Tsunami Warning and Mitigation System with timelines of 0-2 years and beyond 2 years. The plan will be distributed through SOPAC to enable PIC's to utilize this information to develop their country preparedness and response plans.



Participants of the NPTAW represented Pacific Island Countries and territories of Guam, American Samoa, Commonwealth of Northern Mariana Islands, Federated States of Micronesia, Republic of Palau, and the Republic of Marshall Islands.

**Association of Southeast Asian Nations
(ASEAN) Sub-Committee on Meteorology &
Geophysics, Lao PDR,
19-21 September 2006**

The Twenty-Eighth Meeting of the ASEAN Sub-Committee on Meteorology and Geophysics (SCMG) was held on 19-21 September 2006 in Vientiane, Lao PDR. Fred Stephenson, Vice-Chair of ICG/PTWS, attended representing the tsunami warning system. At the meeting, Mr. Stephenson presented a concept paper whereby the IOC, through its International Tsunami Information Centre and the Secretariats of the ICGs for the Pacific Tsunami Warning and Mitigation System (PTWS) and the Indian Ocean Tsunami Warning and Mitigation System (IOTWS), working directly with ICG Member States, proposing to initiate cooperation and collaboration on mutually beneficial programmes and activities to support the strengthening of tsunami warning and mitigation of Member States participating to the ASEAN Sub-Committee on Meteorology and Geophysics.



View of the main meeting room during a presentation.

In his presentation, Mr. Stephenson provided the SCMG national representatives with information on the organizational structure and purpose of the ICG/PTWS and ITIC. He stressed the motivation that is needed in order to strengthen capacity building, and to promote the sustainability of mitigation programmes across the entire southeast region. The IOC believes that it is important and critical to engage and build appropriate partnerships at the organizational levels that work on behalf of Member States. The SCMG within ASEAN is viewed as the appropriate level for direct engagement and cooperation for the implementation of durable and effective systems.

A number of potential ITIC lead capacity building activities and cooperative initiatives were identified. Potential areas of cooperation were tsunami warn-



ASEAN Sub-Committee on Meteorology and Geophysics (SCMG) Officers are (left to right) Madam Sri Woro B. Harijono, Director General of Indonesian National Agency for Meteorology and Geophysics (BMG), Chair, ASEAN SCMG, His Excellency Dr. Maydom Chanthanasinh, Vice President of Science, Technology and Environment Agency, Lao P.D.R., Mr. Singthong Pathoum-mady, Director of Division, Meteorological Station Network, Lao P.D.R., Vice-Chair, ASEAN SCMG.

ing operations, data sharing, hazard identification and risk assessment, and preparedness, education and outreach programmes for stakeholders.

The presentation made reference to the highly successful International Round-Table on Earthquakes and Tsunami Risks in Southeast Asia and the South China Sea Region held in Kuala Lumpur, Malaysia, 27-28 April 2006. The Action Plan developed at that meeting was the primary motivation for the concept paper presented in Vientienne.

In support of this proposal, a summary of recent IOC tsunami and earthquake capacity building initiatives in the Pacific and Indian Ocean regions was provided. This included augmentation and upgrade of sea-level stations (GLOSS) to support tsunami warning, upgrading of the IOTWS regional seismic network and related training, tsunami warning centre and emergency response operations, training in numerical modeling, and the development of TsunamiTeacher and other educational and awareness materials.

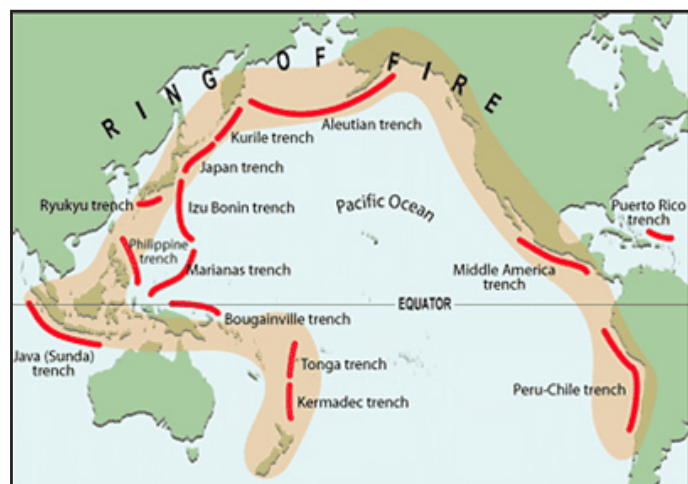
The Meeting expressed its appreciation to the IOC-ITIC for the support given to several ASEAN Member Countries in establishing their tsunami early warning systems, and its initiatives for capacity building. The Meeting supported the IOC proposal and requested the Chairman of SCMG to formalize this decision by official letter to IOC-ITIC. Mrs. Sri Woro B. Harijono, Director General of the Indonesia Meteorological and Geophysical Agency and Chairperson of SCMG provided that letter to the ICG/PTWS Secretariat in October 2006.

ITIC-PTWC NEWS

The International Sismología and Numerical Simulation of Tsunamis, Training Course, Guayaquil, Ecuador, 10-22 July 2006

A training course on seismology and tsunami numerical modeling was conducted in Guayaquil, Ecuador, from 10 - 22 July. The course was attended by over 15 participants from Colombia, Peru and Ecuador. The workshop was sponsored by the Oceanographic Institute of the Navy of Ecuador (INCAR) and the IOC-ITIC.

Christa Von Hillebrandt-Andrade, Director of the Puerto Rico Seismic Network (PRSN), University of Puerto Rico, and Dr. Modesto Ortiz Figueroa, Tsunami modelling researcher at the Center of Scientific Research and Graduate School of Ensenada, Mexico (CICESE), were instructors for the training session. The objective of the course was to understand the seismology of earthquakes and physics of tsunamis as it relates to tsunami warning operations, as well as describe and to apply numerical modeling techniques such as the use of codes developed originally as part of the IUGG-IOC TIME project, to develop coastal tsunami inundation maps.



Tsunami source zones (shaded) and subduction zones (red lines) in and around the Pacific Basin. Courtesy USGS.

USGS/IOC Seismology and Tsunami Training, Malaysia, 21-25 August 2006

This training was sponsored by Malaysia Meteorological Department (MMD), UNESCO's Intergovernmental Oceanographic Commission (IOC), the U.S. Geological Survey (USGS) and the U.S. Agency for International Development (USAID). Responsible organizers were Dr. Yap Kok Seng, Director General, Malaysian

Meteorological Department, Dr. Laura Kong, Director, IOC International Tsunami Information Centre, Hawaii, and Drs. Walter Mooney, and Annabel Kelly of the U.S. Geological Survey. The course was attended by over 50 participants from Indonesia, Malaysia, Sri Lanka, Thailand and Vietnam.

The training in seismology and tsunami warning, which was also carried out in Sri Lanka, Indonesia, Thailand, and the Maldives, provided technical assistance to Malaysia and other countries in the region on basic seismology and on "end to end" tsunami risk reduction from monitoring and evaluating earthquakes and tsunamis to disseminating a warning to the public.

The training also focused on the tsunami and earthquakes hazards of the South China Sea Region. Tsunami generating and warning scenarios from both the Indian Ocean and the South China Sea region were covered. Since April 2006, the Japan Meteorological Agency (JMA) and Pacific Tsunami Warning Center (PTWC) of the USA have provided interim tsunami advisory services to Member States of this region. PTWC and JMA are experienced operational tsunami warning centres of the Pacific Tsunami Warning System (PTWS), which has been in operation since 1965.

The learning format of the course was through a series of lectures and hands-on learning during practical sessions. All lectures were copied to CD's and made available for distribution at the end of the course.

The lecturers for the course were Dr. Rajender Kumar Chadha, National Geophysical Research Institute (NGRI), India, Dr. Annabel Kelly, U.S. Geological Survey, Menlo Park, California, USA, Dr. Laura Kong, Director, IOC International Tsunami Information Centre, USA, Professor James Mori, Disaster Prevention Research Institute, Kyoto University, Japan, and Mr. Masahiro Yamamoto, Senior Tsunami Advisor, IOC, France.

Indonesia Tsunami Standard Operating Procedures (SOPs) Assistance

A project called "Strengthening Tsunami Warning Centre (TWC) and Emergency Responses: Development of Standard Operating Procedures (SOPs) in Support of an Indonesia Tsunami Drill on 26 December 2006", is being carried out by the IOC International Tsunami Information Centre (ITIC) with funding and in collaboration with the United Nations Development Programme. An SOP is a set of written instructions that typically document a routine, or repeti-

SOPs, *continued*

tive activity followed by an organization. The Project is divided into two sub-projects; Sub-project 1, to strengthen the standard operating procedures of the national and regional tsunami warning centres, and Sub-project 2, to strengthen local tsunami emergency responses at district/provincial government levels.

The first mission to support tsunami warning centre standard operating procedures for Indonesia team personnel included Dr. Laura Kong of ITIC, Dr. Osamu Kamagaichi of JMA and Dr. Stuart A. Weinstein of PTWC. The principal goals of the mission were to examine the current state of the operations of Indonesia's tsunami warning system, help formulate Standard Operating Procedures (SOPs), and make recommendations on how the system could be improved over the next few weeks to years.



One of the meetings to discuss Standard Operating Procedures (SOPs) for Indonesia's BMG. Dr. Osamu Kamagaichi (left) of JMA and PTWS national contact for Japan, discusses communication points with Dr. Masahiro Yamamoto (center) of the IOC Tsunami Unit and Dr. Charles "Chip" McCreery (right) of the Pacific Tsunami Warning Center in Honolulu.

The team looked at several key factors including number and quality of seismic and sea-level datastreams, software for automatic and interactive seismic processing, SOP's, bulletin contents and downstream communications.

With respect to seismic data, Indonesia's Meteorological and Geophysical Agency (BMG), currently receives approximately 60 real-time seismic datastreams from a variety of instruments consisting of short period and broadband seismometers, and accelerometers. These datastreams flow into BMG over several different paths in such a manner that the absence of any pathway will not deprive BMG of all data from any particular region of Indonesia. These instruments represent a firm founda-

tion on which Indonesia's TWS is built and will only get better as instruments are added. Current plans call for a completed BMG seismic network at twice the current number of instruments. BMG will face challenges analyzing that amount of data due to current limitations of the interactive and auto-processing seismological software currently available and used at its national centre.

With respect to sea-level, BMG and its responsible agency, BAKOSURTANAL, are working to improve the amount of sea level data being received in near-real-time for tsunami monitoring. BMG currently receives data from only four (4) near realtime sea level gauges through the WMO's GTS system. This data is available over the GTS courtesy of a GLOSS upgrade of pre-existing tide stations performed by the University of Hawaii Sea Level Center. Given the length of Indonesia's coastlines, the number of gauges reporting to BMG needs to be vastly increased. BAKOSURTANAL, Indonesia's Department of Geodetics and Ocean Monitoring, maintains 60 tide stations of which 25 stations are dial-up, making them inconvenient for data retrieval. The remaining 35 use analog recording devices on site, and the data can only be retrieved by visiting the site.

BMG has also developed a system referred to as the "5 in 1" for disseminating messages, which includes technologies like SMS, and uses a pre-existing police communications network as a backbone to send messages to local government officials and police. The system was significantly upgraded in response to the Java tsunami of 17 July 2006.

On the recommendation of the team, the BMG is also restructuring its message products to make them more efficient and understandable. A period of time will be required before BMG's downstream partners understand the new content of messages and what they mean in terms of their emergency public safety response.

With respect to SOPs, the team identified several documents to support TWC operations, including operations manuals, flow charts, warning focal point lists, and action check lists. BMG has responded by creating teams composed of BMG personnel to create these documents.

The second mission (Sub-project 2) will continue with assistance for all recommendations, focus on implementation of RANET satellite communications for issuance of national warnings issued by BMG, and the planning and documents needed for carrying out a Bali Tsunami Drill on 26 December 2006.

Caribbean Visitors to ITIC 17-25 September 2006

Dr. Lorna Inniss, Coastal Zone Management Unit, Barbados, and Vice-Chair of IOCARIBE, and Julie Leonard, USAID/Office of Foreign Disaster Assistance, Regional Advisor for the Caribbean visited Hawaii to learn about best practices in tsunami mitigation, and in particular to gather information and advice for the development of a Caribbean Tsunami Information Centre (CTIC).

At ITIC, Dr. Laura Kong, ITIC Director, helped Inniss and Leonard to better understand the relationship between an IOC/ICG and its Secretariat, and gave suggestions for coordinating, setting direction, and providing capacity building for the Caribbean Early Warning System. Terms of Reference for a CTIC were finalized by the team, including how the ITIC would support the CTIC.

Dr. Inniss and Ms. Leonard also visited the Pacific Tsunami Warning Center (PTWC) for a tour and discussions with Dr. Charles MCCreery, PTWC Director and Dr. Kong. Discussion topics included seismic and sea-level data acquisition, warning products and protocols, dissemination mechanisms, regional and interim global warning roles of the Center, relative importance of having a regional (Caribbean) warning center as opposed to a distant center, such as the PTWC or the West Coast/Alaska Tsunami Warning Center (WC/ATWC), function of the PTWS Communications Plan and national contact and tsunami warning focal points.



Lorna Inniss (right) with Julie Leonard (left) in the ITIC office during their trip to Hawaii.

To gain a more thorough understanding of how a tsunami warning system works and the role of its component parts, the team also visited Hawaii State and Oahu County Civil Defense agencies to see their Emergency Operating Centres and discuss with staff tsunami warning dissemination protocols, warning mechanisms, and the important role of the Hawai'i Tsunami Technical Review Committee – a multi-sectoral coordinating committee for setting directions in improving mitigation.

Located in Honolulu, the International Tsunami Information Centre (ITIC) was established on 12 November 1965 by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). In 1968, the IOC first convened the International Coordination Group for the Tsunami Warning System in the Pacific (ITSU). In 2005, ITSU became the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS) so as to better convey the comprehensive approach required to reduce tsunami risks.

The present 30 Member States are: Australia, Canada, Chile, China, Colombia, Cook Islands, Costa Rica, Democratic People's Republic of Korea, Ecuador, El Salvador, Fiji, France, Guatemala, Indonesia, Japan, Malaysia, Mexico, New Zealand, Nicaragua, Papua New Guinea, Peru, Philippines, Republic of Korea, Russian Federation, Samoa, Singapore, Thailand, Tonga, United States of America, and Vietnam.

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