July - December 2012 VOLUME XLIV, NUMBER 2

Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System

TSUNAMI NEWSLETTER

International Tsunami Information Center

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Three Major Earthquakes Strike Pacific Basin in a Nine-Day Period

Three major earthquakes struck Central America and the Philippines from 27 August - 5 September 2012. Notable were the 27 August El Salvador earthquake (Mw 7.3) in which PTWC issued a Fixed Regional Warning; the 31 August East Philippine earthquake (Mw 7.6) in which PTWC issued an Expanding Regional Warning; and the 5 September Costa Rica earthquake (Mw 7.6) in which PTWC issued a Fixed Regional Warning. Tsunamis were measured in these events, with damage and injuries reported from the El Salvador event.

The El Salvador M 7.3 earthquake occurred on 27 August 2012 at 04:37 UTC at a depth of 12 km as a result of thrust faulting on or near the subduction zone interface between the Cocos and Caribbean plates. A maximum 36 cm amplitude tsunami was measured in Baltra, Ecuador. El Salvador preliminary maximum inland inundation was reported at 300 meters and maximum runup heights at 5 meters. Coastal flooding was also reported in Nicaragua. In the aftermath of the event, the Intergovernmental Oceanographic Commission (IOC) and ITIC were requested to coordinate post tsunami survey assessments and help improve capabilities of El Salvador to respond to future events. Post-tsunami surveys are essential for scientists to understand tsunamis and to evaluate potential improvements to forecasting models used by tsunami warning centers. NOAA's Pacific Tsunami Warning Center (PTWC) in Hawaii provides warning information to El Salvador and other countries throughout the Pacific. PTWC will benefit greatly from

Evidence of tsunami overwash in El Salvador. Photo courtesy of Dr. Hermann Fritz, Georgia Institute of Technology.

Continued p. 4

SUMMARY OF EARTHQUAKES

1 JULY - 31 DECEMBER 2012

Reported by: International Tsunami Warning Centres

Compiled by: International Tsunami Information Center, ITIC

Advisories issued by international tsunami warning centers. The Pacific Tsunami Warning Center (P) issues: Tsunami Information Bulletins (TIB), Fixed and Expanding Regional Warnings (FRW, ERW), and Ocean-wide or Widespread Watch/ Warnings (TWW) for the Pacific; Tsunami Information Bulletins (TIB), Local, Regional, and Ocean-wide Tsunami Watches (LTW, RTW, TW) for the Indian Ocean (IO) until 31 March 2013; Tsunami Information Statements (TIS), Local, Regional, and Ocean-wide Watches (LTW, RTW, TW) for the wider Caribbean (C). The Japan Meteorological Agency (J), issues: Tsunami Advisories (NWPTA) for the Northwestern Pacific; Tsunami Watch Information (TWI) for the Indian Ocean until 31 March 2013. The West Coast/Alaska Tsunami Warning Center (A) issues: Tsunami Information Statements (TIS), Tsunami Advisories (TA), Tsunami Watch/Warnings (TWW) for Canada, the US (including Puerto Rico, excluding Hawaii and US-affiliated Pacific Island countries), and the US/British Virgin Islands. Depth (from GCMT solution), epicenter and Mw from the USGS (G), and Mw from PTWC, WC/ATWC, and JMA at action time. Other earthquakes with Mw greater than or equal to 6.5 and a depth no greater than 100 km, as recorded by USGS, have also been included. Wave height and period measurements from sea level gauges (g) reported as amplitude (amp), peak to trough, or greatest value for either flow depth (fd) or runup (r) as indicated. Event location (e.g. name) is derived from PTWC message(s).

DATE	TIME (UTC)	LOCATION	EPICENTER	DEPTH (km)	M_w	PTWC (P), JMA (J) or WC/ATWC (A) ACTION	ACTION TIME (UTC)	TSUNAMI? DAMAGING?	MAXIMUM MEASUREMENT and LOCATION
25-Jul	00:28	Off W Coast of Northern Sumatra	2.657° N 96.126° E	15	6.6 (J, P) 6.4 (G)	(P) 01 TIB (J) 01 NWPTA	00:34 00:44	NO NO	
25-Jul	11:21	Solomon Islands	9.721° S 159.730° E	27	6.6 (A, J, P) 6.5 (G)	(P) 01 TIB (A) 01 TIS (J) 01 NWPTA	11:28 11:30 11:40	NO NO	
28-Jul	20:04	New Ireland Region P.N.G	4.655° S 153.159° E	58	6.6 (A, J, P) 6.5 (G)	(P) 01 TIB (A) 01 TIS (J) 01 NWPTA	20:11 20:12 20:29	YES NO	8 cm (amp) (g) Port Villa, Vanuatu (A)
10-Aug	18:38	Alaska	52.658° N 167.425° W	14	6.3 (A) 6.2 (G)	(A) 01 TIS	18:40	NO NO	
14-Aug	03:00	Sea of Okhotsk	49.784° N 145.126° E	604	7.3 (P) 7.7 (G)	(P) 01 TIB (A) 01 TIS	03:09 03:14	NO NO	
18-Aug	09:42	Sulawesi, Indonesia	1.343 °S 120.103° E	12	6.6 (A, P) 6.3 (G)	(P) 01 TIB (A) 01 TIS	09:48 09:50	NO NO	
26-Aug	15:06	Northern Molucca Sea	2.197° N 126.835° E	90	6.7 (A, J, P) 6.6 (G)	(P) 01 TIB (A) 01 TIS (J) 01 NWPTA	15:13 15:19 15:20	NO NO	
27-Aug	04:37	Off Coast of Central America	12.278° N 88.528° W	12	7.4 (A, P) 7.3 (G)	(P) 01 TIB (A) 01 TIS (P) 02 FRW (A) 02 TIS (P) 03 FRW (P) 04 FRW (P) 05 FRW (P) 06 FRW	04:45 04:46 04:58 05:23 05:42 06:16 06:27 07:02	YES YES	36 cm (amp) (g) Baltra, Ecuador (A)

Earthquakes, *continued*

DATE	TIME (UTC)	LOCATION	EPICENTER	DEPTH (km)	M_w	PTWC (P), JMA (J) or WC/ATWC (A) ACTION	ACTION TIME (UTC)	TSUNAMI? DAMAGING?	MAXIMUM MEASUREMENT and LOCATION
31-Aug	12:48	Phillipines Islands Region	10.838° N 126.704° E	46	7.6 (A, G, J, P)	(P) 01 ERW (A) 01 TIS (J) 01 NWPTA (P) 02 FRW (A) 02 TIS (J) 02 NWPTA (P) 03 FRW (J) 03 NWPTA (P) 04 FRW	12:55 12:57 13:05 13:29 13:36 13:50 14:25 14:48 14:54	YES NO	12 cm (amp) (g) Omaezaki, Japan (A)
5-Sep	14:42	Off Coast of Costa Rica	10.086° N 85.305° W	31	7.6 (A, G, P)	(P) 01 TW (C) (A) 01 TIS (P) 01 ERW (P) 02 TW (C) (P) 02 FRW (A) 02 TIS (P) 03 FRW (P) 04 FRW	14:47 14:49 14:50 14:50 15:25 15:36 16:23 17:02	YES NO	15 cm (amp) (g) Santa Cruz, Galapagos, Ecuador (A)
26-Sep	23:40	Andreanof Islands Aleutian Is.	51.634° N 178.293° W	13	6.9 (A, P) 6.4 (G)	(A) 01 TIS (P) 01 TIB	23:44 23:47	NO NO	
30-Sep	16:32	Columbia	1.916° N 76.355° W	166	7.4 (A, P) 7.3 (G)	(P) 01 TIB (A) 01 TIS	16:38 16:39	NO NO	
9-Oct	12:32	Balleny Islands Region	61.033° S 153.960° E	16	6.6 (P) 6.4 (G)	(P) 01 TIB	12:44	NO NO	
12-Oct	00:32	Aru Islands Region, Indonesia	4.842° S 134.085° E	18	6.7 (A, G, J, P)	(P) 01 TIB (A) 01 TIS (J) 01 TWI	00:37 00:39 00:51	NO NO	
24-Oct	00:46	Costa Rica	10.121° N 85.314° W	23	6.6 (A, P) 6.5 (G)	(P) 01 TIB (A) 01 TIS	00:50 00:52	NO NO	
28-Oct	03:04	Queen Charlotte Islands, Canada	52.769° N 131.927° W	12	7.7 (A, P, G)	(A) 01 TWW (P) 01 TIB (P) 02 TIB (A) 02 TWW (P) 03 TIB (A) 03 TWW (A) 04 TWW (A) 05 TWW (A) 06 TWW (A) 01 TA (A) 02 TA (A) 03 TA (A) 04 TA A) 05 TA (A) 06 TA (A) 07 TA	03:07 03:13 03:20 03:34 03:41 04:10 04:48 05:02 05:44 06:17 06:53 07:49 08:47 09:47 10:49 11:44	YES NO	79 cm (amp) (g) Kahului, Maui, Hawaii (A)
7-Nov	16:36	Guatemala	14.083° N 91.916° W	29	7.4 (G, P) 7.5 (A)	(P) 01 TIB (A) 01 TIS (P) 02 TIB	16:41 16:43 18:26	YES NO	7 cm (amp) (g) Acajutla, El Salvador (P)
11-Nov	01:13	Myanmar	23.009° N 95.884° E	14	7.0 (J, P) 6.8 (G)	(P) 01 TIB (J) 01 TWI	01:22 01:37	NO NO	

Earthquakes, *continued*

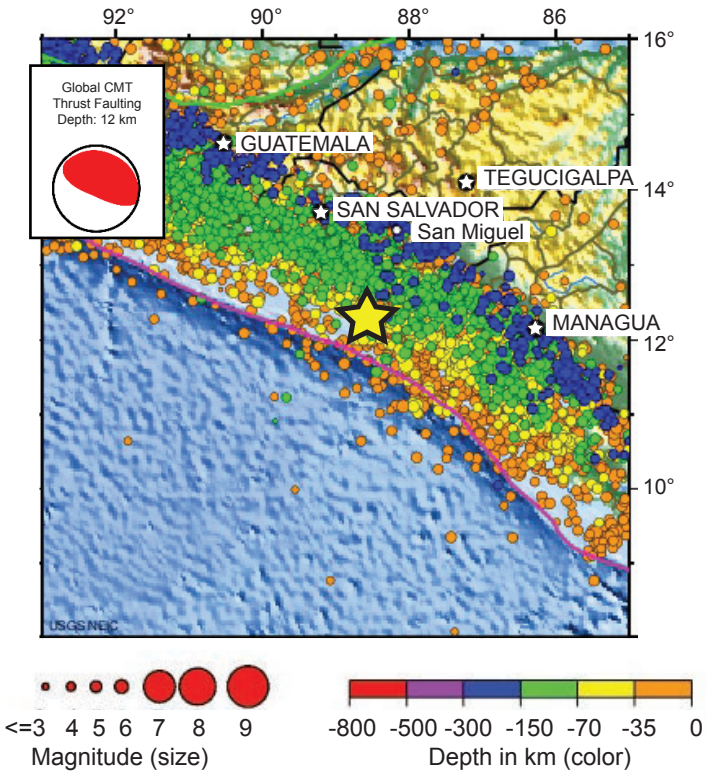
DATE	TIME (UTC)	LOCATION	EPICENTER	DEPTH (km)	M_w	PTWC (P), JMA (J) or WC/ATWC (A) ACTION	ACTION TIME (UTC)	TSUNAMI? DAMAGING?	MAXIMUM MEASUREMENT and LOCATION
11-Nov	22:15	Near the Coast of Chiapas, Mexico	14.164° N 92.167° W	14	6.6 (A, P) 6.5 (G)	(P) 01 TIB (A) 01 TIS	22:24 22:28	NO NO	
12-Nov	20:42	Gulf of Alaska	57.797° N 142.809° W	19	6.5 (A, P) 6.3 (G)	(A) 01 TIS (P) 01 TIB	20:46 20:49	NO NO	
16-Nov	18:13	Kuril Islands	49.273°N 155.476°E	44	6.8 (A, J, P) 6.5 (G)	(P) 01 TIB (A) 01 TIS (J) 01 NWPTA	18:21 18:22 18:36	NO NO	
7-Dec	08:18	Off East Coast of Honshu, Japan	37.889° N 144.090° E	58	7.3 (A, J, P)	(P) 01 TIB (A) 01 TIS (J) 01 NWPTA (J) 02 NWPTA	08:25 08:27 08:31 09:30	YES NO	17 cm (amp) (g) Ofunato, Japan (A)
10-Dec	16:53	Banda Sea	6.540° S 129.815° E	162	7.2 (J, P) 7.1 (G)	(P) 01 TIB (J) 01 NWPTA	17:02 17:20	NO NO	
21-Dec	22:28	Vanuatu	14.331° S 167.290° E	199	6.6 (A, P) 6.7 (G)	(P) 01 TIB (A) 01 TIS	22:36 22:37	NO NO	

Three major, *continued*

understanding how their predictions corresponded with the recent event field measurements. Post-tsunami survey methodology has improved in recent years with ITIC working closely with the IOC to develop a recently published manual to standardize the practice.

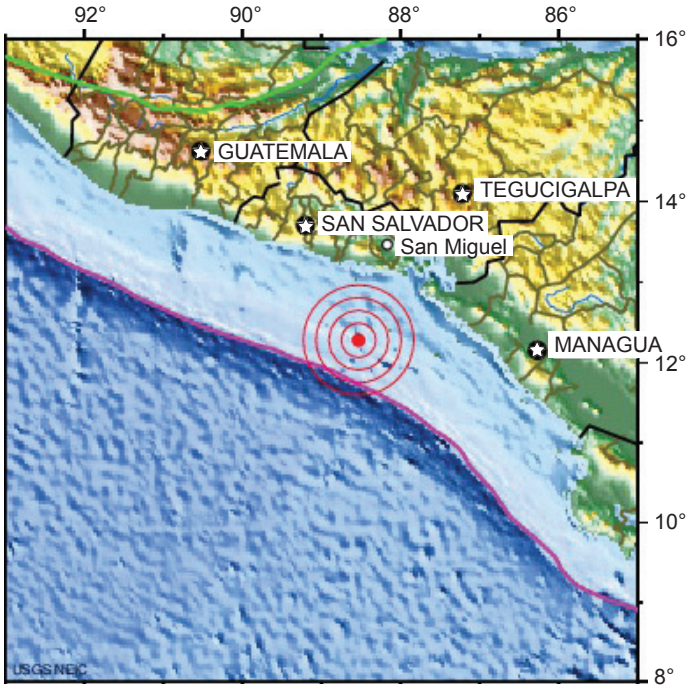
The East Philippine M 7.6 earthquake occurred on 31 August 2012 at 12:48 UTC at a depth of 46 km as a result of reverse faulting within the oceanic lithosphere of the Philippine Sea Plate. Preliminary location of the earthquake indicates this was an intraplate event, 50 or more km to the east of the subduction zone plate boundary between the Philippine Sea and Sunda plates. A maximum 12 cm amplitude tsunami was measured further north at Omaezaki, Japan.

The Costa Rica M 7.6 earthquake occurred on 5 September 2012 at 1442 UTC at a depth of 31 km as a result of thrust faulting on or near the subduction zone interface also between the Cocos and Caribbean plates. A maximum 15 cm amplitude tsunami was measured at Galapagos, Ecuador. PTWC initially issued a Caribbean Tsunami Watch, which was immediately withdrawn when the earthquake location was reevaluated to be on the Pacific side of Costa Rica. PTWC then issued a Pacific Fixed Regional Tsunami Warning.

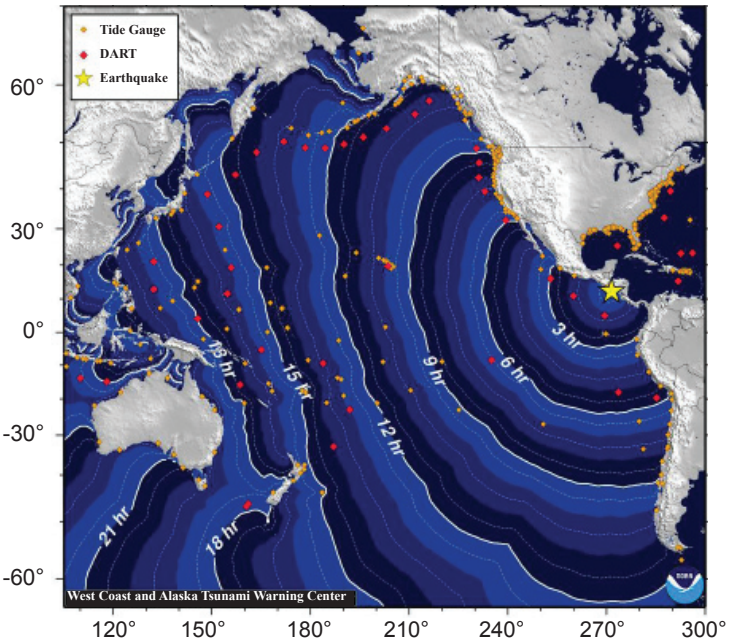


Historic regional seismicity with Central America earthquake location marked by by yellow star. Map courtesy of USGS National Earthquake Information Center (NEIC).

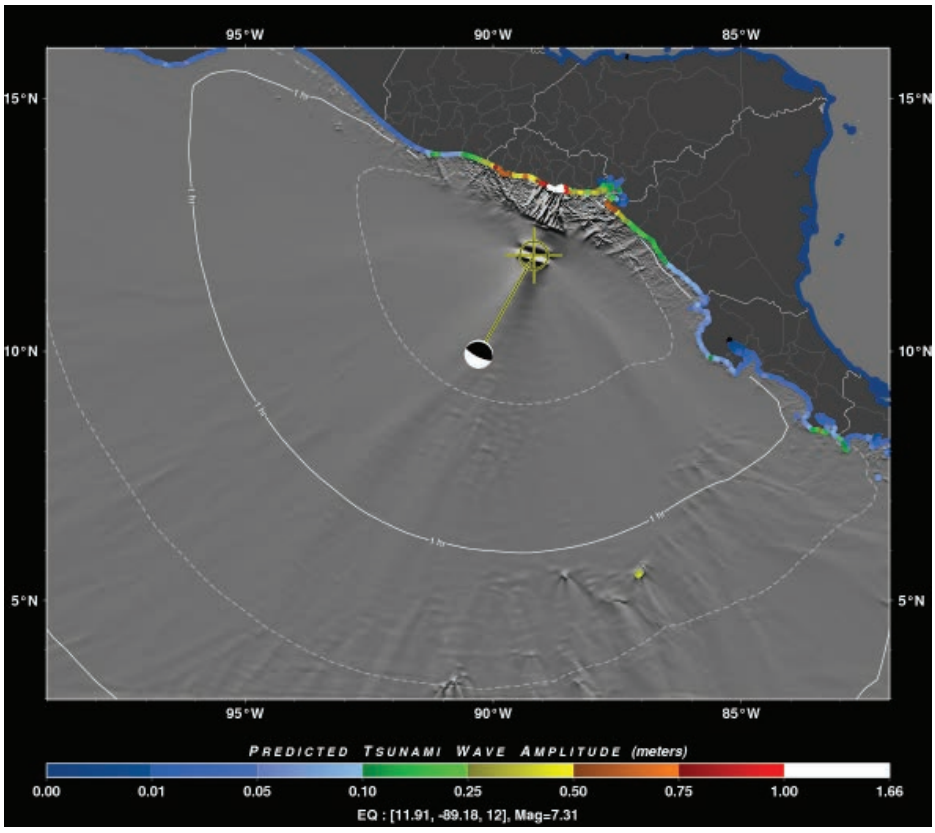
Three major, *continued*



Magnitude 7.3 off coast of Central America, 27 August 2012, depth 12 km. Map courtesy of USGS National Earthquake Information Center (NEIC).

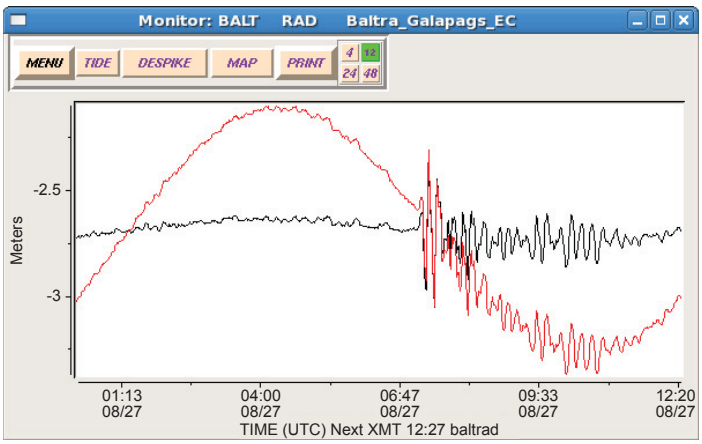


Central America tsunami travel times. Map courtesy of WC/ATWC.

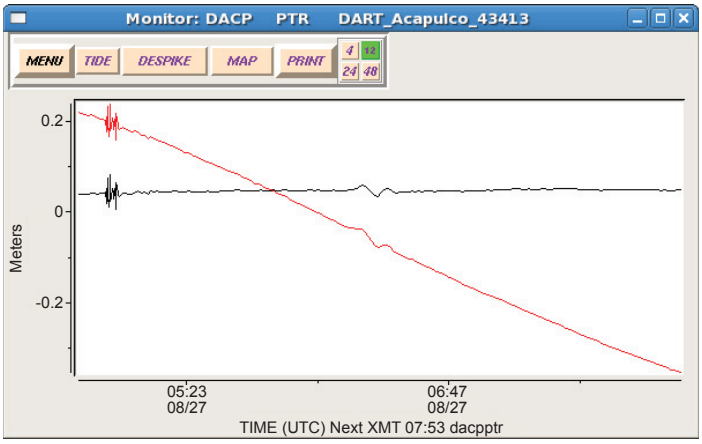


PTWC Real-Time International Forecasting Tsunami (RIFT) model simulation showing the predicted coastal tsunami wave amplitudes from the 0437 UTC 27 August 2012 thrust earthquake. Map courtesy of PTWC.

Three major, *continued*



Although only a very small tsunami (0.1 m amplitude) was recorded on Acajutla, El Salvador sea level station, a larger tsunami (0.4 m) was observed at Baltra, Galapagos Islands, Ecuador. Courtesy of PTWC.



DART 43413 deep-ocean instrument off Mexico recorded a 1 cm tsunami. Courtesy of PTWC.

Tide gage/ Measurement Location	Observed Arrival time (UTC)	Peak amplitude (above sea level in cm)	Time of Peak Amplitude Measurement (UTC)	Initial motion	Sample Interval (min)
Acajutla, El Salvador*	0529	10	-	-	1
La Union, El Salvador	0625	3	0626	up	1
Baltra, Ecuador	0709	36	0720	up	1
Santa Cruz, Ecuador	0724	20	0741	up	1
La Libertad, Ecuador	0818	18	1127	up	1
Easter Island, Chile	-	20	1723	-	1
Juan Fernandez, Chile	1300	7	1620	-	1
San Antonio, Chile	1257	2	1429	-	1
Valpariso, Chile	1305	6	1518	-	1
Lottin Point, New Zealand	2036	6	2233	-	1

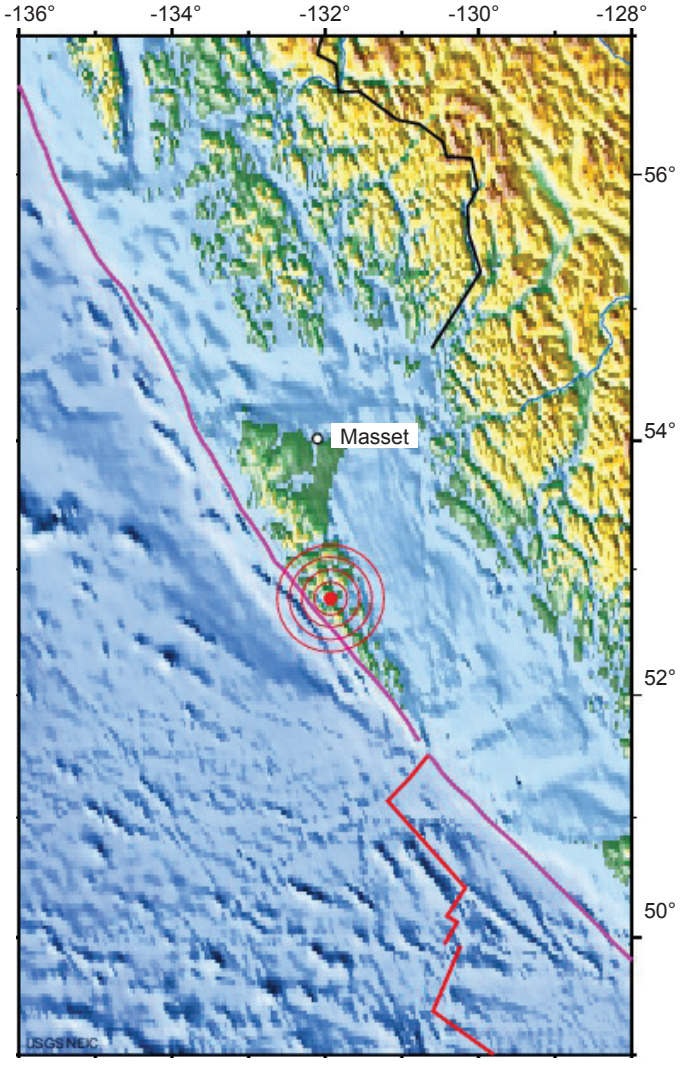
*Sea Level Measurements of the Mag 7.3 Central America Tsunami. Courtesy of WC/ATWC. * Courtesy of PTWC.*

Queen Charlotte Islands, Canada, 28 October 2012, UTC 03:04, M_w = 7.7

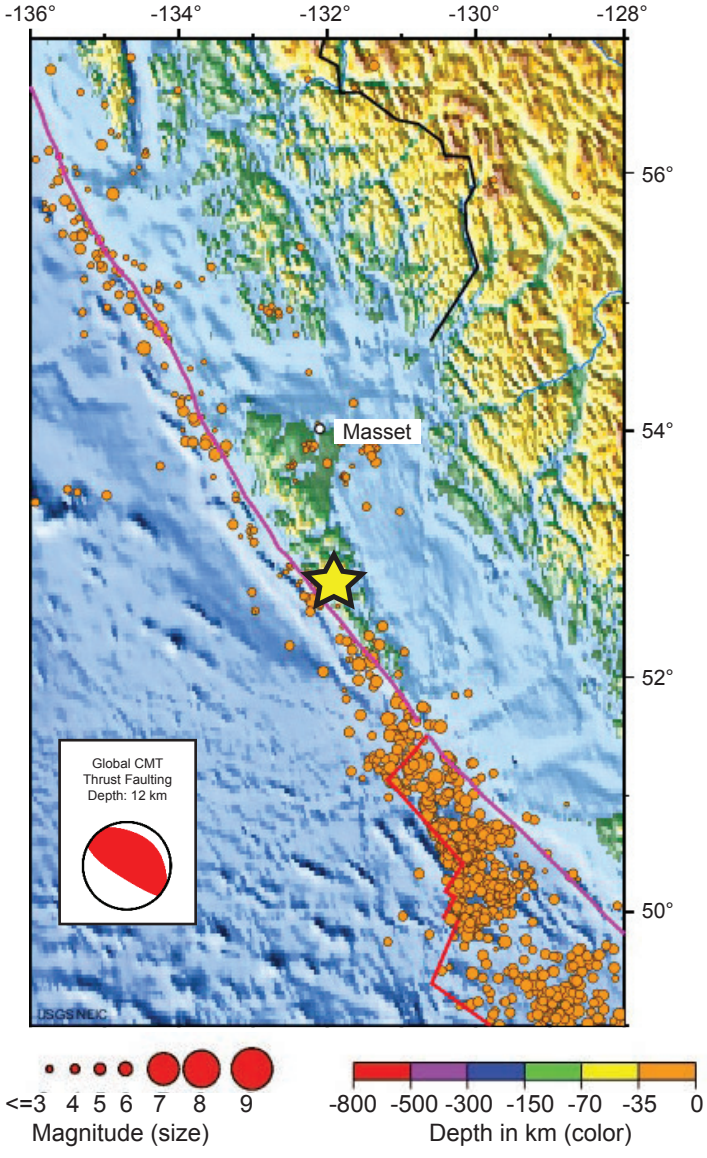
The 28 October 2012 (0304 UTC) / 27 October 2012 (2004 PDT, 1704 HST) magnitude 7.7 Haida Gwaii earthquake generated small, non-destructive tsunami that were measured from Alaska to Calfornia and in Hawaii; much smaller waves were also measured throughout the Pacific. Tsunami Warnings were issued by WC/ATWC for SE Alaska and Northern British Columbia at 2007 PDT, and downgraded to Advisories at 0049 PDT 28 October for SE Alaska and at 0247 PDT for Northern BC. Advisories were also issued for Southern BC through Northern California. A Tsunami Warning was issued by PTWC for Hawaii at 1909 HST 27 October, and downgraded to an Advisory at 0101 HST 28 October. Waves up to 5 ft were observed on Maui and the Hawaii Island, but little damage was reported statewide. One person died on Oahu during the tsunami warning when a speeding vehicle rammed into parked cars that were waiting for the closed coastal road to reopen.

Queen Charlotte, *continued*

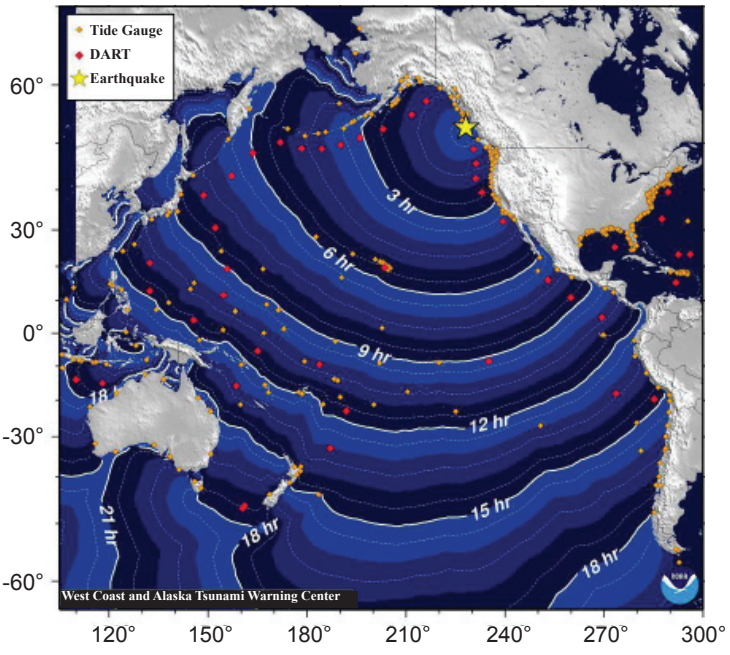
According to the NOAA National Geophysical Data Center / World Data Service for Geophysics / (http://www.ngdc.noaa.gov/hazard/) Global Historical Event database, 7 confirmed local tsunamis have occurred in the British Columbia region over history. The largest runup was 9.0 m from a M7.3 June 23, 1946 earthquake that generated numerous landslides and ensuing tsunami. A major submarine slope failure on April 27, 1975 generated tsunami waves of up to 4.1 m in Kitimat Inlet, British Columbia. Tsunami waves up to 5.0 m that were probably generated from the March 28, 1963 underwater slump were observed on Graham and Queen Charlotte Islands. Minor traces on tide gauges have been observed in British Columbia from 41 teletsunamis generated by large earthquakes around the Pacific Rim as well as the M9.1 2004 Indian Ocean tsunami. The largest runups were 6.4 m at Port Alberni and 5 m at Shields Bay from the M9.2 March 28, 1964 Prince William Sound, Alaska, USA earthquake and tsunami. The 1964 tsunami caused $10 million damage on Vancouver Island.



Magnitude 7.7 Queen Charlotte Islands, Canada, 28 October 2012, depth 12 km. Map courtesy of USGS National Earthquake Information Center (NEIC).

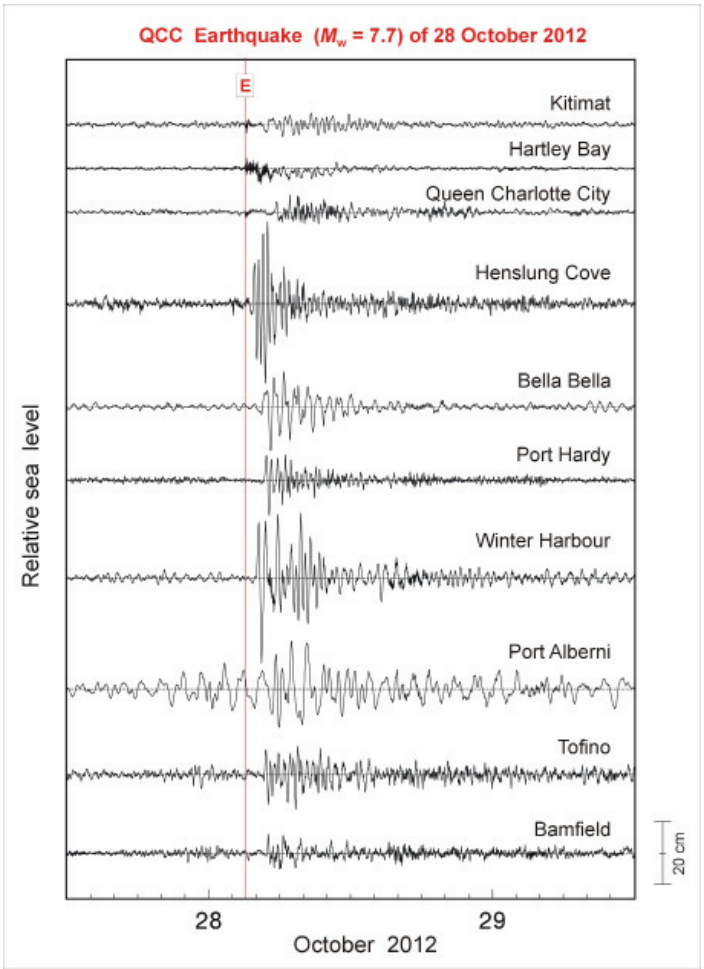


Historic regional seismicity with Queen Charlotte Islands, Canada earthquake location marked by by yellow star. Map courtesy of USGS National Earthquake Information Center (NEIC).

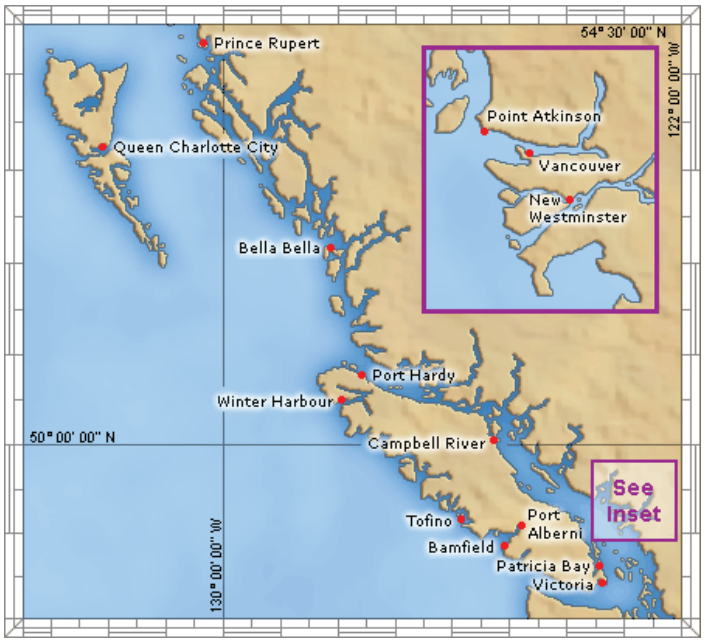


Queen Charlotte Islands tsunami travel times. Map courtesy of WC/ATWC.

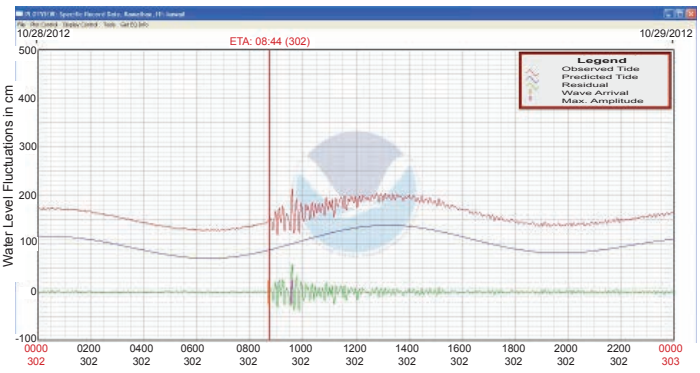
PTWC RIFT model simulation showing the predicted maximum off-shore tsunami wave amplitudes from the 0304 UTC 28 October 2012 earthquake. Map courtesy of PTWC.



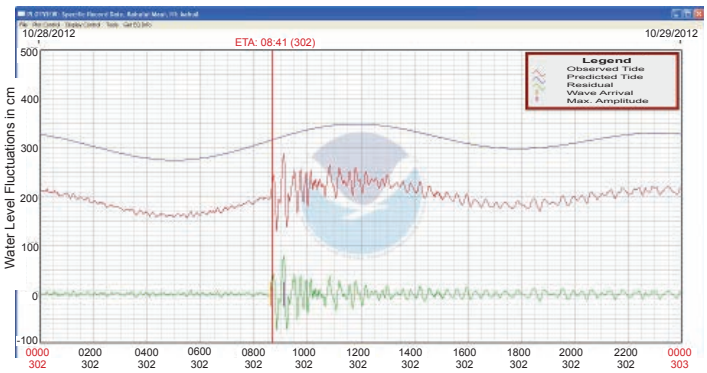
Canada sea level records. Courtesy of Sasha Rabinovich, Denny Sinnott, Canadian Hydrographic Service.



Canada sea level stations. Map courtesy of Sasha Rabinovich, Denny Sinnott, Canadian Hydrographic Service.



A 58 cm amplitude tsunami was recorded at Kawaihae, Hawaii. Courtesy of WC/ATWC.



An 80 cm amplitude tsunami was recorded at Kahului, Maui. Courtesy of WC/ATWC.

ITIC-PTWC NEWS

ITIC Consultation in Vanuatu, Port Vila, Vanuatu, 17-21 December 2012

ITIC Consultation in Vanuatu, Port Vila, Vanuatu, 17-21 December 2012

At the invitation of The World Bank, the ITIC Director provided technical consultation to the government of Vanuatu for implementation of the Vanuatu Tsunami Warning System for Port Vila and Luganville. The project was under the World Bank's (WB) Project Mainstreaming Disaster Risk Reduction in Vanuatu. The Project Management Unit (PMU) under the Vanuatu Meteorological and Geo-Hazards Department (VMGD) administered and coordinated the implementation of the Project. The UNESCO/IOC-NOAA ITIC, operated by the NOAA NWS Pacific Region since 1965, has served as a primary resource agency assisting countries to build and strengthen their tsunami warning systems. The Pacific Tsunami Warning Center (PTWC) provides warning services for the Pacific Ocean.

The following is a Summary of ITIC Activities and Discussion:

- Participated in WB meeting with VMGD PMU Manager on project implementation. The tsunami components are 1. Risk Mapping to Support Urban Preparedness and Planning, and 2. Tsunami Warning System for Urban Areas. Also discussed project components,subject matter expertise (SME) required, and activities to achieve success.
- Participated in VMGD PMU Project Manager consultations with National Disaster Management Agency Director and Geo-Hazards Manager.
- Discussed Tsunami Warning Center requirements, equipment, and staffing with Geo-Hazards Manager and Staff. The plan was for the TWC responsibility to transfer from the Forecast Section to the Geo-Hazards Section.
- Discussed potential support of ITIC in WB Project with Geo-Hazards Manager.
- Discussed potential support of ITIC in WB Project with WB Disaster Risk Management Specialist.

Vanuatu Tsunami Warning Desk at the Vanuatu Meteorological and Geo-Hazards Department. Photo courtesy of L. Kong.

ITP-Intl, Vanuatu, *continued*

- Consulted with VMGD Director to learn highest priorities tasks within WB Project.
- Routine check on status of VMGD TWC operational tools, including need for upgrades. Earthquake and sea level monitoring tools were first installed by ITIC during 2009 visit.
- Briefed Forecast Section Manager and Geo-Hazards Manager on the PTWC New PTWS International Tsunami Products that will start in February 2013, and on Exercise Pacific Wave 2013 that will occur in April 2013.

The following are Outcomes of the ITIC Technical Consultation:

This was an exploratory mission to enable all stakeholders to understand their needs. The VMGD Geo-Hazards Manager, as the lead implementer, discussed with her Senior Staff, Forecast Section, and VMGD Director, and provided feedback to The World Bank.

- Learned of the current status of the Vanuatu TEWS, and provided updates on PTWS activities for 2012, current PTWC operational tools, and planned PTWC new products.
- Provided Terms of Reference for SMEs to support WB VMGD TEWS components.
- Provided Tsunami Warning Operations Center list of considerations, and examples of layouts and photos of existing centers around the world. VMGD should identify their specific needs, and equip its center accordingly.
- Provided Emergency Operations Center list of considerations. NDMO to determine what their role will be before, during, and after a tsunami, and equip its center accordingly.
- Discussed possible types of assistance that ITIC and PTWC could provide, and mechanisms by which to provide such assistance to support World Bank Project.
- Installed, upgraded, and provided training on sea level (Tide Tool) monitoring tool. The operational tool currently resides in the Forecast Section since they are responsible for issuing national tsunami advisories. Also installed on Geo-Hazards computer that serves as backup.

Esline Garaebiti of the Vanuatu Tsunami Warning Center reviews global earthquake activity and has color coded tsunami SOPs posted on the wall at the Vanuatu Meteorological and Geo-Hazards Dept. Photo courtesy of L. Kong.

ITIC Training Programme Hawaii (ITP-Hawaii), Honolulu, Hawaii, USA, 20-31 August 2012

The International Tsunami Information Center (ITIC) in conjunction with the Pacific Tsunami Warning Center (PTWC) performs an annual training course for different countries, located in the Pacific Basin, in order to train, develop and standardize procedures and actions to mitigate the effects of tsunamis. This course was conducted between 20-31 August, in Honolulu, USA, and it consisted of two weeks of classroom and professional visits to PTWC and relevant tsunami agencies. The main purpose of this course was to request participating countries to expound on the Standard Operating Procedures (SOPs) for local and regional tsunamis, which consist of pre-planned actions for the receipt, analysis, dissemination and monitoring of seismic and oceanographic parameters used for watches, warnings and cancellations of tsunamis. Moreover, participants were trained on the planned new international tsunami forecast products of the PTWC.

The participating countries were the following: American Samoa, Barbados, Chile , China, Colombia, Federated States of Micronesia, Chuuk State, Malaysia, México, Perú and Solomon Islands.

ITP-Hawaii, *continued*

Country Trip Reports ITP-Hawaii 2012

American Samoa

by Daniel A. Langkilde, Alexander Tali, Adulbeau "Lomi" Akapo, Department of Homeland Security

Summary

The ITP-Hawaii 2012 was a two-week end-to-end training course on Tsunami Early Warning and Mitigation Systems, and covered at the very start how tsunamis are generated, how they are detected and verified at tsunami warning centers, how bulletins are then issued, how EOCs and emergency management organizations receive the bulletins, and how they disseminate the information and warnings to their own communities. Contents of the bulletins were explained in detail, and how the new products will look and how to read them.

The course also covered methods of emergency communications and included tabletop exercises. Actual visits to field sites included the Pacific Tsunami Warning Center, State of Hawaii Civil Defense Department, and various tsunami related facilities on the Big Island of Hawaii.

Several speakers and presenters were featured on a daily basis during the course, all of whom are experts and scientists in their respective fields. The participants included representatives from several countries around the Pacific Rim. The course itself was coordinated by the International Tsunami Information Center (ITIC) which is headquartered at the NOAA offices in Honolulu.

Outcome

All participants received certification at the end of the course, and are now considered tsunami 'experts' in

Participants of the 2012 ITIC Training Programme - Hawaii. Front row (l to r): Dr. Laura Kong (ITIC); Edward Young and Jeffrey LaDouce (US NWS Pacific Region Headquarters); Dr. Charles McCreery (PTWC); Brian Yanagi (ITIC). 2nd row (l to r): Tan Yin San (Malaysia Meteorological Dept); Sub-Lt Ceci Cruz (Directorate of Hydrography and Navegation of Peru); George Baragamu (Solomon Islands National Disaster Management Office); Manoah Tepa (Solomon Islands Meteorological Service); Akapo Akapo (American Samoa NWS); Kerry Hinds (Barbados Dept of Emergency Management); Tingting Fan (China National Marine Environmental Forecasting Center); Maria Rivera (Colombia Geological Survey). Back row (l to r): Nicolas Arcos (ITIC); Jesus Bernal (Armada De Mexico); Sanchez Salle (Federated States of Micronesia); Jorge Yanez (Mexico Civil Protection); Cdr Enrique Silva (Hydrographic and Oceanographic Service of the Chilean Navy); Daniel Langkilde (American Samoa Dept of Homeland Security); Adulbeau Akapo (American Samoa Dept of Homeland Security); Alexander Tali (American Samoa Dept of Homeland Security); Dr. Qinzheng Liu (China Disaster Prevention and Mitigation Center); Lt Hector Fierro (Hydrographic and Oceanographic Service of the Chilean Navy). Photo courtesy of ITIC.

Country Trip Reports, *continued*

their respective communities.

I learned a great deal from the course on how the PTWC monitors seismic activity in the Pacific, how they receive data when an earthquake is detected, how they verify the information and forecast tsunamis, and how they issue bulletins and warnings to clients throughout the region and the world. I also understand now why it takes the PTWC about 7 to 10 minutes to issue their first bulletin once an earthquake is detected.

I also learned how EOCs are supposed to respond to tsunami alerts and how this timely information is supposed to be disseminated to the public quickly and effectively.

During the course of the training, we were able to identify the following weaknesses in our standard operating procedures which need to be improved:

1. EOC personnel need legal authority and designation to act once a tsunami warning is issued. There might not be enough time to notify superiors first.
2. Procedures need to be developed for issuing a "Precautionary Message" once an earthquake is felt, while we await the first bulletin from the PTWC. This message would put the community on alert to wait for an official message on whether to evacuate or not.
3. Media SOPs need to be developed on how to disseminate information to the public during emergencies.

Daniel Langkilde delivers a presentation on the American Samoa Tsunami Program. Photo courtesy of ITIC.

Overall Remarks

The course was excellent and I learned a great deal from it. The speakers and presenters did a great job in making the material interesting. The field trip visits added to the learning experience enabling us to actually see how procedures are implemented. I highly recommend that more ASDHS staff attend these ITP courses in the future. Well worthwhile!

Barbados

by Kerry Hinds, Department of Emergency Management

Objectives of Course

The 2012 ITP-Hawaii Training Workshop focused on Standard Operating Procedures (SOP) for tsunami warning and tsunami emergency response with special emphasis on preparing especially for local and regional tsunamis; as well as introduced the course participants to the new international tsunami forecast products which would be utilised from 2013 by the PTWC. The overarching goal of the course was to improve operating procedures for tsunami warning and emergency response an essential key to successful early warning.

Specifically the 2-week training course sought to provide:

1. An overview of the history and operation of the Pacific Tsunami Warning and Mitigation System.
2. An overview of the important role of regional and national tsunami warning centers in monitoring and evaluating the tsunamigenic potential of earthquakes, and in issuing timely tsunami warning messages to government emergency officials who can then act to save lives and reduce damage to coastal communities.
3. Training and familiarization with the Pacific Tsunami Warning System and other regional systems, Sub-regional and National Warning Systems, and Emergency Response concepts of operations and standard operation procedures.
4. Working examples of an end-to- end tsunami warning and mitigation system demonstrating close stakeholder coordination and partnership for operational warnings and in preparedness activities.

Country Trip Reports, *continued*

5. Participants with a better understanding of the end-to-end system by engaging in a series of informational presentations and discussions; site visits to the Pacific Tsunami Warning Center, Emergency Operations Centers, seismic or water level station field sites, the Pacific Tsunami Museum, tsunami memorials, and the USGS Hawaiian Volcano Observatory.
6. Participants with a basic understanding of existent mechanisms in participant countries through country presentations.
7. Information on and orient participants to the different tsunami warning decision support tools and software available for use in their centres.
8. Participants with the tools to participate in tsunami exercise role-playing as tsunami warning centres or emergency response agencies responding to a local or regional tsunami.

Course Administration, Delivery and Logistics

Clearly the course was well organised in terms of course content and delivery, sequencing of agenda items, the mixture of theory and practical, classroom and field settings, science and emergency management components and the presence of the numerous subject matter experts who delivered various components of the course.

It must be noted, however, that Hawaii provided an excellent location for the delivery of the course since access to sites, expert resource personnel who are well-versed in tsunami science, tsunami warning systems and emergency management systems, tsunami education and awareness, public education and relations, tsunami decision support tools and communications systems and tools.

The logistical management and coordination during the two weeks of the course was well executed. It allowed participants to focus on the course. Accommodation at the course venue was comfortable and offered an environment conducive to learning and interaction amongst participants. The hotel accommodation was also comfortable and provided a relaxing setting especially after intense all-day working sessions over the two week period. The staff at the ITIC and the other places which course participants visited were very accommodating and made the experience unforgettable and truly enjoyable.

Day One commenced with a welcome and address by the NOAA and ITIC Directorate. The speakers gave insight on their current jobs and portfolios, local and international tsunami experiences, the history of the course and the relevancy of the training. This session set the tone of the course and what could be considered the overarching goal of the ITIC Training Programme: Tsunami Warning and Mitigation Systems, that is**,** "to get the information to the people who need it and ensure they have the confidence to use it and act accordingly." The remainder of the session dealt with the usual administrative details which included introduction of the trainers and participants, orientation to the island, location, facilities, and an overview of course logistics as well as the course agenda.

Dr. Kwock Fai Cheung, a University of Hawaii Professor and tsunami modeller, makes a presentation on modelling and inundation mapping. Photo courtesy of ITIC.

Tsunami Science

Understanding the science behind tsunami hazard is a crucial part of our management of that hazard. The value of the science cannot be underscored enough. The "tsunami science" sessions which were delivered throughout the training workshop were integral in placing the tsunami hazard in perspective. Participants were given a wealth of information as it related to the source generation of tsunamis, wavelength effects, wave arrival, wave dispersion, times magnitude of past tsunami events, understanding and assessing the tsunami risk, as well as modelling for tsunamis, past, present and ongoing tsunami research.

The application of the science, for example the modelling, is indeed a critical factor in assisting the emergency management community in developing

Country Trip Reports, *continued*

strategies to help the population and ensure a greater level of public safety. To illustrate further post event modelling can be used to produce scenarios for possible events for the emergency management community. The application of the science can also be used to generate tsunami inundation maps which can be useful job aids for emergency management for example for evacuation planning purposes.

Notably the science also assists us in identifying areas of need including but not limited to:

1. a definite need for paleo-tsunami research which would aid in forecasting and planning for tsunami events
2. development of robust warning systems
3. review and production of accurate inundation maps

Warning Mechanism

The warning component of any system takes into consideration detection, threat evaluation and the use of warning products. Course participants were given detailed examples and information on local, national, regional and global warning mechanisms and networks utilised for the tsunami hazard. It was suggested in many instances these warning mechanisms were works-in-progress and subject to continuous process improvement. There were discussions on the various components of the warning mechanisms including the forecasting and warning tools, existing and new products, warning centres' standard operating procedures, resource needs and resource constraints including equipment and human resources as well as the level of automation of the system.

NWS Pacific Region Deputy Director Edward Young, Jr. demonstrates "Chatty Beetle" communications platform to disseminate tsunami alerts to isolated coastal communities. Photo courtesy of T. San.

Emergency Management Mechanism

During the course, participants were informed about the necessity of having an effective emergency management mechanism in place which could deal with the potential effects and impacts of the tsunami hazard. Participants were introduced to a number of systems which were indeed tested by recent tsunami events for example Japan, Chile, American Samoa amongst others.

It was noted that the emergency management systems within different jurisdictions while possessing some similarities did vary quite a bit especially in the areas of capacity, capability, past experience with tsunami events and structure. However, two notable areas of importance and core requirements of all emergency management systems were stakeholder coordination and the legal authority to carry out mandated functions. The responsibility of the emergency management community to the public encompassed public alerting by multiple effective means; spearheading evacuations; issuing all clears; and generally being able to educate and put mechanisms in place to create a culture of safety.

A major focus of the course was the importance and need for Standard Operating Procedures as a guide not only to the emergency management community but to all stakeholders in the system. The documentation of such plans and procedures was and is an essential component of any system. Many examples of detailed and tested documented standard operating procedures were given including those prepared by the warning centres for example the Pacific Tsunami Warning Centre Standard Operating Procedures, standard operating procedures used by emergency management such as those from the Philippines, Japan and Hawaii.

Public Awareness and Education

The main focus or goal of any public awareness and education effort is to ensure that the public is prepared and know what to do in any event. Many of the sessions focused on this area and participants were able to understand the fundamentals of public awareness and the essential components of any public education programme.

It was reinforced that the engagement of the media as a partner was critical in any public awareness and education exercise. Clearly defined rules of

Country Trip Reports, *continued*

engagement must be a feature of any collaboration with the media since this can have an impact on the effectiveness of the response whether real or perceived.

The sessions during the course were a good balance of theory and practical and gave participants the necessary tools to develop a public awareness programme, guide and or evaluate an existing public awareness programme.

Mr. Brian Yanagi (standing), ITIC, provides guidance on how to develop Tsunami Standard Operating Procedures for Emergency Management using templates. Photo courtesy of ITIC.

Decision Support Tools and Communication Technologies

Course participants were introduced to a number of decision support tools and communication technologies. These tools and technologies continue to be instrumental in building robust and redundant warning and communication systems. Decision Support Tools such as the CISN Real time Earthquake Display and TideTool are examples of products which are currently being utilised in many systems around the world. Communication Technologies provide alternative options for countries who are improving their in-house system capacity. Most country systems utilised multiple communication technologies and tools in an effort to keep open lines of communication to the various publics and stakeholders. The use of radios, fixed lines, cell phone technology, EMWIN, Chatty Beetle, HF Radios are but some of the technologies and tools which were discussed during the sessions. Discussions centred on the strengths and weaknesses of the various tools and technologies, costs, interoperability. However more importantly was the discussion on redundancy and ensuring that communication redundancy is a feature of any system being used.

Country Presentations

Participants were requested to deliver country presentations highlighting their in-country tsunami management systems. Generally the participants' presentations focused on

- situational overview and analysis of their country as it related to the tsunami hazard
- the administrative and legal authority for tsunami management (warning, preparedness, mitigation, response, and recovery),
- triggering events which has signalled the need to put an end-to-end system in place
- linkages and relationships among stakeholders in the existing system with a focused emphasis on linkage between the warning centre and the emergency management authorities,
- the decision support tools which are utilised in the existing systems,
- training and equipment requirements of the existing systems
- policies, plans and standard operating procedures
- human resource needs of the system

It was noted from the various presentations that countries were at varying stages in the development of their end-to-end systems. The development of national level capacity for an end-to-end system was very dependent on stakeholder support and resources at the community, local, national, regional and international levels.

- The governance mechanism and supporting network of the Intergovernmental Oceanic Commission as well as the guidance of the ITIC and PTWC were seen as critical components of regional and international support to capacity building within the countries.
- The endorsement by national governments through the provision of funding, development of strategy and action plan for tsunami warning and preparedness; enactment of legislation and regulations that support the system; drafting and

Country Trip Reports, *continued*

adoption of policies , plans and procedures was also seen as contributing and necessary factors in building the tsunami end-to- end system.

- The acquisition of the warning and forecast equipment and decision support tools such as CISN, Tidetool, sirens, modelling equipment, communications systems , sea / tide gauges, DARTS amongst others . The implementation of an emergency alerting system to warn the population.
- The importance of public education and increased awareness of the tsunami hazard and its potential impact.
- The interaction between the national warning and emergency management focal points.

In conclusion, it was noted that the presentations highlighted strengths, weaknesses and existing capabilities and gaps in the all the countries tsunami warning and mitigation systems. Participants were able to see how the implementation of a tsunami warning and mitigation system was similar or in some instances varied from country to country. Country participants were also able to articulate what worked, what did not and why it did not work in their own jurisdiction. This gave other participants insight into possible practical strategies that could be implemented in their own country.

Field Trips

The inclusion of the field trips as part of the course delivery was an excellent learning tool for participants. These field trips included visits to warning centre focal points such as the Pacific Tsunami Warning Centre and the United States Geological Survey Hawaiian Volcanoes Observatory; emergency management focal points such as State of Hawaii Civil Defense and the Hawaii County Civil Defense; historic educational sites such as the Pacific Tsunami Museum, Hilo Tsunami Memorials amongst others. It was an opportunity for participants to gain a better understanding of the operations of these entities, their roles and responsibilities, and the relationships or linkages among these stakeholders in the system. These field trips also served to reinforce what was learnt in the classroom.

Functional Exercise

The exercise on the final days of the course was a fitting culmination to the course. It reinforced the two weeks of instruction that course participants received. It was an opportunity for course participants to problem solve in a team setting, critically thinking through and articulating standard operating procedures in the event of a tsunami impacting their countries. It gave persons the opportunity to re-examine their specific warning and emergency management protocols with a view of improving their existing procedures. It also highlighted best practices which could be considered or applied in other jurisdictions.

ITP participants visit the Pacific Tsunami Warning Center (PTWC). Photo courtesy of B. Yanagi.

Recommendations

1. This course should remain a feature of the global tsunami preparedness initiative. It is comprehensive in its treatment of the tsunami hazard and the end-to-end warning system which is designed to reduce the devastating impact which the hazard can have on the environment and population.
2. It is recommended that the country presentations and the practical exercise sessions be permanent fixtures on the course agenda. While the course presents an excellent overview of the components of an end-to-end system, it must be noted that the inclusion of the country presentations and the exercise sessions added tremendous value to the overall course. Participants were able to communicate their particular in-country experience giving in many instances valuable insight as it related to practical applications on the ground.
3. It is recommended that course participants be

Country Trip Reports, *continued*

utilised as country experts as each participant brought a wealth of knowledge as it related specifically to their country. This is important in terms of continuing to build a global network of professionals and resources.

4. It is recommended that ITIC examine the possibility of developing advanced training courses or providing support to countries in specific areas which this course touched on. One such area is assisting in facilitating the in-country process of developing standard operating procedures for both warning and emergency management.
5. It is recommended that respective country participants be given the opportunity to impart the knowledge gained at this course to other stakeholders within their respective countries with a view of improving their country's existing capability. In the case of BARBADOS this will be done utilising the Technical Standing Committee On Coastal Hazards Mechanism. This committee will be responsible for ensuring that detailed SOPs for the warning centres and emergency management office are developed, tested and institutionalised; as well as a comprehensive and pervasive public awareness programme developed and implemented which will encompass educating and training various segments and sectors of the population and stakeholders within the system.
6. It is further recommended that participants be requested to give an update on the advances in their end-to-end warning systems at least one year after they have attended the course.

PTWC Operations display of seismic activity in Papua New Guinea. Photo courtesy of T. Fan.

Chile

by Cdr Enrique Silva Villagra, Hydrographic and Oceanographic Service of the Chilean Navy (SHOA)

BACKGROUND

The International Tsunami Information Center (ITIC) in conjunction with the Pacific Tsunami Warning Center (PTWC) performs an annual training course for different countries, located in the Pacific Basin and Caribbean, in order to train, develop and standardize procedures and actions to mitigate the effects of tsunamis. This course was conducted between August 20 and September 1, in Honolulu, USA, and it consisted in two weeks of classroom and professional visits to PTWC and relevant tsunami agencies. The main purpose of this course was was to provides training and familiarization with the Pacific Tsunami Warning System and other regional systems, Sub-regional and National Warning Systems, and Emergency Response concepts of operations and standard operation procedures.

The participating countries were the following: China, Malaysia, American Samoa, Solomon Island, Micronesia, Barbados, Perú, Colombia, México and Chile.

The National Tsunami Warning System (SNAM) of the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) is continuously enhancing its operational procedures, so that the participation in this course will allow to propose and suggest various modifications to improve the procedures, equipment and staff that currently is operating the SNAM, in order to SHOA has an efficient, modern and updated tsunami warning center to give security to the public and country.

ATTENDANCE

Staff who participated in the commission was as follows:

1. Cmdr. Enrique Silva, Deputy Director of SHOA.
2. Lt Héctor Fierro, Head of Third Party Services Department

DEVELOPMENT

The course consisted mainly of lectures given by professors and scientific professionals such as from ITIC, PTWC and the University of Hawaii. The program was as follows:

Country Trip Reports, *continued*

Day 1: Welcome and Programme Overview

1. Welcome: Director of ITIC, Dr. Laura Kong, and staff welcomed and explained the daily activities to be undertaken during the entire course. Representatives of the 10 participating countries were introduced.
2. Presentation of the countries´ SOPs: the first country's speaker was Chile, which presented the progress of SNAM after the earthquake and tsunami of February 27, 2010, the current SOPs and the short-term plans for SNAM.
3. Earthquake and Tsunami Science-generation, propagation, impact.
4. Tsunami Risk Assessment-Methods and Role of Tsunami Deposits.

Day 2: IOC Tsunami Systems, End to End Tsunami Warning, Tsunami Modelling, and Inundation, Country Presentations

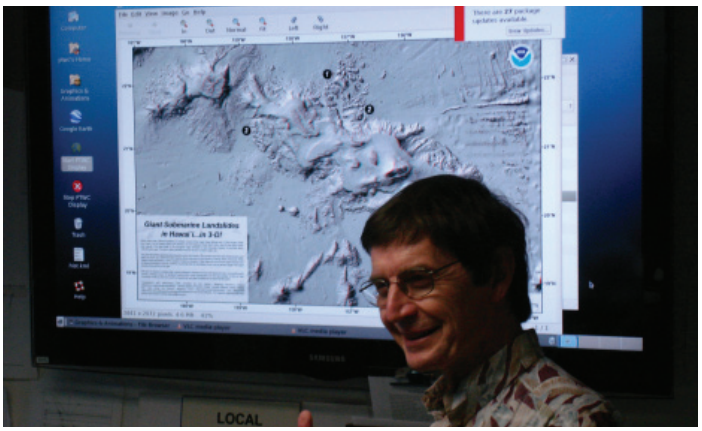
5. Tsunami Risk Assessment: Modeling and Mapping of Tsunami Inundation
6. International and National Tsunami Warning and Mitigation Systems - Requirements and Implementation Pacific Tsunami Warning and Mitigation System (PTWS) - organizations and operations
7. End-to-end Tsunami Warning – Stakeholder and their needs, Roles and Responsibilities, Standard Operating Procedures, and their linkages
8. Hawaii example: Hawaii Tsunami Warning and Mitigation System
9. Tsunami Warning Decision Support Tools – Overview: Message Alerts, Real-Time Earthquake Display (CISN); Sea level monitoring (Tide Tool, IOC Sea Level Monitoring web site); Tsunami Databases (WDC/NGDC web tools, TsuDig), Tsunami Travel Time (TTT) calculation - demonstration and/or installation: Message Alerts, Real-Time Earthquake Display (CISN) - demonstration and installation
10. Lessons Learned from Past Tsunamis - Tsunami Warning

Day 3: Lessons Learned, TWC and PTWC SOPs

11. Lessons Learned from Past Tsunamis - Tsunami Warning
12. PTWC Concept of Operation and Standard Operating Procedures (SOP) for Distant, Regional, and Local Tsunamis: Monitoring, Detection and Evaluation, Instrumentation and Methodologies (seismic, sea level, forecasts (travel time, wave height, etc), Data communications, Messages and Message Dissemination
13. TWC SOPs and Checklists: Templates and examples of SOP best practices. Homework - Review & improve country TWC SOP / Checklists (especially for local/regional threat) for input to Aug 29-30 exercise
14. New PTWC Products: Why, What (criteria, types), When, How, including forecast products
15. Visit Pacific Tsunami Warning Center and HON Seismic station

Day 4: PTWC New Products, Country Presentations, Communication technologies

16. New PTWC Products: Forecasts, TWC understanding and interpretation
17. New PTWC Products: Implementation, Rollout, Training, and PacWave13
18. Communication technologies for the transmission of tsunami warnings to local governments and communities – robustness, reliability, redundancy criteria for emergency communications – WMO GTS, EMWIN, Fax, Email, RANET, FM / HF, Mobile/Cell phones, SMS, Internet, Social Media, etc.
19. Hawaii State Emergency Agency Responses to PTWC Tsunami Products



Dr. Gerard Fryer, Senior Geophysicist at PTWC, displays a Historic Giant Hawaiian Landslides 3-Dimensional map. Photo courtesy of ITIC.

Country Trip Reports, *continued*

Dr. Paul Okubo, Senior Seismologist at the US Geological Survey - Hawaiian Volcanoes Observatory on the Island of Hawaii, displays various screens of data used to monitor volcanoes. Photo courtesy of J. Yanez.

Day 5: Tsunami Emergency Response (TER)

20. Tsunami Emergency Response, including Stakeholder Coordination and Roles of Agencies – Overview
21. Lessons Learned from Recent Tsunamis - Emergency Response, Samoa Tsunami.
22. New PTWC Products: TER understanding and interpretation
23. Conducting public coastal evacuations - "Downstream" Communications Process
24. TER SOPs and Checklists: Templates and examples of SOP best practices. Homework - Review & improve country TER SOP / Checklists (especially for local/regional threat) for input to Aug 29-30 exercise
25. How to Plan, Conduct, and Evaluate Tsunami Exercise guideline, Homework - Read Guideline in preparation for Aug 29-30 Exercise
26. Warning Dissemination and Public Alerts: Information Flow and Role of Media
27. Information Flow SOPs: Templates and examples of SOP best practices Homework - Review & improve country Info Flow/Media SOP / Checklists (especially for local/regional threat) for input to Aug 29-30 exercise

Day 6: Visit to the Big Island of Hawaii, guided tour and exhibition at the Tsunami Museum, memorials in Hilo and Laupahoehoe (Tsunami, 1946)

Day 7: Visit to the Naniloa Volcanoes Park, exposure in the volcanic monitoring center of United States Geological Survey (USGS), exposure and visit at emergency office of the island of Hawaii, return to Oahu

Day 8: Tsunami Education, Awareness, Mitigation, and Preparedness

28. Tsunami Education and Awareness - International Perspectives
29. Tsunami Mitigation - Hard & Soft Countermeasures Public Policy
30. Designing buildings for tsunami loading - FEMA P646, ASCE 7 and International Building Code updates
31. Tourism sector and TsunamiReady Program.
32. Tsunami Exercise - Overview and Format.
33. Tsunami Exercise - Preparation - SOPs, Checklists, Templates, etc.
34. Tsunami Exercise - Preparation Homework - Finish SOPs, checklists, message templates to be used in Exercise

Day 9: ITP-Hawaii 2012 Tsunami Exercise - Preparation

Day 10: ITP-Hawaii 2012 Tsunami Exercise - Evaluation

CONCLUSIONS AND RECOMMENDATIONS

Considering the above points learned in the course, a much better view about different aspects related to Tsunami Warning Centers, lessons learned, new technologies, procedures, examples of other countries, among others could be obtained. All of these will allow identifying clearly several gaps of National Tsunami Warning System (SNAM). Among the SNAM weaknesses, some could be modified without major difficulties, but others require political will, time and money to be conducted.

There is a key proposal that gives the solution to the current system corresponding to the following number one. However, it requires a suitable decision that considers equipment and trained staff that is efficient and diligent in delivering information, supported by precise and well-structured SOPs, and no doubt to users.

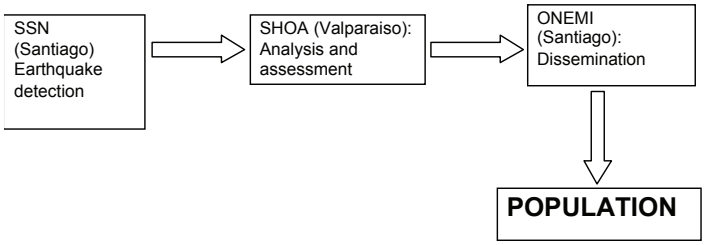
Country Trip Reports, *continued*

Actually, within the proposals that do not require great efforts to fruition, but which are fundamental for the operation of a Tsunami Warning Center, are the assessment and modification of the SOPs which must be reviewed and modified periodically. In relation to these procedures, a series of measures and changes will be proposed to implement or evaluate their implementation in the short and medium term.

Complex and simple proposals to be evaluated and implemented and according to what we have learned through this training course are:

1 . INTEGRATION OF AGENCIES

The current organizational structure related to SNAM, is divided into three institutions in the following scheme:



In relation to the above scheme, the flow of information between the organizations and population is illogical (information travels from Santiago to Valparaiso and it returns to Santiago again). Consequently, considering the current positions of the Centers Tsunami Warning, where the time between the earthquake and warning dissemination to the public should be kept to a minimum, where communications suffer serious damage and where responsibility should be centralized to avoid aberrations such as occurred on 27 February 2010, when the tsunami warning was not released to the public, it is recommended that a single institution carries out all this work, or at least, the seismological institution with the organization responsible for evaluation of the earthquake should join in two institutions.

2. MAKING DECISION SUPPORT SYSTEM

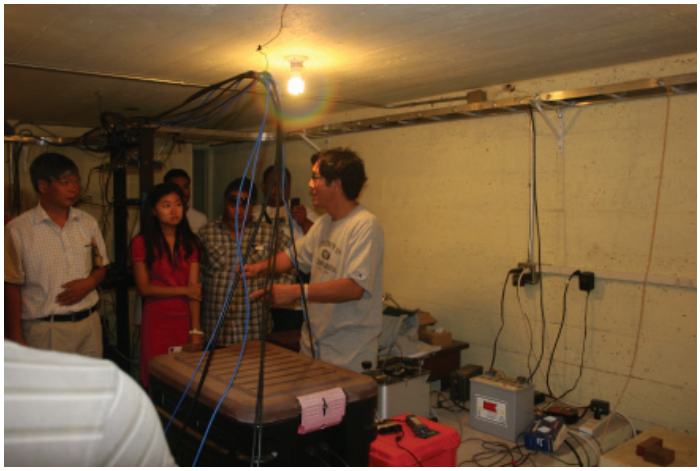
The SNAM operational system has a number of weaknesses in the making decision support system that can be improved in the short and medium term. The following are the failures and suggestions.

a. SNAM deliveries, for near-field earthquakes, tsunami watches and warnings for the whole country, but it cannot identify the areas to be affected by the tsunami and those which will not. Also, it cannot identify the areas that could be affected by destructive tsunamis (e.g. in Talcahuano February 27, 2010) or tsunamis with lower hazards. (Valparaiso March 11, 2011).

   Proposal: to report two tsunami warning levels based on wave height on the coast, using numerical tsunami forecast model that simulates the behavior of a tsunami wave after an earthquake. To repeat this procedures a thousand times in order to store thousands of pre-modeled scenarios in a database. Simultaneously, to design a computer application that allows displaying an image in seconds with different tsunami warning levels (colors) on the coast of Chile, based on earthquake parameters which should be entered into the application. (All this is currently running and must be completed in December 2012).

b. SNAM must manually enter data into an application for each earthquake to send warnings by e-mail, fax and SHOA web page. It must also manually enter earthquake location details for the Tsunami Travel Time program (TTT).

   Proposal: To develop programs that receive information from emails, or CISN display and introduce and process the data automatically, providing a proposed response (which must be approved by the Chief Service Officer). In short, all the possible systems must be automated to prevent human error and increase response actions.



Dr. Paul Okubo, USGS, describes operations in an underground seismic vault at the Hawaiian Volcanoes Observatory on the Island of Hawaii. Photo courtesy of J. Yanez.

Country Trip Reports, *continued*

3. STANDARD OPERATING PROCEDURES (SOP)

The following are a series of proposals based on lessons learned and recommendations of the ITIC and PTWC:

a. To review and modify earthquake magnitude thresholds, tsunami watches and warnings.

   1. Each country has a different reality and must make its own analysis based on historical data (such as SHOA does). There is non-destructive tsunami record from 7.0 on the Richter scale, which does not match with the actual 7.5 threshold. If a 7.4 earthquake in shallow waters occurs, it could generate a destructive tsunami. In addition, PTWC will do exactly the same thing; Peru transmits warnings for earthquake of magnitude over 7.0 and Ecuador over 7.3.

   2. To conduct a study to separate by sector (north of Puerto Montt and south, following the geological line that divides Chile in two main areas of seismic activity) and have 2 different procedures, depending on location of the epicenter.

   3. Medium intensity earthquakes are reporting. This role should be responsibility of in-country seismological services. In the case of countries that have Tsunami Warning Center in conjunction with the seismic division is justified, but not in the case of Chile. It is suggested to report the earthquakes greater than or equal to 6.0 on the Richter scale.

   4. Far-field earthquakes are reported in accordance with magnitude over 6.5 and less than 100 km depth. It is suggested to change to 7.0 or higher for all the earthquakes, regardless of the depth and only those within the Pacific Basin.

b. To check positions of the current staff covering SNAM guard and responsibilities in time of crisis (during an earthquake) and in normal times for near and far field, since it has not been specified in such manner. For example, it has been found that in seismic events in the middle of the night, SNAM takes 5 to 10 minutes to disseminate warnings after receiving the seismic data, because the Chief Service Officer should dress himself quickly and go down from the wardroom to validate the information.

   This can be avoided if the responsibility is given to the oceanographer between 1 and 8 am, who is at the SNAM and is an expert in the area.

   It is also recommended to propose times for all the activities; for example, the information should be disseminated simultaneously by VHF and within 3 minutes per fax, e-mail and website, at the moment it is received.

   It is generally suggested to review all the procedures, positions and responsibilities to rewrite the current SOPs, with all the associated documentation (such as Permanent Task Order, Internal Permanent Order, Internal Task Order OPT/OPI/ OTI). Note that the SOPs must be designed so that each event has the same quality in the result, no matter who is on duty or who serves in particular.

Pacific Tsunami Museum Visitation in Hilo. Photo courtesy of J. Yanez.

4. INSTRUCTIONS AND TRANSFER OF INFORMATION TO THE NATIONAL EMERGENCY OFFICE OF THE MINISTRY OF INTERIOR (ONEMI from its abbreviation of Spanish).

In the course various topics related to the emergency were covered, which could be useful for ONEMI and SHOA. Some of these are as follows:

a. To widen the tsunami warnings, including television and radio which will receive and broadcast automatically on all channels available. A radio frequency destined only for

Country Trip Reports, *continued*

emergencies can also be assigned. It could allow hearing reports on the emergency regulations.

b. To consider the use of sirens with voice message machine on all the coastal communities, for tsunami warnings.

c. To include tsunami inundation charts in telephone directories for locations that have such a tool.

d. To consider police roadblock for flood areas in case of tsunami warning.

e. Exercise in schools, as these institutions are available to receive any instruction or extracurricular activity that is helpful.

f. To implement a month called "a tsunami month", for mass dissemination of tsunami information to the population. Exhibitions, books, pamphlets, or any printed information must be considered. An example, it may be February, in commemoration of 27F.

5. CONTINUATION OF COURSE

It is recommended to continue participating in this course, because its high international level and due to it allows evaluating SNAM performance, identifying weaknesses and strengths, updating knowledge and obtaining experience of various warning centers. Within two vacancies that can be used by Chile, it is suggested that attendance at such course be assigned to at least one of the members of SNAM, either technical or managerial person.

Stories of amazing tsunami rescues on display at the Pacific Tsunami Museum in Hilo. Photo courtesy of M. Arcila Rivera.

China

by Tingting Fan, National Marine Environmental Forecasting Center (NMEFC) of SOA

In order to assist countries in strengthening their warning systems on the development of tsunami warning and emergency response standard operating procedures (SOPs), the International Tsunami Information Center (ITIC) training workshop from 20 to 31 August 2012 was held in Hawaii, USA. Ten Member States with sixteen delegates of Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS) attended this workshop. Delegates for China were Dr. Qinzheng Liu from National Marine Hazard Mitigation Service (NMHMS) and Ms. Tingting Fan from National Marine Environmental Forecasting Center (NMEFC) for State Oceanic Administration (SOA).

The training workshop was mainly conducted into three parts: tsunami warning, tsunami emergency response and local tsunami exercise. Most of the courses were given by lecturers from ITIC, Pacific Tsunami Warning Center (PTWC), National Weather Service for Pacific Region (NWS/NOAA) and University of Hawaii. A twenty-minute country presentation covering the status of tsunami warning and mitigation from respective participant was required by the organizers.

The training programme focused on tsunami warning studies for the first four days, from fundamental knowledge such as earthquake and tsunami sciences, tsunami hazard and methods of risk assessments, modeling and mapping of tsunami inundation to responsibility introduction on different levels of tsunami warning systems. For tsunami warning systems, firstly an overview of international and national tsunami warning and mitigation systems and SOPs of tsunami warning system on behalf of stakeholders were given. Secondly, tsunami warning decision support tools and lessons learned from historical tsunamis were learnt. Also, Hawaii was taken as an example in understanding an end-to-end tsunami warning and mitigation system. Finally, the programme highlighted on the study of a regional tsunami warning center PTWC's operation concepts, SOPs and its new international tsunami forecasting products which will be used experimentally in 2013. During this part, participants visited to PTWC and Hawaii State Civil Defense Emergency Operations Center, and how the State Emergency Agency response to PTWC tsunami products was included in the visiting presentations.

Country Trip Reports, *continued*

The second study session on Tsunami Emergency Response (TER) lasted for two days. Courses covered tsunami emergency response operation concept, lessons learnt from past tsunamis, TER interpretation and understanding on new PTWC products, TER SOPs and evacuation conduct, etc.

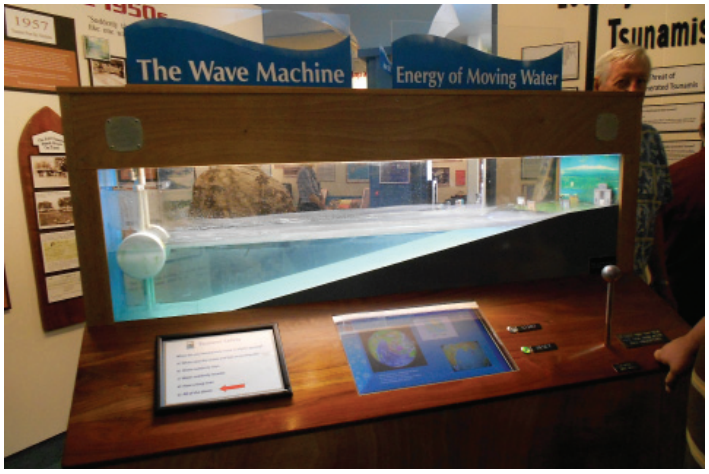
A two-day off-island field trip to Hilo (Big Island), Hawaii was arranged by the organizers to visit the Pacific Tsunami Museum, Hawaii County Civil Defense, US Geological Survey Hawaiian Volcano Observatory and Hawaiian Volcano National Park.

Tsunami education to the public and the response of tourism and communities to tsunami preparedness were taught after came back from Hilo, as well as the benchmarks on building designing for tsunami loading.

After finishing all the courses on tsunami warning and emergency response, how to prepare, conduct and evaluate a tsunami exercise were introduced by the lecturers to prepare the tabletop local tsunami exercise. The organizers divided the trainees into three groups according to their countries geographical positions: South America Team, Pacific Island Team and Asia Team. The tsunami drill was processed by the time sequences information received from strong ground shaking, earthquake CISN information, PTWC bulletins, sea level monitoring data and media calls etc. Group participants were asked to join role-playing as tsunami warning centers or emergency response agencies in the exercise and share their countries SOPs using the checklists templates and guidelines provided during the training. This active interaction improved the understanding of participants on tsunami warning and mitigation system to a large extent.

On the last training day, all the participants concluded what they learned in the workshop, and how the knowledge would be used and improve in their own countries SOPs. Teachers from ITIC awarded the certificate to every student and announced the closing ceremony.

Consequently, I am very thankful that ITIC could provide such an informative and logical tsunami training workshop. China currently is now developing technics like automatic tsunami information production and dissemination platform and planning to build 40 seismic stations monitoring deep ocean earthquake around North West Pacific region and South China Sea that will shrank the tsunami issuing time to several minutes. We also have a South China Sea quantitative tsunami forecasting system and a serious of tsunami models developed by ourselves to calculate tsunami in short time before getting PTWC results for individual country (China). However, from the communication with different country representatives and lecturers, I enhanced the awareness that the construction of a tsunami warning system is not only depending on the technical developments. Hereby I have some thoughts from different angles.



A wave tank demonstrates how a tsunami is generated at the Pacific Tsunami Museum in Hilo. Photo courtesy of T. San.

For our government, firstly, risk assessments and hazard evacuation maps need to be produced for the China coastal areas that vulnerable to marine hazards, in order to provide an efficient path for the local governments to rescue and conduct evacuation. Frankly speaking, the tsunami risk assessment for China coastlines is limited. Next, due to the marine hazard information issuing by the National Marine Forecasting Center can not disseminate cross level to corresponding government or forecast agency, it is a waste of time when emergency event is occurred, such as local tsunami, for local government to take action. Hence, an effort direction is tsunami warning and mitigation staff that can have the authority or legal effect to communicate with superior leaders or local governments to issue warning, or even make decision. Further, it is important to unify the emergency response procedures for local governments and stakeholders,

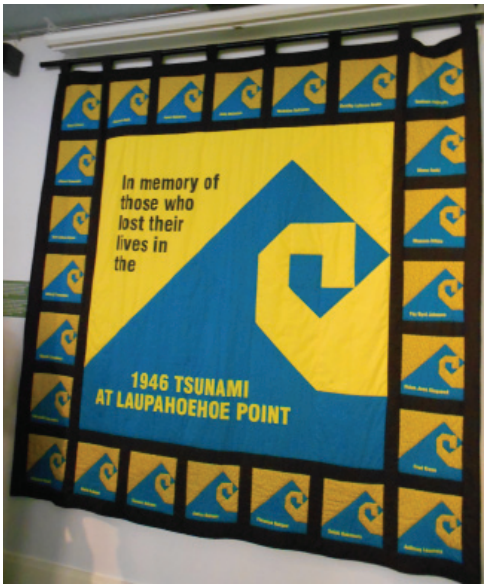
Country Trip Reports, *continued*

for instance, police station, fire protection department, and interpretation of tsunami warning and mitigation products, so legal reports for mitigation departments to take action are also need. Last but not the least, we need to propose tsunami warning SOP for local tsunami. The reason is China has not affected by the local destructive tsunami yet, so the current SOP is suitable for distant tsunami, but no one knows when local tsunami will happen.

For communities and the public, there are many good examples deserving to learn, like tsunami protection wall, evacuation sign, siren, etc, especially tsunami education to the public for a better coordination for governments.

For media, it is efficient to use media to spread information for warning department, take Japan NHK as a case, host need basic determination ability to appease and guide the public. But during warning time in tsunami warning center, staff that make media response and deal with operational warning should be separated.

From this training workshop, to my point of view, one ability build up for China's tsunami warning system might be to learn and share more experienced information with countries that encountered by tsunami threat.



Memorial quilt displayed at the Pacific Tsunami Museum in Hilo of the April 1, 1946 tsunami that devastated an elementary school at Laupahoehoe Point on the Island of Hawaii. The names of students and teachers line the perimeter of the quilt. Photo courtesy of T. San.

Columbia

by María Mónica Arcila, Colombian Geological Survey

1. PURPOSE OF COMMISSION

Objective

Represent the Colombian Geologist Survey (SGC) during the Training Programme Hawaii (ITP- Hawaii) related to tsunami early warning and mitigation systems, under the direction of the International Tsunami Information Center (ITIC).

Place

Honolulu, Hawaii, USA

Date

20–31 August 2012

Participant countries

Central America (Mexico), South America (Chile, Colombia, Peru), Southwest Pacific (American Samoa, Micronesia, Solomon Islands), Southeast Asia (China, Malaysia), and the Caribbean (Barbados).

2. MAIN ACTIVITIES AND OUTCOMES

- There was held a presentation on the status of tsunami warning and mitigation activities in Colombia. Presentation showed the context of Colombia in terms of population, social conditions and disaster risk; provided brief information on disaster risk management in the country and the activities of the Colombian Geological Survey; presented an outline of earthquakes hazards in the country; and finally showed the main elements related to tsunami, their study and progress in Colombia. Moreover, it was an identification about others country's tsunami mitigation efforts.
- The programme provided an overview of the history and operation of the Pacific Tsunami Warning and Mitigation System.
- Information was given about the role of different local, regional, and national level tsunami warning centers in monitoring and evaluating the tsunamigenic potential of earthquakes, and in issuing timely tsunami warning messages to government emergency entities to save lives, reduce records of losses and damages, and improve disaster risk management to

Country Trip Reports, *continued*

Madam Pele, Goddess of Fire Mural Display at the Jagger Museum - Hawaiian Volcanoes National Park, Island of Hawaii. Photo courtesy of T. San.

coastal areas. To Colombia, this is particularly important due to the high hazard, vulnerability and risk to seismic and tsunami phenomena in the Pacific region.

- The course provided training with the Pacific Tsunami Warning System. Also, there was information about emergency response concepts and standard operation procedures. There was given useful examples of an end-to-end tsunami warning and mitigation system to demonstrate coordination and partnership for operational warnings and in preparedness actions.
- During the training programme participants learned about Standard Operating Procedures (SOP) for tsunami warning and tsunami emergency response, focus on preparing for local and regional tsunamis.
- Specific attention was given to the new international tsunami forecast products to be introduced experimentally by the PTWC in 2013.
- Participants attended a tsunami exercise role-playing as tsunami warning centers or emergency response agencies responding to a local or regional tsunami.
- Participants visites Emergency Operations Centers, station field sites to seismic or water level, and the University of Hawaii. Moreover, there was a trip to visit the Hawaii County Civil Defense Agency, the Pacific Tsunami Museum (Hilo, Hawaii - Big Island), tsunami memorials, and the USGS Hawaiian Volcano Observatory.

3. LESSONS LEARNED AND APPLYING KNOWLEDGE

The main outcome after the Training Programme Hawaii (ITP-Hawaii) include that technical capacities and institutional organization for tsunami early warning and mitigation systems in Colombia would be improved.

The Colombian Geological Survey established the National Seismological Network in order to maintain a permanent watch on seismic activity in the country (36 remote stations strategically located in the mainland and 2 island areas), to provide relevant information to detect earthquakes that could generate tsunamis. Also, DIMAR has a tide gauge network in the Pacific Region, and has installed radar and pressure gauges in the bay of Tumaco, Buenaventura Bay and Malpelo Island, and soon in Gorgona Island.

In this context, the information and materials provided during the course could be useful to generate inundation maps trying to achieve a more complete characterization of the Pacific coast in Colombia. So, all the material was shared with agencies responsible for studying and monitoring of geological hazards including tsunami and seismic hazards; and the government's emergency response, through virtual media (e mail, DVD and Drop Box).

In case of a possible near source tsunami event in Colombia, the Geological Survey reports the details of the quake such as magnitude, duration and location, and DIMAR makes mathematical modeling to estimate the time of arrival of the wave and its altitude.

The Geological Survey reports to the Risk Management Division and Dimar, according to the characteristics of the event, suggests the Risk Management Division to issue the alert or alarm to the Regional Committees and Local Prevention and Response Disaster to prepare the population for evacuation. In this case, tsunami exercises role-playing attending during the ITP Programme could be interesting to give recommendation to the tsunami warning center and emergency response agencies in the country.

Currently, Colombia is reviewing the National Plan for Tsunami Risk Management through with the

Country Trip Reports, *continued*

participation of the National Technical Committee of the National System for Disaster Risk Management (SNGRD). So, the tsunami awareness materials, evaluation of tsunamigenic potential of earthquakes, tsunami warning messages, emergency response concepts and standard operation procedures, and lessons from past tsunamis learned during the ITP are important to improve the quality of the National Plan for Tsunami Risk Management. Recommendation provided by the Colombian Geological Survey to this Plan, takes into account the knowledge in the tsunami area learned in the ITP Programme.

Finally, the National Unit for Disaster Risk Management (UNGRD), agency in charge of directing and coordinating the National System for Disaster Risk Management (SNGRD) is providing technical assistance to municipalities (local level) to validate and adjust the Plan for Tsunami Risk Management with the technical support and the participation of the Colombian Geological Survey. This process has the aim of promoting a better understanding of tsunami and improve the implementation of disaster prevention, risk reduction, and disaster relief strategies in local development processes.

Currently, the UNGRD and the Geological Survey are conducting training workshops in different areas of the Pacific Coast (first workshops were conducted in Salahonda, in Tumaco, Nariño on October 01 – 03 and Mosquera, Nariño on October 04 – 06). All knowledge learned during the ITIC Training Programme has been incorporated.

Hilo Tsunami Memorial dedicated to the lives lost in the Japanese town of Shinmachi from both the 1946 Alaska and 1960 Chile tsunamis. Photo courtesy of T. San.

Federated States of Micronesia (FSM), Chuuk State

by Sanchez Salle, Weather Service Office Chuuk

The trip started on the 17th of the month of August and ended on the 4th of the month of September 2012. The purpose of the trip was to attend this training on ITIC Tsunami Programme (ITP Hawaii) in Honolulu Hawaii. Part of the training was also to visit the Hawaii State Civil Defense and Pacific Tsunami Warning Center in Honolulu and Pacific Tsunami Museum, Hawaii County Civil Defense and USGS Hawaiian Volcano Observatory, Tsunami Memorials and National Volcano Parks in Hilo Hawaii. The actual time of the training was from the 20th – 31st of the month of August.

In general, the training was new to me and in fact was one of the best trainings I ever had. The presentations on the topics of tsunami and the related topics and mitigations of the whole nature of the course were distributed to our reach and well-consumed among the participants. Due to the good presenters of each and every one of the topics of the entirety of the course, our expectation to learn something is well-achieved.

The first week (August 20th – 24th) of the course covered some topics on Earthquake and tsunami science and tsunami hazard and risk, tsunami system, modeling and warnings and tsunami emergency response and communications. Our group also visited the Hawaii State Civil Defense where a presentation was also given to us on how they operate during an emergency event. The second week (August 27th – 31st) of the course was a very interesting trip to Hilo Hawaii where we also visited the Pacific Tsunami Museum, Hawaii County Civil Defense, USGS Hawaiian Volcano Observatory, National Volcano Parks and Tsunami memorials. Some of these places we visited, a presentation from each place was also given to us on how they operate and/or how each was built to serve each purpose. Toward the end of the second week, our group did some tabletop on tsunami and lastly we did the course evaluation, for me it was very good.

This course was carried out accordingly because of their well organized and good presenters for each topic. I hope this course could be converted to a one day workshop with two or three of the good presenters and could educate the entire population of our nation, FSM.

Country Trip Reports, *continued*

Mexico

by Jesús Alberto Guerrero Bernal, Centro de Alerta de Tsunamis, Secretaría de Marina - Armada De México

Background

During the past four years, four destructive and deadly tsunamis have occurred worldwide, with different levels of warning for those countries with tsunami warning systems including five countries were affected by this phenomenon, since the coastal population is the most vulnerable to these phenomena, because they only have a few minutes before the arrival of the first great wave. Historically, about 90% of victims worldwide (99% in the Pacific) have been the result of local tsunamis. The main lesson learned from recent events is that preparation is essential and extremely critical, focused on areas with higher threat of tsunamis.

To save lives, we should develop response plans to events of this nature, in addition to training and educating people to be affected. Before the event, we should also perform continuous preparation, since as such, there a season of tsunamis and can happen at any time.

At the Twenty-Fourth Session of the Intergovernmental Coordination Group for the Tsunami Warning System in the Pacific (ICG / PTWS) held in Beijing, China in 2011, the task force members from different PTWS countries approved the use of new enchanced products of the Pacific Tsunami Warning Center (PTWC).

Training Program ITIC

This time, the program was covered in a time of 10 days, during which subjects were different, having given lectures by staff belonging to the ITIC, PTWC and the University of Hawaii and have made visits to different emergency management centers in Honolulu, including a field trip to the City of Hilo, Big Island, Hawaii.

Attended by 16 participants from the Asia, the Caribbean and the Pacific, all belonging to the systems responsible for Civil Protection and Emergency Management, Tsunami Warning System in the Pacific and Climate Services in their respective countries.

In the case of Mexico, attended by staff from the Directorate General of Civil Protection (DGPC), under the Ministry of Interior (SEGOB) and Tsunami Warning Centre (CAT), the Navy Secretariat (SEMAR), the two secretariats, members of the National Tsunami Warning for Mexico (SINAT), as representatives of the National Focal Point and Contact.

The topics of the conferences, given just to name a few, were the basic principles of generating earthquakes and tsunamigenic earthquakes, propagation and effects global risks of tsunamis in the Pacific tsunami risk assessment, including flood modeling and mapping by tsunamis tsunami lessons learned from the past, new products PTWC forecast for your understanding and comprehension, development of standard operating procedures (PSO's), checklists, etc.. In the book describes the activities of the course, as well as items that were in the two weeks.

During visits in Honolulu, the PTWC is located in Ewa Beach, where we were shown the facilities and equipment available to this center, also met staff who integrates their different functions, procedures in case of an earthquake in the Pacific as well as the response to the event and communications made to issue a tsunami warning. Also, visited the Emergency Operations Center of the Hawaii State Civil Defense located on the slopes of Diamond Head. This dependence was received conference how the state is organized to address an emergency, depending on the nature of this (tsunami, earthquake, volcanic eruption, hurricane, terrorist attack, etc..) And a tour observing facilities for teams that have to carry out the tasks assigned to them.

The trip to the city of Hilo, Big Island, Hawaii, included visits to the Pacific Tsunami Museum, the Emergency Operations Center of the Hawaii County Civil Defense, the Tsunami Memorial Monument, Hawaii Volcano Observatory USGS and Jagger Museum in Hawaii National Volcano park and other sites of this park.

We obtained different publications (books, pamphlets, posters, DVD's) concerning earthquakes, tsunamis, videos with description of a tsunami and its consequences, information about actions to take during an earthquake and the resulting tsunami, new bulletins of arousal and prognosis to be issued by the PTWC, which will be tested for analysis during exercise "Pacific Wave 2013".

Country Trip Reports, *continued*

I learned from the course the following:

PTWC is the main center for tsunami warning for the Pacific Ocean and has support from the Japan Meteorological Agency.

- The PTWC advice is appropriate for countries based in issuing the tsunami alert. Yet each, a country must use the technologies available to it.
- Each country is responsible for the issuance of the alert and emergency agency responsible for the evacuation of areas at high risk of tsunami.
- Maps and flood modeling for densely populated areas in Hawaii are current and in operation.
- The procedures of Hawaii emergency agencies, designated the responsibilities of each member institution of emergency management.

The actions proposed to SINAT to improve and streamline the operation of SINAT, are as follows:

- What are appropriate SOPs to implement for tsunami warnings, checklists of actions to take to issue a tsunami warning, the flowcharts for tsunami warning and planning template for drills tsunami.
- To develop a mechanism to assess the response during a major disaster, in order to discover the efficiencies and weaknesses that need to be strengthened when presented with a real fact, based on the “Guidelines to plan, conduct and evaluate Tsunami exercises (UNESCO 2011).
- To liaise with members of SINAT, processing of travel time maps of tsunami waves, tsunami inundation maps for coastal populations more prone to the effects of these phenomena and make an awareness and training constant of the coastal population, development of evacuation routes in case of tsunami and within these buildings mark where you can protect (vertical evacuation).
- That collaborate in shaping Mexican coastal flooding with SINAT members.
- To coordinate with the corresponding instance for providers of mobile phone services in the country, providing support for issuing tsunami warnings via SMS messages.

Hilo Tsunami Evacuation Map displayed on sliding boards at the Hawaii County Civil Defense Emergency Operations Center. Photo courtesy of J. Yanez.

Mexico

by Jorge Yáñez López, Civil Protection General Direction, Department of Interior

Activities

During the two weeks of the training the participant countries presented an overview of the local systems of tsunami warning centers and emergency management agencies. The resources of the different countries are not the same, but it is clear that everyone is doing a great effort within their possibilities to develop reliable early warning systems. The countries in the training were: Barbados, Chile, Colombia, México, Perú, China, Malaysia, Solomon Islands, Confederate States of Micronesia and the territory of American Samoa.

We visited some agencies and places, in all of them we receive a briefing about their activities and we could ask questions and exchange information. These agencies were related to scientific and technical actions.

The main topics of the program were the following:

1. Scientific aspects of earthquakes and tsunamis;
2. Tsunami hazards global and in the Pacific basin;
3. Assessment of tsunami risk;
4. Models and maps of tsunami inundations;
5. Operations and organization of tsunami warning centers;
6. Tsunami warning communications;

Country Trip Reports, *continued*

7. Tsunami warning decision support tools;
8. Standard operating procedures of the Pacific Tsunami Warning Center and the main characteristics of the new products;
9. Tsunamy emergency response;
10. Overview of the process of design, plan, conduct and evaluate tsunami exercises;
11. Warning dissemination and public alerts;
12. Engineering considerations for construction codes;
13. Tourism sector;
14. Tabletop Exercise.

Galen Yoshimoto of Hawaii State Civil Defense explains how the Emergency Operations Center displays hazard information to enable public safety decision making. Photo courtesy of T. San.

Lessons Learned

a. The best way to improve early warning and mitigation systems is to reinforce the sinergy between science, technology and operations. It is very important for people in the Emergency Management Agency to have some scientific and technological background so they can understand the principles of the event they are facing.

b. From the unexpected magnitude of the Tohoku Earthquake, one research topic is that the theory of "gaps" in faults, that is, the idea that it is more likelihood to expect a big earthquake in an area where no earthquakes had happened in recent years has to be reviewed. In the case of Mexico this is very important because many response plans are based in the hypothesis that the "Big One" will occur at the Guerrero Gap, a zone that have been in silence for more than one hundred years. However, we shouldn't forget the other fault zones off shore from Michoacán to Chiapas and also in the northern state of Baja California.

c. The earthquakes that have a slow movement can cause tsunamis and tsunami warning centers should check the data of the Theta phase in order to do a better forecast. It seems this was the case of the El Salvador earthquake on Sunday, August 26, 2012.

d. The effects of a tsunami are of many categories. The most important is the impact of big waves in the coastline that can cause injuries, deaths and damage to property from the force of the water, and the flood that is caused. But also in the case of some non-destructive tsunamis, classified like this because don't generate big waves. However, the maritime currents created in harbors or bays can cause damages to boats, ships and people if they are in the sea.

e. The most part of the operations when a tsunami ocurrs should have been done before, with education and information in all the areas that can be affected. We have to be sure that people understand the messages that are issued and they have means to receive them. It is necessary to adapt the media we are going to use to the actual conditions of villages, towns and cities, because some systems like sirens, are very expensive and are not available for everyone.

f. The actions and scope of responsibilities of the local tsunami warning center and the emergency management agency must be absolutely clear, as well as the actions that local civil protection organizations have to do. The tsunami warning center should issue an alert when the country or some zone are at risk, the emergency management agency should transmit that alert to people and other government agencies at the federal, state and local level, send advices to people and also coordinate the response operations. But the local emergency management organizations are the only agencies that can issue the ALL CLEAR messages.

Country Trip Reports, *continued*

g. It has to be at least four kind of messages for all the event: first the alert; second recommendations to people about they have to do; third the warning cancellation and finally the ALL CLEAR message. In a particular situation many messages of each kind could be issued, but once and alert is issued people should wait to the ALL CLEAR message to return safety. No one should confuse a warning cancellation message with an ALL CLEAR message.

h. It seems that China and Malaysia have enough resources and interest to establish and improve their tsunami warning centers, in Latin America, Colombia seems to be a little behind the other continental countries. Chile of course has a very good system, however the April 2010 earthquake and tsunami show many areas they have to improve. Barbados with very little resources is working hard in the right direction. A common problem of Solomon Islands, Micronesia and American Samoa are the difficulties to ensure that everybody receive the warning because they are states composed of many islands and it is very difficult to create a communications infraestructure to service all of them. However, the experiencie of American Samoa in the 2009 earthquake and tsunami showed that education and exercises are the best way to prepare communities in situations like those.

i. The universal advise in case of a strong earthquake for people who are at the coastline: RUN INLAND AND TO HIGHER GROUND. People should use vertical evacuation if they do not have time to do the former in strong buildings and at least 15 meters from sea level.

j. It happens that during the two weeks of the programme PTWC issued two warnings. The first one include Mexico for the El Salvador earthquake on Sunday, August 26 and I communicate to my country the information that Dr. Laura Kong gave me in the moment. After about two hours the warning was cancelled and I have the chance to evaluate the response of the Emergency Management Agency. The second warning was issued for the Phillipines earthquake on Friday, August 31 and included Hawaii, that very day the Director and Deputy Director of PTWC gave us a briefing about what they do in that particular event.

Multiple redundant telephone communications established within the Hawaii State Civil Defense Emergency Operations Center. Photo courtesy of J. Yanez.

Standard Operating Procedures Improvements

This is a check list to improve standard operating procedures:

1. It is mandatory to have them written.
2. All the stakeholders should know the products that the Emergency Management Agency issues in case of a tsunami. These are: distribute bulletin warning of the local tsunami warning center; advices for people to do in the form of e-mail, text message, phone calls, press release, fax message or any other way of communication; register damage assessment and coordinate response operations at the federal level;
3. All the staff of the Emergency Management Agency in the communications and operations centers must know the activities they have to do in order to receive, send, write and register the former products in the established timeline and with no mistakes;
4. Write the timeline expected in the standard operating procedures, because a late action could be useless;
5. Verify that staff of the communications and operations areas can speak in english, in case they received a phone call from the PTWC;
6. Design and annual plan for exercises: tabletop, drill and functional, for the Emergency Management Agency staff;

Country Trip Reports, *continued*

Peru

by Sub-Lieutenant Ceci Rodriguez Cruz, Directorate of Hydrography and Navigation of Peru (DHN)

I want to inform that I participated in the ITIC Training program 2012, which was held in the city of Honolulu - Hawaii, from 20 to 31 August this year.

a. The Program of the International Tsunami Information Centre (ITIC) was started at 0830 hours on Monday, August 20, 2012, with a welcome ceremony by Dr. Laura Kong, Mr. Brian Yanagi and Mr. Nicolas Arcos, after they gave us material for the program development we continued with three exhibitions of different countries about our own tsunami warning center. Also, in the afternoon we talked about earthquakes and tsunami generation, propagation and impact.

b. On Tuesday, August 21st, we talked about the development of a communication protocol of Hawaii as an example to explain the tsunami warning system and spoke about numerical models and flood maps. Also, we continued with presentations by three more countries.

c. On Wednesday, August 22nd, were talked about lessons learned from past tsunamigenic events, PTWC also shared their current business processes and products of monitoring, models and their respective interpretation of RIFT numerical model. Furthermore, we then visited the PTWC where we could see the equipment, software, numerical models and facilities the Centre has.

d. On Thursday, August 23, we continued with country presentations. Also, we talked about decision tools as the CISN, Tide Tool, SL Monitoring Facility. Also addressed issues of risk management and communication technologies for tsunami warning transmission. In the afternoon, we visited the Emergency Operations Centre of Civil Defense where noted different facilities and equipment at their disposal.

e. On Friday, August 24, we continued with the country exhibition. Subsequently, we discussed the response of a Tsunami Warning Center from beginning to end. They talk about the communication processes of national and internal operating procedures that each country should have. We saw the SOP of Japan and the United States.

f. On Monday, August 27, we attended the Hilo, Hawaii Island, visited the Emergency Operations Center of Hawaii County Civil Defense, attended the Pacific Tsunami Museum, with memories of tsunamigenic events in the area.

g. On Tuesday, August 28, we attended the Hawaii Volcano Observatory, where we saw the volcano monitoring and seismic monitoring of the area.

h. On Wednesday August 29, we talked about issues related to the information that must be provided in an operational protocol, the role played by the media during a tsunami event. We also saw the issue of mitigation, public education, publicity and continued to treat the subject of tools that support the decision of a Tsunami Warning Center.

i. On Thursday, August 30, we talked about the design of buildings to withstand the impact of a tsunami, the vertical and horizontal evacuation as required by the affected coastal area. Also formed working groups in which I participated with the country of Mexico, Colombia and Chile where we shared information about the communication protocol and checklists in each country.

j. On Friday, September 1st we continued the group exercise where we evaluate the most appropriate way to react to an earthquake with tsunami source both far and near, we made a final discussion and a graduation ceremony program.

Recommendations to the Peruvian Tsunami Warning Center

- Encourage research paleotsunamis (in coordination with the INGEMMET), in order to have historical data tsunamigenic events in our coast.
- When there's a navigation we should use different routes to complement bathymetric data of the Peruvian coast, and it has to be with better resolution.
- Support the development of numerical models for the implementation of the database of precomputed tsunamigenic events, in order to supplement the decision tools.

Country Trip Reports, *continued*

- Also, each hydrographic brigade of sea and land must make information sessions in different schools, emphasizing the earthquake as a natural alarm. It must end with an exercise and a tsunami survey.
- Extend the DIPECHO project or encourage the start a similar education program in coordination with the countries of the region.
- The responsible officers, the operator and the staff of the Tsunami Warning Center should have instant communication by text message in a real situation.
- Have computers with greater capacity in order to have the results of numerical models in less time.
- Implement more equipment and personnel in the Alternate Tsunami Center.
- To provide facilities for the English language skills to all staff on duty in the National Tsunami Warning.
- In the cancellation message, we should write a recommendation to specify caution to low areas during the next 24 hours.
- Propose to INDECI disseminating evacuation routes by different means such as through telephone directories.
- For the next ITIC program, propose the presence of a representative of INDECI.
- Require sending each POV of each institution involved in the National Tsunami Warning, to verify its existence and application.
- Add to the flood charts a positive margin maximum flood line as a precaution.
- Establish a checklist guard relay communications equipment available in order to verify its operation, which must be tested at the beginning of each guard relay.
- Have a roll-call emergency operators signed weekly by each operator in order to update the role in advance.
- Change the position of the antennas and wiring of building B, which is the area of temporary refuge staff, in order to avoid accidents.
- Include in PO-SNAT the participation of observers and hydrographic checkpoint Harbormaster by calls or other form of communication in order to have an on-site report of an earthquake with tsunami.
- Recommend to the education component has a natural disaster subject in all primary schools.
- Tell IGP share information with PTWC gauges in order to have greater seismic data.
- Have gauges with GOES antenna in order to have more data and share it with PTWC.

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 35 Member States with Tsunami National Contacts and Tsunami Warning Focal Points 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, Niue, Panama, Papua New Guinea, Peru, Republic of the Philippines, Republic of Korea, Russian Federation, Samoa, Singapore, Solomons, Thailand, Tonga, Tuvalu, U.S.A., Vanuatu and Vietnam.

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