January-March 2007 VOLUME XXXIX, NUMBER 1

Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System

TSUNAMI NEWSLETTER

International Tsunami Information Centre

TABLE OF CONTENTS

Japan Tsunami Emergency Management Study Tour Case Study: Wakayama Prefecture

By Brian Yanagi, Disaster Management Specialist, ITIC, brian.yanagi@noaa.gov

Japan has a long and well documented history of earthquakes and local tsunamis. Japan has reacted to this domestic hazard by developing a comprehensive and mature "end to end" Tsunami Early Warning and Mitigation System (TEWS). In the context of the Japan TEWS, Japan disaster management agencies have created Tsunami Emergency Response Plans (TERP) and Standard Operating Procedures (SOP's), which are well written and routinely tested. Currently, there is limited international sharing of tsunami emergency management practices. Most TERP and SOP's are domestically developed within each country.

Lighted tsunami evacuation route specially constructed to lead above and away from the ocean, up a hill in Kushimoto City in Wakayama Prefecture.

In late March, Brian Yanagi took part in a Japan Tsunami Emergency Management Study Tour to investigate "best practices" for local tsunami early warning response. The Japan Study Tour was organized by the Asian Disaster Reduction Center (ADRC) and the Japan Meteorological Agency (JMA). Visits were made to JMA offices, the Cabinet Office (National Disaster Management Agency), Fire and Disaster Management Agency in Tokyo, and Disaster Management Offices in Wakayama Prefecture and Kushimoto City, south of Osaka. Visits were also made to NHK public television studios, and the Ministry of Land, Infrastructure, and Transportation Office in Tokyo.

Example of Japan water gate that reflects tsunami waves and storm surge from traveling further inland causing more destruction.

Japan Meteorological Agency

JMA is currently able to deliver a domestic, local earthquake and tsunami message within two to three minutes after an earthquake. JMA

(*continued page 18*)

SUMMARY OF EARTHQUAKES

JANUARY- MARCH 2007

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

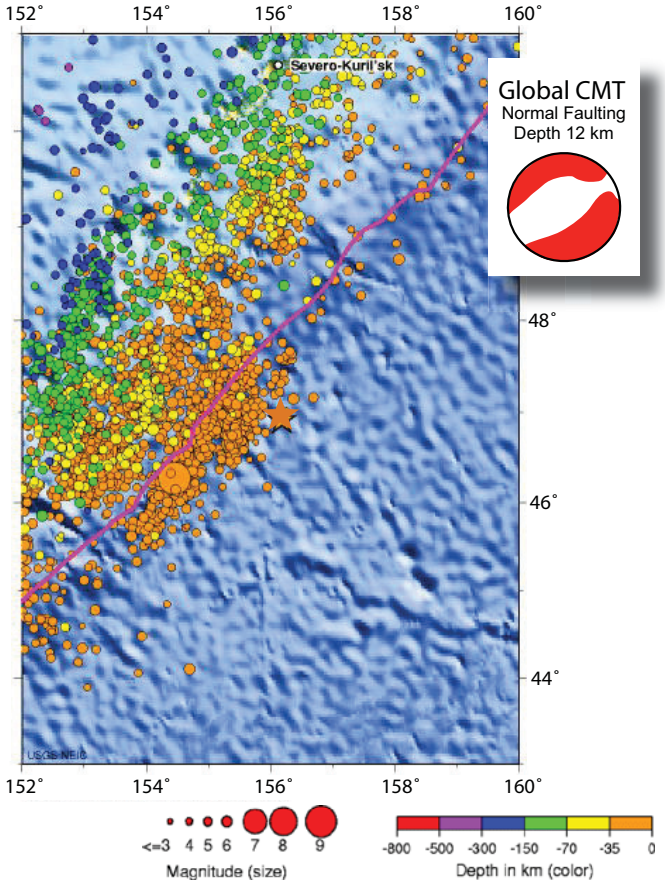
DATE	TIME (UTC)	LOCATION	EPICENTER	DEPTH (km)	M_w	PTWC (P) or JMA (J) ACTION	ACTION TIME	TSUNAMI? DAMAGING?	MAXIMUM HEIGHT AND PLACE
13 Jan	04:23	East of the Kuril Islands	46.243° N 154.524° E	12	8.4 (P 001) 8.3 (J 01-2) 8.2 (J 03, P 002-6) 8.1 (H) 7.9 (G)	RWW 001 RWW 002-Supplement RWW 003-Supplement 004 Cancellation 005 Cancellation 006 Cancellation (J) TWI 01 (J) TWI 02 (J) TWI 03	04:34 05:41 06:44 07:23 10:11 13:02 04:36 07:15 07:48	YES YES	37.1 cm Crescent City
21 Jan	11:27	Northern Molucca Sea	1.065° N 126.282° E	22	7.6 (P 002) 7.5 (H) 7.3 (G) 7.2 (J, P 001)	TIB 001 TIB 002 (revised magnitude) (J) TWI	11:44 12:16 11:48	YES No	34 cm Jailolo, Indonesia
30 Jan	04:55	West of Macquarie Island	54.740° S 146.298° E	14	6.8 (G, H, P)	TIB	05:08	No	
30 Jan	21:38	Mariana Islands Region	20.985° N 144.696° E	22	6.9 (J, P) 6.6 (H) 6.5 (G)	(P) TIB (J) TWI	21:50 21:56	No	
31 Jan	03:16	Kermadec Islands New Zealand	29.776° S 178.002° W	55	6.6 (P) 6.5 (H) 6.4 (G)	TIB	03:33	No	
4 Feb	20:57	Cuba Region	19.372° N 78.518° W	16	6.4 (P) 6.2 (G, H)	TIB	21:08	No	
20 Feb	08:04	Southern Molucca Sea	1.034° S 126.977° E	12	6.8 (P) 6.7 (H) 6.5 (G)	TIB	08:19	No	
25 March	00:40	Vanuatu Islands	20.617° S 169.357° E	42	7.3 (P) 7.1 (G, H)	TIB	01:00	YES No	16 cm Port Vila
25 March	00:42	Noto, Honshu, Japan	37.336° N 136.588° E	12	7.1 (P) 6.9 (G) 6.7 (H)	(J) 001 (J) 002 (P) TIB	00:43 02:30 01:05	YES No	0.21 m Suru
25 March	01:08	Vanuatu	20.754° S 169.354° E	32	6.9 (G, H)	—	—	No	

East of Kuril Islands, 13 January 2007, 04:23 UTC, Mw=7.9

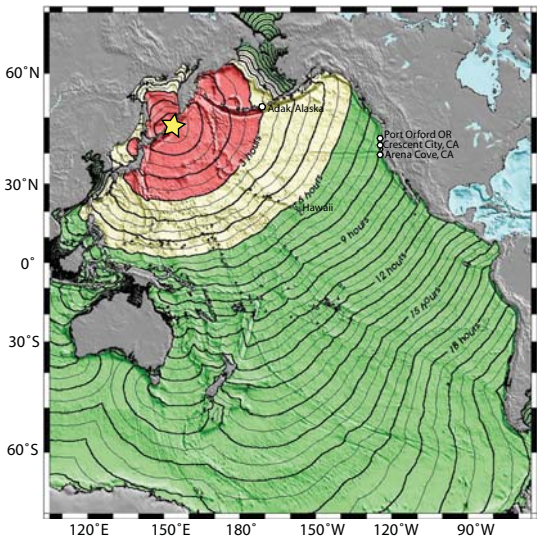
At 04:23 UTC 13 January 2007, a magnitude 8.2 earthquake centered east of the Kuril Islands, which is just north of Hokkaido and near the mainland of Russia. The earthquake generated a tsunami wave placing several countries in the western Pacific into Warning status. Within 11 minutes of the earthquake, a Tsunami Watch was issued for US interests of Hawaii, Wake Island, Midway, the Northern Marianas, Guam, the Marshall Islands, Belau, and the Federated States of Micronesia, along with Johnston Island.

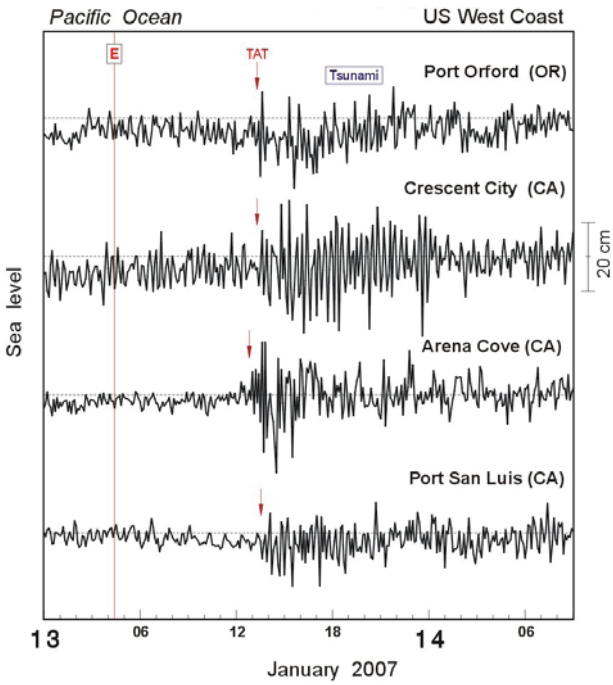
The hourly updates from the Pacific Tsunami Warning Center (PTWC) resulted in the US interests in Guam, the Northern Marianas, Wake, Midway, the Marshall Islands, and the parts of the Federated States of Micronesia including Yap, Pohnpei and Chuuk being upgraded to a Tsunami Warning. US interests in Hawaii, Belau, Johnston Island and Kosrae remained in 'Tsunami Watch' status. The first hourly update came after a report from Hokkaido in northern Japan - the first measurement of the tsunami wave.

At 07:23 UTC on 13 January 2007, all warnings and watches were cancelled within the Pacific Tsunami Warning Center's area of responsibility based on several measurements of a small non-destructive tsunami wave. Measurements ranged from 6 to 10 centimeters in the western Pacific to 32 centimeters in Shemya, Alaska.



Map showing historical seismicity from 1900 to the present and location of epicentre (coutesy of USGS NEIC). The orange star indicates the current earthquake's epicenter.

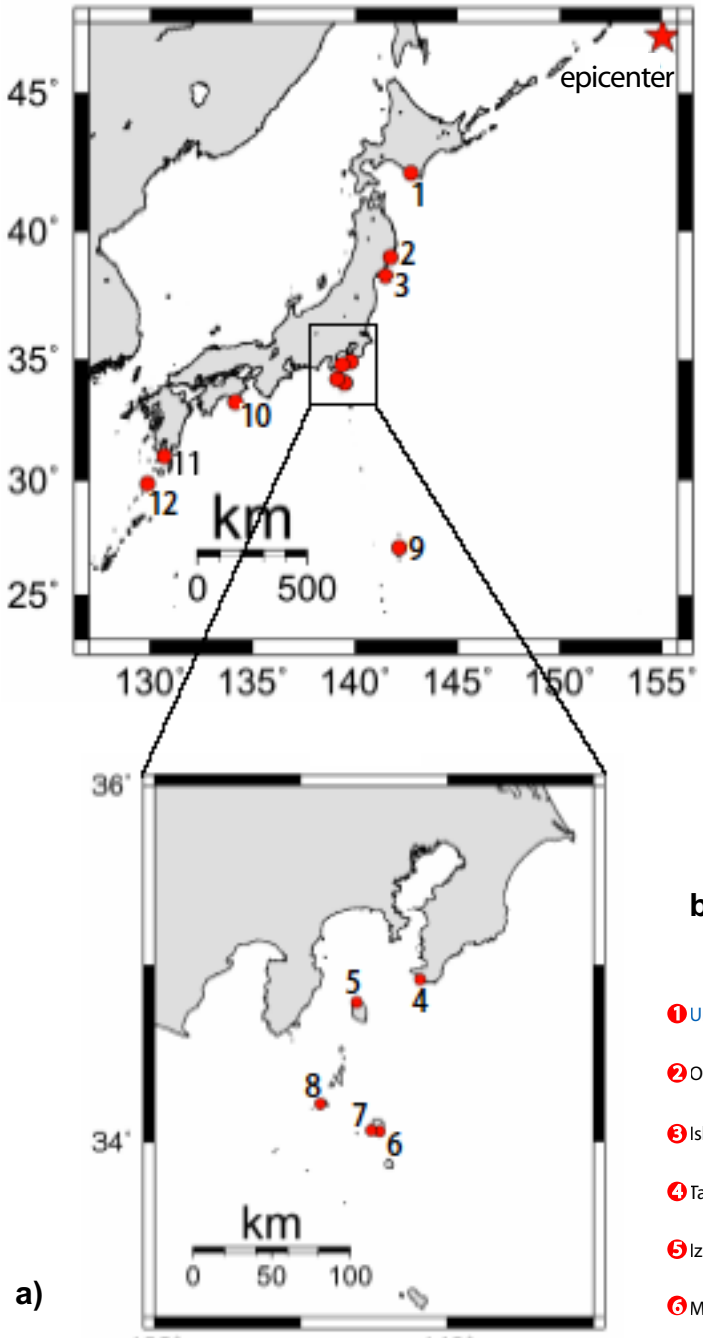


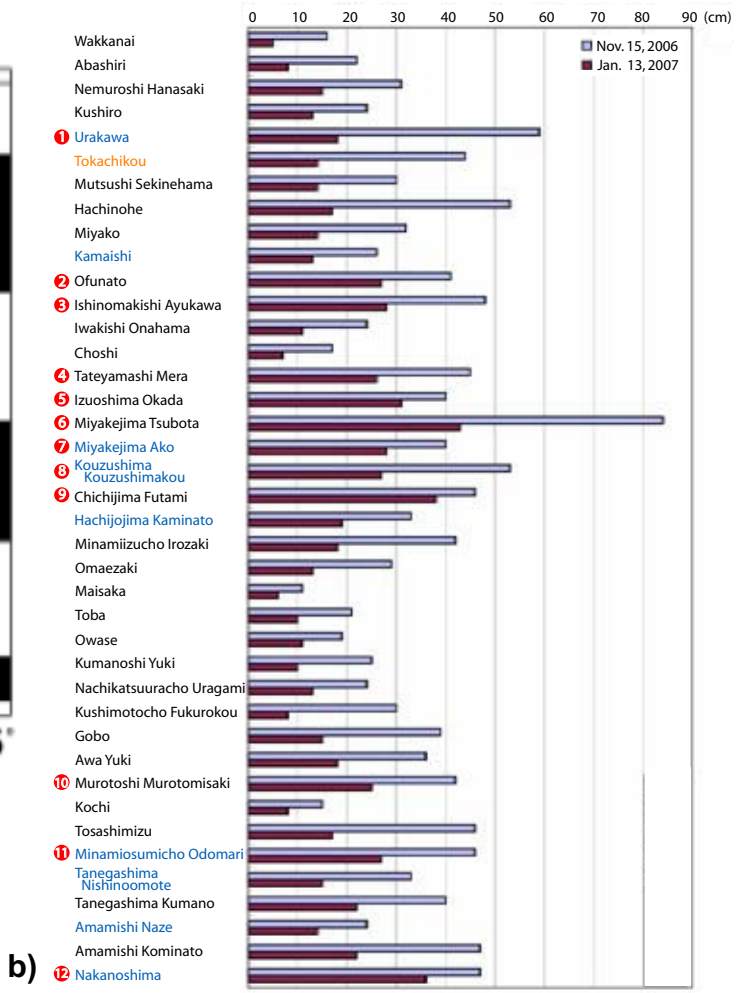


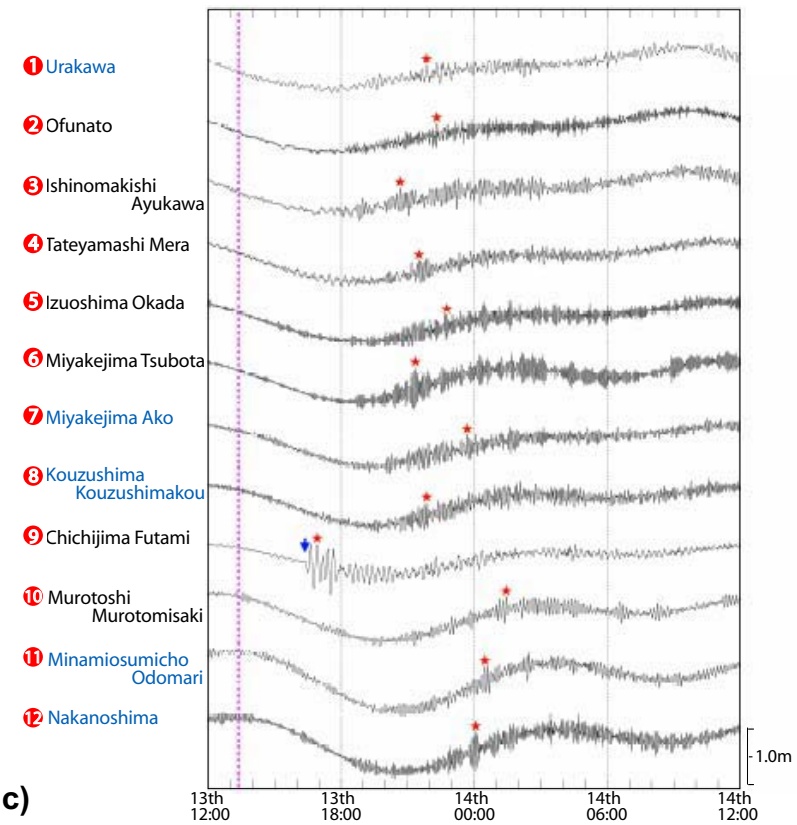
cm	Station reporting
10	Hana-saki, Japan
4	Adak Alaska
32	Shemya Island, Alaska
33	Arena Cove, Alaska
37	Crescent City, California
20	Port San Luis, California
12	Hilo, Hawaii
14	Kahului, Hawaii
9	Nawiliwili, Hawaii
27	Port Orford, Oregon
18	Midway Island;
9	Wake Island.

Tsunami wave heights in centimeters (peak-to-trough) were recorded at the following tide stations as reported by NOAA's National Geophysical Data Center (NGDC).

Kuril Islands, *continued*







Above: a) Map with inset showing the stations in Japan reporting wave data following the Kuril Island Earthquake 13 January 2007. Above right; b) A chart comparing wave records from Japanese stations, comparing records from the recent Kuril event (13 January) with wave heights recorded for the 15 November 2006 event. c) Individual tide records according to stations referred to on the map. Red dash refers to time of earthquake. Red stars indicate point of maximum wave height. The stations with names in blue, are operated and maintained by the Japan Coast Guard, while those in black are maintained by Japan Meteorological Agency (JMA), while Tokachibu (in orange) is maintained by the Hokkaido Development Bureau of the Ministry of Land, Infrastructure and Transport Japan, (MLIT).

Kuril Islands, *continued*

No fatalities or injuries were reported with this event. In Guam and the islands of Hawaii, beaches were closed and campers were moved but no evacuations were conducted. City buses were placed into position to begin evacuations of beaches in Oahu as were emergency personnel in some of the more susceptible locations if they became necessary. Beaches remained closed on islands for several hours prior and after the predicted arrival time of the waves due to potentially strong and unusual currents.

The PTWC issued three bulletins within the initial three hours of the Warning and Watch process and issued two supplemental products to inform the public of the sea level measurements as the initial wave arrived at various locations in the Pacific Ocean Basin.

The National Weather Forecast Offices in Guam, Honolulu and American Samoa issued Special Weather Statements alerting the public to move out of the water and leave beach areas.

Numerous conference calls were made with Hawaii Civil Defense and Emergency Management Offices by the NWS offices throughout the event. Conference calls between the two US Tsunami Warning Centers as well as the international warning centers took place several times to coordinate Pacific Basin Wide Warnings, Watches and to share data. Communications with the NWS offices in the Pacific Region and the regional headquarters were numerous throughout the event.

All media markets through the Pacific were alerted. Several media interviews were conducted through the PTWC including all four television stations and both newspapers in Oahu, Hawaii. The Director of Operations at the NWS Weather Forecast Office in Honolulu also conducted two television interviews the next day, in order to follow up on the events of the previous night.

During the event, nine members of the PTWC and one member from Pacific Regional Headquarters were in the PTWC office to aid in answering questions via phone, media press conferences and coordination with other offices.

Kuriles 2007 Marine Expedition, First Stage Results

Tatiana Ivelskaya, Sakhalin Tsunami Warning Center, 78, Zapadnaya Str, Yuzhno-Sakhalinsk, 693000, Russia
E-mail: tanya.ivelskaya@gmail.com

The first stage of *Kuriles 2007* marine expedition of the Institute of Marine Geology and Geophysics (Yuzhno-Sakhalinsk, Russian Academy of Sciences) was performed aboard Iskatel'(researcher)-4 ship in July 2007. The expedition has been carried out owing to financial support from the Russian Fund of Basic Research and the Presidium of the Far East Branch of the Russian Academy of Sciences.

Experts from the following institutes and agencies took part in the expedition:

- Institute of Marine Geology and Geophysics, Yuzhno-Sakhalinsk,
- Pacific Institute of Geography, Vladivostok,
- Sakhalin Tsunami Center,
- Washington University,
- Institute of Volcanology and Seismology, Petropavlovsk-Kamchatsky,
- Alaska Volcanological Observatory,
- Physicotechnical Institute, Saint-Petersburg,
- P.P. Shirshov Institute of Oceanology, Moscow and
- Sakhalin Regional Museum.

The main objective of the expedition was to inspect displays of Kurile Island earthquakes and tsunamis on November 15, 2006 and January 13, 2007 including to search for seismic faults and definition of tsunami run-up heights along the central Kuril Islands coast (Urup, Simushir, Ketoy Islands).

There was performed a detailed inspection of Central Kuril Islands coast with the purpose of detection of tsunami flooding zones, namely:

- *measurement of the tsunamis run-up heights and maximum penetration;*
- *performing of geological cross-sections to reveal traces of paleotsunamis*.

Data received during the inspection are valuable for testing of numerical models allowing to estimate further a tsunami hazard for this region.

For both of the strong earthquakes in Simushir area on November 15, 2006 and January 13, 2007 tsunami warnings were issued by Sakhalin Tsunami Warning Service. The earthquake of November 15, 2006 caused a transoceanic tsunami.

While the tsunami warnings were in effect, there was no information regarding actuality of a tsunami along the coast nearest the earthquake epicenter. Naturally, such a state of affairs makes for difficulties in analysing the situation and decision-making for cancellation of a tsunami warning.

Based on preliminary calculation data, the tsunami wave height could run up to 4-6 meters for the nearest coast (Simushir Island). According to results of the inspection of the coastlines of the Central Kuril Islands

Kuril survey, *continued*

(Urup, Simushir, Ketoy) there is a great excess over the calculated data.

Survey results of Central Kuril Island coasts (maximum run-ups) are as follows:

- Urup Island- 6 meters;
- Ketoy Island- 8-10 meters;
- Simushir Island- more than 10-15 meters.

This is preliminary information. At present data is being processed. The obtained data are extremely important not only for scientific researches with the purpose of studying the nature of tsunami (including mechanisms of wave generation and propagation, evidence along coasta) but also for Tsunami Warning Systems.

Simushir Island, Spaseniya Bay, Pacific coast. The float found in alder bushes, a distance some hundred meters from the coast. Right, Simushir Island, Mil'na Bay, Okhotsk coast, evidence of tsunami. All photos coutesty of T. Ivelskaya.

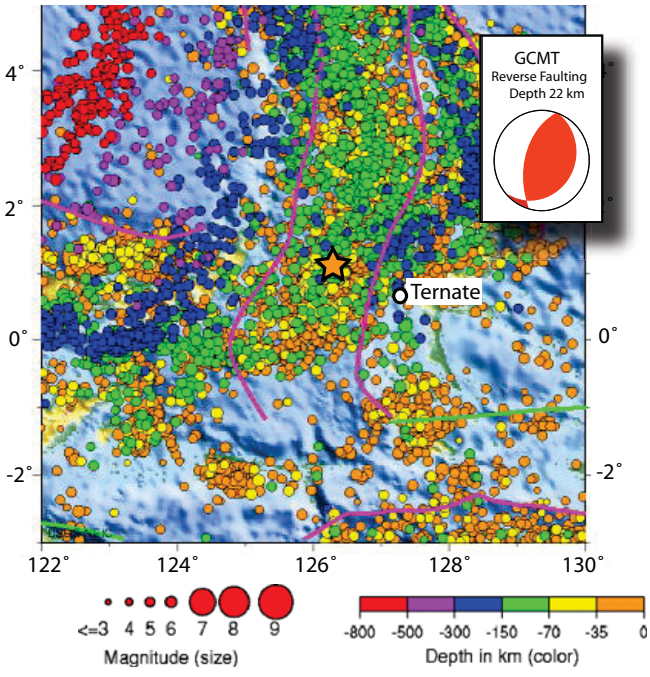
Simushir Island, Dushnaya Bay, Pacific coast.A blockage of logs found in a branch of the river.

Northern Molucca Sea, 21 January 2007, 11: 28 UTC, M_W= 7.5

An earthquake occurred on 21 January 2007 measuring Mw 7.5 (G) at 11:28 UTC, approximately 125 km (80 miles) from Ternate, Molussas, Indonesia. Tsunami bulletins were issued by PTWC and the Northwest Pacific Tsunami Advisory, that a local destructive tsunami was possible following an earthquake of this magnitude.

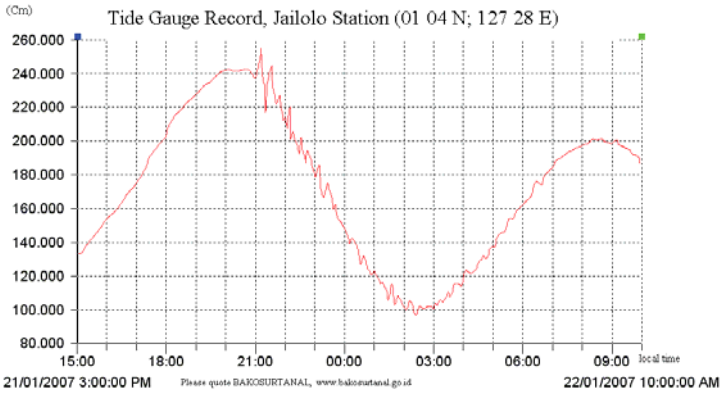
One person died of a heart attack, 3 others killed, 4 others injured and minor damage to some buildings at Mandano, Sulawesi, Indonesia. Felt (VI) on Ternate; (VI) at Bitung and Tondano, (V) at Kotamobagu, (IV) at Gorontalo, Sulawesi; (IV) in southern Halmahera, Indonesia.

Reports were later verified that a very small tsunami did occur and that several people were swept out to sea by the wave.

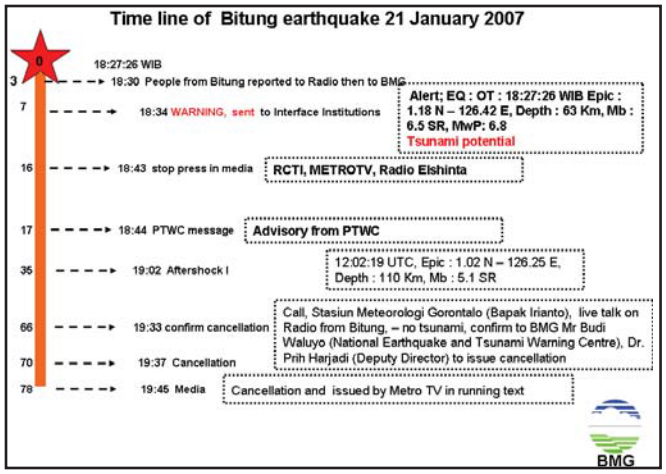


Right: Map of historical seismicity in the area of the epicenter (yellow star) from 1990 to the present. Global Centroid Moment Tensor (GCMT) shows seismic analysis of the earthuqke. Map courtesy of the USGS National Earthquake Information Center (NEIC).

Molucca, *continued*



Sea level record from Jailolo station, Indonesia. Courtesy of Indonesia's Meteorological and Geophysical Agency (BMG).

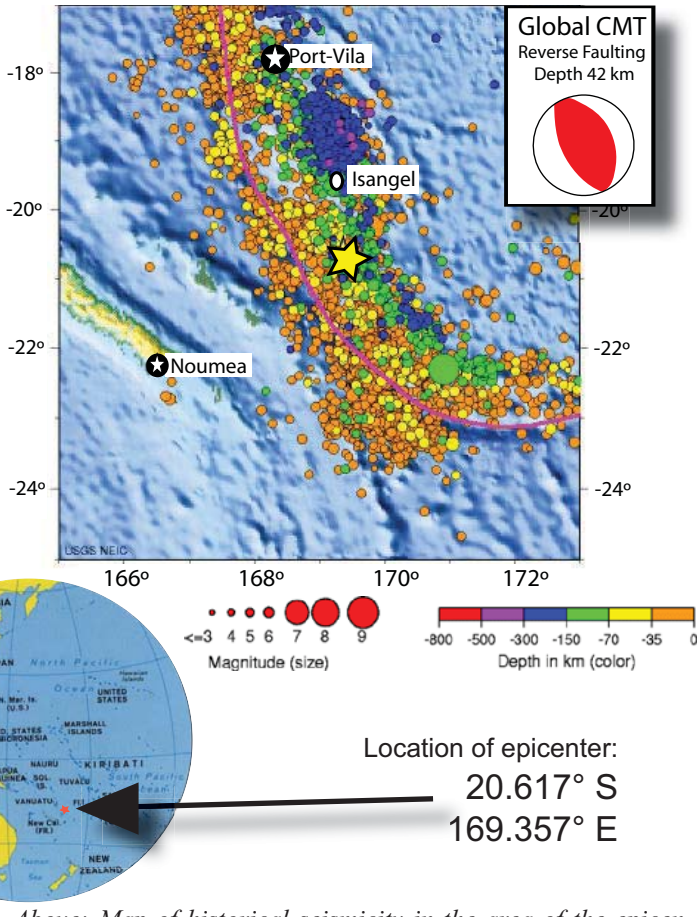


Timeline from BMG showing the series of messages and actions associated with the 21 January earthquake and tsunami in the Molucca Sea. From a BMG presentation slideshow..

Vanuatu, 25 March 2007 00:40 UTC, M_W =7.1

A major earthquake, measuring 7.1 M_W (USGS) occurred 120 km (75 miles) south of Isangel, Tanna, Vanuatu at 00:40 UTC, 25 March 2007, which was 11:40 am, local time. The earthquake was felt (III, on the Modified Mercalli Intensity Scale) at Port Vila, Vanuatu and Mont-Dore, New Caledonia. Also felt at Noumea and Yate, New Caledonia. There were no reports of damage, but a tsunami measuring 16 cm, peak to trough, was recorded at Port Vila, Vanuatu and 4 cm peak to trough measurement was made at Honiera, in the Solomon Islands.

Sea level records received from postings on the WC/ATWC website: http://wcatwc.arh.noaa.gov/previous.events/03-25-07-Vanuatu/03-25-07Vanuatu.html, showing the indications of a tsunami at sea level stations Port Vila (top) and Honiera, Solomon Islands (bottom).



Above: Map of historical seismicity in the area of the epicenter (yellow star) from 1990 to the present. Global Centroid Moment Tensor (GCMT) shows seismic analysis of the earthuqke. Map courtesy of the USGS National Earthquake Information Center (NEIC). Globe shows more general location in the Southwest Pacific

Kanazawa, Honshu Japan, 25 March 2007 00:42 UTC, M*w*=6.9

Summary of the Earthquake and Tsunami on 25 March in Noto Peninsula

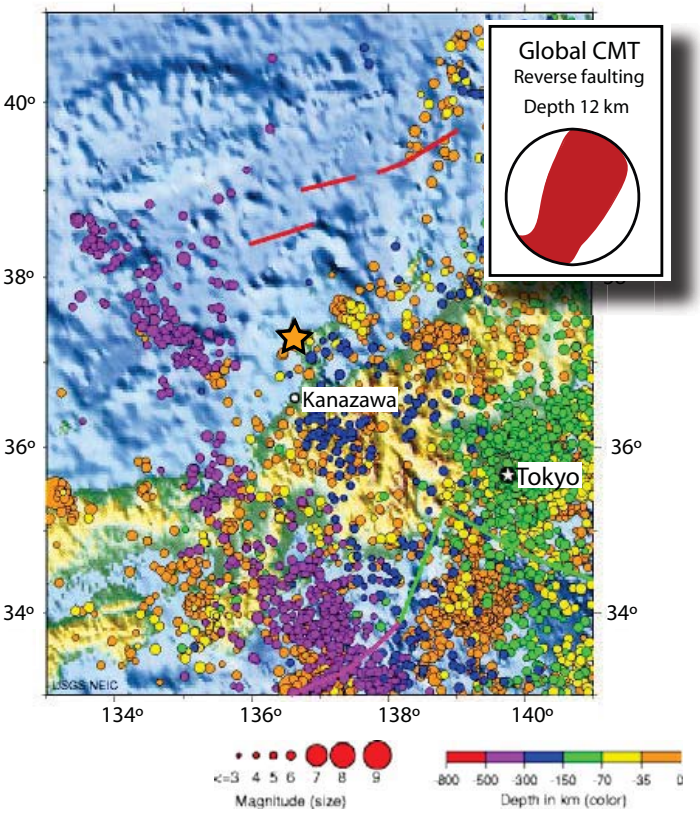
Earthquake

Origin Time: 00:41, 25 March 2007 (UTC)
Latitude: 37.2° N
Longitude: 136.7° E
Depth: 11km
Magnitude: 6.9 (M_{jma})

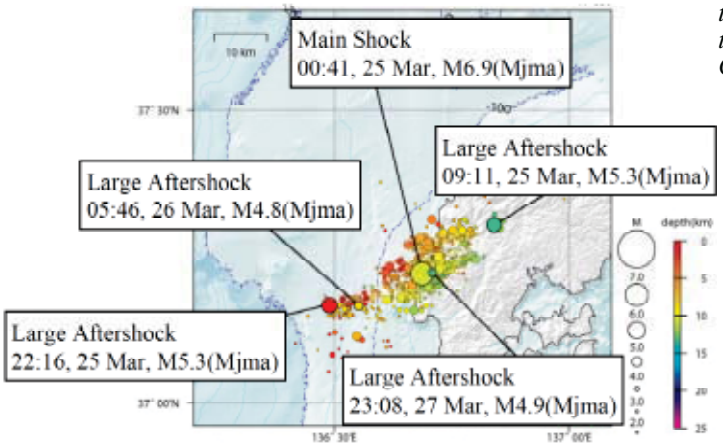
(More than 300 felt aftershocks in the following week.)

More than 60 landslides occurred in and around the Noto peninsula area of Japan. Roads were damaged, and cracks were generated in the landing field of Noto airport. Train service was temporarily interrupted and water supply was stopped because of damage to pipes.

There were 359 people injured and one person crushed by a stone latern. More than 13,556 houses were destroyed.



Above: Map of historical seismicity in the area of the epicenter (orange star) from 1990 to the present. Map courtesy of the USGS National Earthquake Information Center (NEIC). Global Moment Tensor Solution from http://gtml.org.



Tsunami Warning

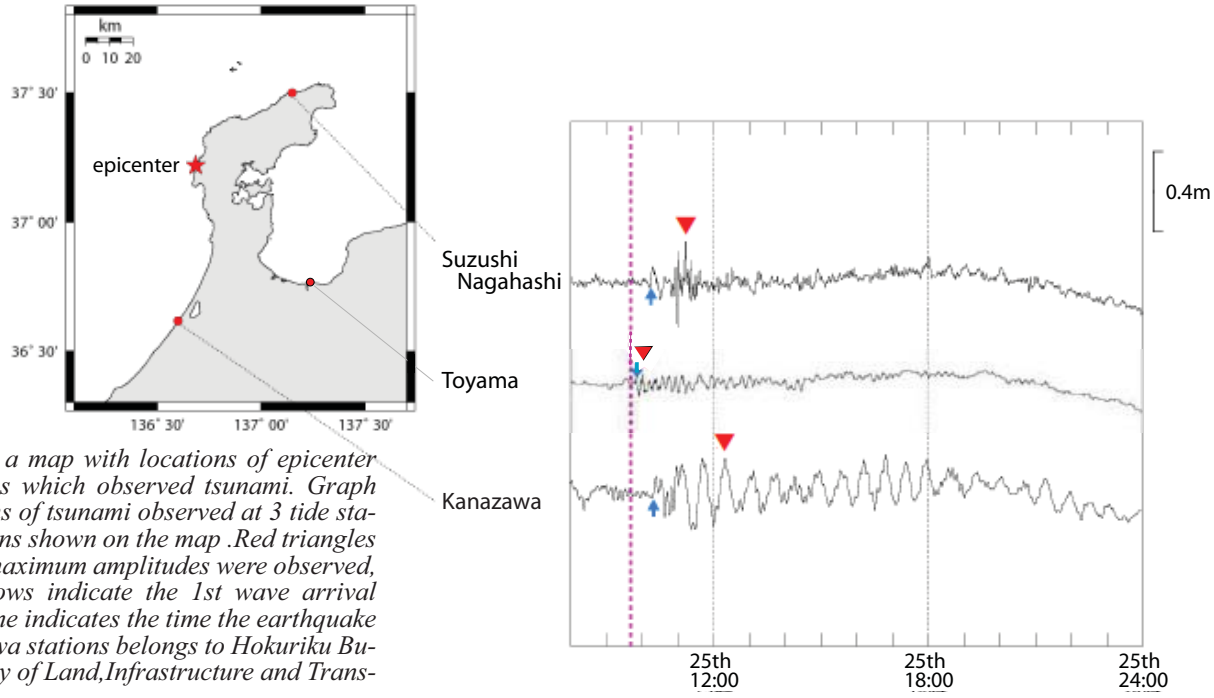
00:43 Tsunami advisory was issued by JMA

02:30 Tsunami warning was cancelled.

Observed Tsunami Height (zero-to-peak)

Station name	1st wave arrival	max. tsunami height
Suzushi Nagahashi	01:15	22cm
Kanazawa	01:21	18cm
Toyama	00:51	6cm

Kanazawa, *continued*



The left picture is a map with locations of epicenter and 3 tide stations which observed tsunami. Graph showing waveforms of tsunami observed at 3 tide stations at the locations shown on the map .Red triangles indicate the time maximum amplitudes were observed, whereas blue arrows indicate the 1st wave arrival time. The dotted line indicates the time the earthquake occurred. Kanazawa stations belongs to Hokuriku Bureau of the Ministry of Land,Infrastructure and Transport Japan (MLIT)

IOC NEWS

ICG/ IOTWS-IV Mombasa, Kenya, 28 February to 2 March 2007

By Tony Elliott, Head of ICG/IOTWS Secretariat,
E-mail: t.elliott@unesco.org

The Fourth Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS) took place in Mombasa, Kenya from 28 February to 2 March 2007 at the Sarova Whitesands Hotel.

Progress since ICG/IOTWS-III (Bali, August 2006) was reviewed and the scope of activities planned for the next intersessional period was discussed. The meeting noted the extensive work undertaken by Member States during the intersessional period, and the encouraging progress around the region including the deployment of several deep ocean tsunami detection instruments. The continuing support of the interim tsunami advisory providers (PTWC and JMA) for the countries of the Indian Ocean rim was acknowledged, as was the opening of the IOC Jakarta Tsunami Information Centre (JTIC), and the capacity building and communications support from the IOC's International Tsunami Information Center (ITIC).

One of the main outcomes of the meeting was the formation of a Task Team to develop an implementation plan to establish an interoperable system for the provision of tsunami watches for the Indian Ocean by the end of 2008, which is the target date for taking over this responsibility from PTWC and JMA.

The formation of the ICG/IOTWS Steering Group as a coordination mechanism for the IOTWS was recognised, and the outcomes of the first meeting of the group were noted, including a call to address sustainability issues for the system detection hardware which is currently being installed.

Dr Jan Sopaheluwakan of Indonesia was elected as Chair of the ICG/IOTWS for the next term, and Mr Rick Bailey of Australia and Dr Shailesh Nayak of India were elected as Vice Chairs.

View of the meeting room at the Sarova Whitesands Hotel in Mombasa.

Jakarta Tsunami Information Center (JTIC) Website Online

Under the auspices of UNESCO-IOC, the Jakarta Tsunami Information Centre (JTIC) is a centre dedicated to being the clearing house of information on the development of the Tsunami Early Warning System in Indonesia and the point of dissemination of information on tsunami preparedness through a website; *www.jtic.org*.

In its unique position in Indonesia, JTIC strives to become a quality information centre focusing specifically on tsunami hazard by periodically compiling information and data from verified sources. Its website is presented in two languages (English and Bahasa) and hosts various quality materials (books, booklets, leaflets, posters, newsletter, articles, etc) on tsunami. It is hoped that these quality resources could in turn be of useful reference for decision makers and other stakeholders involved in the development of Tsunami Early Warning System in Indonesia (Ina TEWS) and in conducting public education on tsunami. This endeavor has been made possible through the cooperation between JTIC and various parties, both national and international, that share their activities and programmes information on the management of tsunami mitigation (upstream and downstream).

Some other items available on the website are guidelines and common knowledge on how people can be prepared for tsunamis and what to do when the hazard strikes. These include the Tsunami glossary; Tsunami Teacher; amd examples of tsunami standard operating procedures (SOPs) from different regions. In the future, it is intended that the website will be the source of SOP information for area/districts in Indonesia who are in the process of developing SOP for tsunami disaster and could use examples of available SOP from other districts.

Among many distinctive features available, the JTIC website provides a special section called “Discussion Forum” in which the general public and experts alike can discuss and contribute materials on tsunami-related issues. Consequently, through this forum, it is expected that the public can enrich the discourse on the man-

The JTIC website is building features to connect the public with mitigation materials and to provide forums for discussion of any number of tsunami related topics. It can be found at http://www.jtic.org.

JTIC, *continued*

agement of tsunami mitigation in forms of breakthrough ideas and recommendation. As a starting point, the website has set eight threads, currently in place within the Discussion Forum;

(1) Capacity Building,
(2) Community Preparedness,
(3) National SOP,
(4) Local SOP,
(5) Seismic Monitoring,
(6) Oceanographic Monitoring,
(7) Tsunami Modeling and
(8) Communication Systems.

These threads have been created to start galvanizing discussion on different topics within the Forum. To provide JTIC with a members database, the forum requires registration from visitors. This database will in turn help JTIC inform visitors of future new threads, topics, articles or additional features posted on the website.

JTIC is already online, however it is still at a developmental stage. Therefore, some of the features have limited information, but more will continue to be added and updated. We are open to suggestions on how to continue developing and improving the content of the JTIC website.

We would also welcome tsunami-related materials to be posted on our website, including the information of your organization's involvement in the development of Tsunami Early Warning System in Indonesia, Tsunami Preparedness, Community Development and Capacity Building for tsunami mitigation in Indonesia.

Please send your suggestion, comments, ideas and information to *info@jtic.org*.

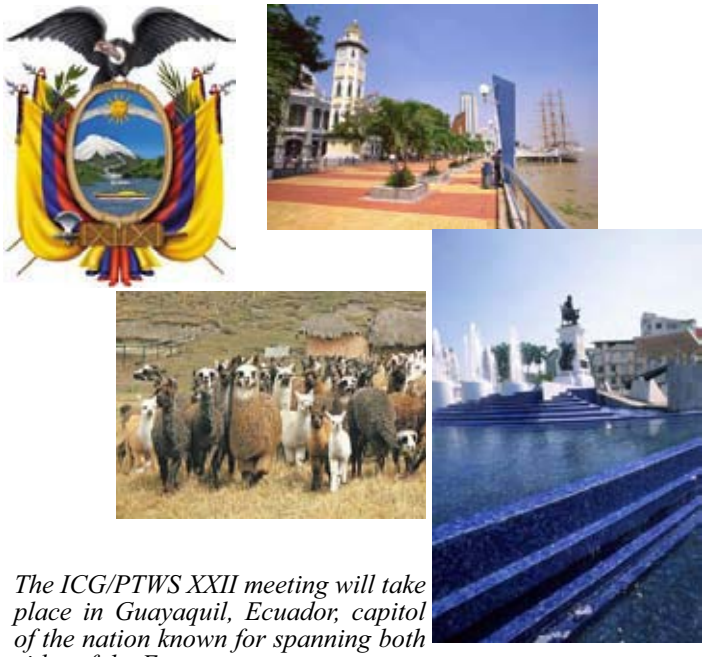
ICG/PTWS NEWS

ICG/PTWS--XXII, Guayquil, Ecuador 17-20 September 2007

The twenty-second session of the UNESCO Intergovernmental Oceanographic Commission's Intergovernmental Co-ordination Group for the Pacific Tsunami Warning and Mitigation System (IOC ICG/PTWS) will be held 17-20 September 2007 in Guayaquil Ecuador. The four day meeting is being hosted by Ecuador's Instituto Oceanográfico de la Armada (INOCAR). Prior to the meeting requests are being sent for all Member States to submit National Reports and to communicate and update their 24/7 contacts and national representative information.

Scheduled sessions will include Intersessional reports from ten categories of agencies including the ITIC Director's Report. Other sessions will cover implementations in the warning system as a whole and developments in local or regional systems. The meeting is also concerned with working group sessions and reports will be made for these groups meeting during the meeting and of progress made since the last PTWS Session.
All working documents for Session XXII can be found at the ICG/PTWS website, *http://ioc3.unesco.org/ptws/22/PTWS-XXII_working_documents.php*.

The meeting will follow the Sixth International Workshop on Tsunami Mitigation: New Insights in Tsunami Research, Preparedness, Warning and Mitigation, which will be held the week before (14-15 September 2007) in Guayaquil, Ecuador. The workshop is organized by Ecuador's Instituto Oceanográfico de la Armada (INOCAR), and co-sponsored by UNESCO/IOC and the IUGG Tsunami Commission.



The ICG/PTWS XXII meeting will take place in Guayaquil, Ecuador, capitol of the nation known for spanning both sides of the Equator.

Focusing on tsunami topics of interest to Pacific and Caribbean countries, and regionally on tsunami threats to Central and South America, the Workshop provides a high level information platform for scientists and governmental officials involved in tsunami warning and mitigation systems. The Workshop is also open to participation by the other Intergovernmental Co-ordination Groups under UNESCO/IOC. Scientists are encouraged to present the results of their research, as well as to provide new insights in topics related to tsunami preparedness, warning and mitigation.

ICG/PTWS XXII, *continued*

The scientific topics for this workshop are:

1. *Human response to tsunami warning,*
2. *Advances in tsunami early warning systems, including real-time earthquake source characterization, evaluation of tsunamigenic potential of earthquake and non-earthquake events, and new detection/evaluation technologies,*
3. *Tsunami research, including tsunami deposits, regional tsunamis, tsunami wave and sea level dynamics, modelling, post-tsunami surveys and relevant coastal engineering, and*
4. *Mitigation and preparedness emphasizing synergies within a multi-hazard framework.*

The meeting will offer opportunities for showcasing education and awareness tools, including the presentation of materials, techniques and programmes for increasing public awareness, and examples of national and local customizations of tsunami materials.

The second day of the workshop will be devoted to a field trip to Manta Pennisula, Ecuador, where the unique geological features of the area will be evident. Refer to PTWS XXII working document web sites for more details on intersessional working group meetings, *http://ioc3.unesco.org/ptws/22/working_groups_other_tsunami_meetings.php*.

ICG/PTWS Tsunami Warning Centre Coordination Meeting 17-19 January 2007, Honolulu

The Intergovernmental Co-ordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS) held its PTWS Tsunami Warning Centre Co-ordination Meeting 17-19 January 2007 in Honolulu, Hawaii. The meeting was convened by the Directors of the Pacific Tsunami Warning Centre and the International Tsunami Information Centre in order improve coordination and information sharing amongst the tsunami warning centres (TWC), and to improve the quality, accuracy, and timeliness of international tsunami advisory information to Pacific customers. The meeting was attended by 23 participants representing Australia, Canada, France, Indonesia, Japan, New Zealand, Russian Federation, USA, GLOSS and the University of Hawaii Sea Level Center, IRIS Global Seismic Network, Pacific Tsunami Warning Center, West Coast/Alaska Tsunami Warning Center, the IOC Tsunami Co-ordination Unit, and the ITIC. Participants shared information on their current and future operations and upgrades, and their lessons learned from Pacific tsunami events in 2006 and 2007. The Group agreed to take action to enable better and more timely parametric information sharing amongst tsunami warning focal points and des-

Right (next page), Participants at the workshop included in front. Seated, from left to right: Geoff Crane, Bureau of Meteorology, Australia; Tatiana Ivelskaya Ivelskaya, Sakhalin Warning Centre, Russia; Laura Kong, Director, ITIC; Charles, "Chip" McCreery, Geophysicist in Charge, PTWC; Paul Whitmore, Scientist in Charge, WC/ATWC. Standing in the back, from left to right: Tony Leggett , Bureau of Meteorology, Australia; Spiro Spiliopoulos Geoscience Australia; Brian Yanagi, Disaster Management Specialist, ITIC, Bernie Kilonsky, SOEST, Honolulu; Geoff Clitheroe, GNS Science New Zealand; Dominique Reymond, CPPT, Tahiti; Fred Stephenson, PTWS Vice-Chair, Canada; Peter Koltermann, Head, IOC Tsunami Co-ordination Unit, Paris; Masahiro Yamamoto, Tsunami Co-ordination Unit, Paris; Mike O'Leary, Ministry of Civil Defense and Emergency Managment, New Zealand; Sudhardjono, BMG, Indonesia, Rhet Butler, IRIS Global Network, Honolulu; Osamu Kamigaichi, JMA-NWPTAC, Japan.

Warning coordination, *continued*

ignated national emergency operations agencies, clarified terms and definitions and identified shortcomings and solutions for improving international TWC messages, including consideration of the media and warning guidance for the public, and discussed the present state and future plans of operational tsunami wave forecasting and how to best use DART system data to support tsunami warnings and their cancellations. Recommendations and concerns were taken as input to the PTWS Task Team on Messages that will report its findings and recommendations to ICG/PTWS-XXII. The Group agreed on the important value of annual TWC Coordination Meetings. For more details of the meeting visit the ITIC website at *http://ioc3.unesco.org/ptws/22/index.htm.*

The Meeting's Outcome

TOPIC	ORGANIZATIONAL AGREEMENT or ACTION
TWC Information Sharing	ALL AGREE: Important types of data and science interpretations are sharable privately among the TWC. It was generally agreed that every TWC should look at the same data and do their own national assessment to issue national warnings. ITIC ACTIONS: 1) ITIC will seek more information about current implementations of RSS feeds, web crawlers, secure ftp sites, and other possible mechanisms, e.g., e-mail, fax, secure, ftp site which users can access every 10 seconds or so (using a web crawler; Rsync server is a more sophisticated version, Jabber). 2) The Group called for a solution that would provide TWC information sharing, and asked if private communications lines for information sharing, or heads-up messages could be provided. As identified earlier, the ITIC would collect information and provide summaries.
TWC Information Sharing - Earthquake Observatory Msg	WARNING OPERATIONS AGREE: PTWC & WC/ATWC to provide existing observatory messages to designated audiences that need lead time. PTWC ACTION: PTWC to put Mw (or other magnitude type) specifications in its Observatory Message.
TWC Information Sharing - PTWC Msg Time Stamp	PTWC ACTION: PTWC to correct time stamp to immediately before message sent.
TWC Operations - JMA msg	JMA ACTION: JMA to amend their messages since JMA still includes wave prediction information (amplitudes and arrival times) in their messages, even after a cancellation. JMA cancellation means expected wave amplitude is expected to be less than 1m. This may be confusing to customers.
RANET SMS Alert	ITIC ACTION: ITIC to inform TWC and TNC of availability of SMS messaging service.
Operations - "Destructive" threshold	INTERNATIONAL TSUNAMI OPERATIONS ACTION: Australia requested guidance from experts on determining minimum threshold for warnings that use the word "Destructive."
TWC Operations - South China Sea	-AGREE PTWC and JMA: For South China Sea, JMA will follow PTWC lead. -ACTION: JMA, PTWC, and ITIC to further discuss and coordinate for the SCS. A discussion should be held at ICG/PTWS-XXII, and a recommendation endorsed, if appropriate.
Sea Level Data Sharing - GTS	ALL ACTION: Currently, NWPTAC and CPPT and other TWC are not receiving DART, but these should be made available on GTS system, not just through NDBC web site. For this, GTS product header needs to be rebroadcast, and TWC should know the headers of these broadcasts.
Sea Level Network standards	WG 2 CHAIR ACTION: The Group agreed that the tsunami community should be taking the lead to identify sites and transmission requirements. GLOSS should be used for technical expertise, and for requesting upgrades within its programme. The Meeting agreed in particular, that the TWC, with PTWS WG 2 Chair, should take the lead to establish the technical specifications of the PTWS sea level network. In particular, criteria should be established for station location, identification of station upgrade priorities, data sampling, and transmission frequency. These system and station criteria should be based on the importance of stations for determining tsunami warnings.

Warning coordination, *continued*

Sea Level upgrades	WG2 Chair ACTION: The Group further agreed that each country, with technical assistance from their TWC, PTWS WG 2, international tsunami warning centres, and other experts, should develop their own priorities and seek national commitments to host sea level stations and provide these data internationally for use in tsunami monitoring.
Sea Level - GOES Users Group	UHSLC ACTION: GOES User Group meeting notes along with written copy of Kay Metcalf's communication to be provided to Secretariat.
Sea level data sharing and monitoring tools	IOC, ITIC ACTION: This is needed for all TWC. Tidetool and Sea Level Station metadata tools should be made available to everyone. A request to WMO to assist in getting the GTS-transmitted sea level data to be re-broadcast back to countries should be made.
Forecasting - JMA	JMA ACTION: Japan is preparing a paper in English that describes the upgrades to the Japanese forecasting system.
Forecasting - DART data use and interpretation	AGREE: The WC/ATWC and PTWC recommended that DART data be used with caution, and be used with modeling in order to determine a coastal forecast. This is because decisions based solely on the DART signal in the deep-ocean are not yet diagnostic; an exception would be the case where the DART signal is very large so that a destructive wave is expected. However, since the goal is to provide useful information on tsunami impact along coasts (not in the deep ocean), a model must still be computed.
Message content	ALL AGREE: 1) Use wave amplitude and define the term amplitude. 2) Threshold for cancellation: 0.5m for international bulletins; for national bulletins, country develops own thresholds. 3) Units: use metric, or metric and imperial (must specify the units in each case) 4) Time zone of the predicted or observed arrival time must also be identified. 5) Shallow means less than 100 km.
WMO standards	Australia ACTION: Australia to research minimum WMO bulletin standards and report to Task Team.
TWC graphical products	ALL AGREE: Encourage the development of graphical products to supplement the existing text messages, and make these widely available, such as through web sites.
TWC Public Information	ALL AGREE: 1) TWC should emphasize that all information and background information and preparedness guidance is provided through bulletins and additionally through its web page. Phone inquiry by the media and public to the TWC or national authority will not have more information than already made publicly available. 2) TWC and Emergency Managers should engage media to educate them on what is to be expected in a tsunami event. Consideration should be given to find ways in which the media are partners in the dissemination of alert and public safety information. Examples are between JMA and NHK in Japan, and with the Emergency Alert System in the USA.
Use of 'Warning' Bulletins	ALL AGREE: Remove 'warning' from message to indicate international messages are advisory to national authority in same manner as to be implemented in the IOTWS.
Bulletin guidance	INTERNATIONAL TWC ACTION: Provide guidance on suitable actions in international bulletins or Users Guide.
Message Task Team	ALL AGREE: 1) After much discussion, it was agreed that further discussion is needed on reporting, measurement, downgrades, bulletin types, etc. This should be done within the PTWS Message Task Team that involves TWCs. 2) Message Task Team Report and Recommendations should be distributed at least one month prior to PTWS-XXII in order to provide time for review and national position determination. Goal is decision-making at PTWS-XXII.

Ports and Ships	ALL AGREE: The Group recommended that for each harbor, the Port Authority was responsible and that worst case tsunami scenarios should be modeled in order to arrive at the most specific guidance for SOLAS vessels and other port facilities and infrastructure should a tsunami warning be issued.
TWFPs [Tsunami Warning Focal Points] and TNCs [Tsunami National Contacts]	IOC ACTIONS: 1) Need policy for sharing of operational contacts, i.e., focal points. 2) Need clear process for TWFP and TNC and updates, which should be same globally ITIC ACTION: ITIC will combine three lists for TWFP and transmit to TWCs. ITIC will refresh TNC lists on web site as these are updated. ALL AGREE: ITIC will construct a secure web site as soon as possible, and possibly before PTWS-XII.
Users Guide	ALL AGREE: Rename Communications Plan to "PTWS Users Guide." This should be proposed and approved by the ICG/PTWS.
Post Tsunami Evaluations	ALL AGREE: Compilations of lessons learned and other post-tsunami TWC analyses are an important and essential for continually improvement of the system. ITIC and USA ACTION: ITIC and USA to work together to assemble post-event TWC compilations. PTWC to put together five questions for post-event evaluations. Immediately after a significant tsunami, the PTWC or ITIC would send out the questionnaire to TWFP. The ITIC would compile the results and make them widely known.
Medium Term Strategy	ALL (TWCs, PTWS WGs) ACTION: The PTWS Vice-Chair asked the group to consider the development of priority projects that the PTWS and its member states can seek funding for. He called for the PTWS to move beyond recommendations to identify strategies to achieve results.
Regular Meetings	ALL AGREE: The Group agreed on the importance of convening regular TWC Coordination meetings. The Group recommended that TWC Coordination meetings be held annually.

ITIC-PTWC NEWS

PTWC Website Redesigned

by Brian Shiro, Pacific Tsunami Warning Center Geophysicist, E-mail: brian.shiro@noaa.gov, and Nathan C. Becker, PTWC Oceanographer, E-mail: nathan.becker@noaa.gov

We are pleased to announce a major overhaul and upgrade of the NOAA Pacific Tsunami Warning Center (PTWC) website. We hope that visitors to the website, whether they are emergency management professionals or members the general public, will find its greatly improved presentation to be more intuitive and useful when they need information about recent tsunami-related events.

After visitors point their web browsers to the PTWC website (*http://www.prh.noaa.gov/ptwc*), they will see a global summary of seismic events and tsunami hazards analyzed by PTWC for the last 90 days, including any ongoing event. A colored banner at the top of the window indicates the current tsunami threat level (i.e., green=low, yellow=moderate, orange=high, red=severe), and clicking on this banner shows the most recent message sent by PTWC. Below the banner is an interactive map with a corresponding table using this same color scheme to show the locations of recent earthquakes and their tsunami risk as reported in current and past PTWC tsunami messages. If the visitor clicks on any event on the map or "html" under the "Details" column in the table, the browser will then show a detailed description of the event, including a map of the earthquake region. Clicking on the detailed map or the "Message Text" link on the event's webpage will display the original text of the PTWC tsunami message in the browser. Alternatively, the visitor can find the PTWC tsunami messages directly from the homepage by selecting "text" under the "Details" column in the event table.

Though PTWC only provides preliminary scientific data about earthquakes soon after they occur, the United States Geologic Survey (USGS) continues to analyze the earthquake and will later provide improved estimates of the earthquake's parameters. As these improved data become available, PTWC will also update its website to include the newer data in order to avoid confusion for our customers when, for example, PTWC's preliminary magnitude estimate differs from the better-constrained

PTWC website, *continued*

magnitude later determined by the USGS. Therefore, visitors to the PTWC website will always have access to the most current and accurate data without having to visit multiple websites. In addition to the global summary map and table, the new PTWC home page also includes tabbed windows for each of PTWC's customer groups: the countries located in the Pacific Ocean, Indian Ocean, and Caribbean Sea, plus the state of Hawai'i. Each of these windows follows the same scheme as described above for the global summary page, but the information displayed under each tab is only relevant to the specific regions. The figure shown summarizes the website features for the case of the Pacific Ocean tab.

The menu bar on the left side of the PTWC website contains links to useful information. The "About Messages" page describes each message product that PTWC issues, and website visitors can also access this page by clicking on any map legend. The "Information" section contains links to many resources, and the "FAQ" page in particular contains a useful list of frequently asked questions. The "History" and "Responsibilities" pages describe the organization of the Tsunami Warning System and how NOAA's two tsunami warning centers divide and share their responsibilities. The "Contact Us" page allows users to securely send feedback to PTWC.

PTWC's "Really Simple Syndication" (RSS) feeds drive the content of its new website. These live feeds broadcast PTWC's tsunami messages to anyone who wants to receive them via a RSS newsreader on a computer or mobile device. The "Subscribe" page on PTWC's website provides links to each of PTWC's RSS feeds, which are also conveniently available via the "XML RSS Feeds" link at the top of the left menu bar or the RSS symbol at the far right of the browser's address bar. In the future, PTWC also will produce other kinds of message feeds in such formats as Common Alerting Protocol (CAP) and Keyhole Markup Language (KML), the latter of which allows information to be displayed

Clicking on the tabs or regions listed on the left menu reveal recent tsunami messages for that region.

RSS & Email Subscription

Frequently Asked Questions

Email PTWC

Corresponding events on the map and table have the same number and color.

RSS feeds

Status banner color indicates the current tsunami threat level, and clicking on the banner allows the visitor to read the latest tsunami message.

Clicking on the map legend takes visitors to the "About Messages" page that explains PTWC's message types.

Placing the cursor over event symbols reveals a box with more information, and clicking on the symbol (or the "html" link in the table) takes the visitor to the message web page.

Table summarizes recent tsunami messages. The visitor can click "html" to go to the message web page or "text" to read the tsunami message.

PTWC's new website offers many ways to access tsunami-related information. It is found at http://www.prh.noaa.gov/ptwc.

PTWC website, *continued*

in Google Earth. For those users who prefer to receive information via email, PTWC's messages are still available through the International Tsunami Information Center's (ITIC's) electronic mailing list, which can also be accessed via the "Subscribe" page on the PTWC website or from the ITIC website.

Eventually, PTWC's website will move from its present server in Honolulu to a more robust set of redundant servers on the U.S. mainland. This transition will facilitate the inclusion of even more features, such as the ability to look up archived tsunami messages from a database. NOAA plans to eventually have its two tsunami warning centers merge their websites into a single site and locate it at http://www.tsunami.gov. Until then, PTWC's website will have the same address it has had for many years: *http://www.prh.noaa.gov/ptwc*. Please check it out and give us your feedback. Mahalo!

Collaborative effort leads to distribution of Tsunami Travel Time (TTT) Software

US NOAA's National Geophysical Data Center, as the World Data Center (WDC) for Solid Earth Geophysics - Tsunamis, and the IOC's International Tsunami Information Centre (ITIC), are collaborating to provide, free of charge, tsunami travel time calculation and display software to government organizations involved in providing tsunami warning and mitigation services.

The Tsunami Travel Time (TTT) software was developed by Dr. Paul Wessel (Geoware, *http://www.geoware-online.com*), and is used by the NOAA Pacific Tsunami Warning Center for its operations calculations. Map graphics are made using the open-source Generic Mapping Tools (GMT) developed by Drs. Paul Wessel and Walter Smith (*http://gmt.soest.hawaii.edu/*). The ITIC has purchased the TTT license to permit widespread free distribution.

The TTT software calculates first-arrival travel times on a grid for a tsunami generated at a given a source location(s), such as an earthquake epicenter(s). The technique used by the software to compute travel times over an entire grid is an application of Huygen's principle. The principle states that all points on a wavefront are point sources for secondary spherical waves. Minimum travel times are computed over the grid starting at the point of interest (e.g. earthquake epicenter). From the starting point, times are computed to all surrounding points. The grid point with minimum time is then taken as the next starting point and times are computed from there to all surrounding points. The starting point is continually moved to the point with minimum total travel time until all grid points have been evaluated. This technique is explained in Shokin, Y.I., L.B. Chubarov, V.A. Novikov, and A.N. Sudakov, "Calculations of tsunami travel time charts in the Pacific Ocean-models algorithms, techniques, results, Science of Tsunami Hazards, Vol. 5, No. 2, p. 85-113. (Available online at *http://epubs.lanl.gov/tsunami/*)

WORKSHOP AND MEETING SUMMARIES

U.S. National Tsunami Hazard Mitigation Pacific Region Program Meeting 14–15 March 2007, Seattle, Washington

The U.S. National Tsunami Hazard Mitigation Program (NTHMP)–Pacific Region met from 14–15 March 2007 in Seattle, Washington at the NOAA Pacific Marine Environmental Laboratory (PMEL). The meeting was chaired by Mr. R. Jeffrey LaDouce, Director of the US National Weather Service, Pacific Region Headquarters. The meeting was attended by over 20 participants from Alaska, California, Hawaii, Oregon, Washington, U.S. affiliated Pacific Basin territories and commonwealths, NOAA, USGS, ITIC, and the Federal Emergency Management Agency.

The group discussed the passage of a new Public Law, PL 109-424 entitled, "Tsunami Warning and Education Act." The law authorized funding for NOAA tsunami research, forecast and warning programs, the NTHMP, and global tsunami programs. The group also received reports on progress from its mapping and modeling and mitigation sub–committees. Moreover, the group discussed a continuing and evolving process of expanding the NTHMP from its charter U.S. western coastal states established in 1997, to include the eastern and Gulf coast states, and U.S. affiliated Pacific Basin territories and commonwealths.

The next NTHMP meeting will be held in Honolulu, Hawaii 31 October–1 November 2007. For more information, see *http://nthmp.tsunami.gov/index.html*

Wakayama, *continued*

has developed a dense and sophisticated network of seismic intensity and sea level monitoring networks connected by redundant communication pathways. When an earthquake occurs, JMA quickly calculates its hypocenter and magnitude.

The JMA domestic tsunami forecast messages are divided into two general categories: Tsunami Warning (Tsunami height would be above one meter) and Tsunami Advisory (0.5 meter or less). The Tsunami Warning category is divided into two classes: Major Tsunami (three meters or higher) and Tsunami (up to two meters), depending on the estimated tsunami height (*see graph below*).Wave forecast arrival times and estimated wave heights are provided for 66 coastal forecast regions. In addition, if a tsunami is generated, JMA announces observed data as tsunami information. When the threat of tsunami is over, JMA issues a cancellation.

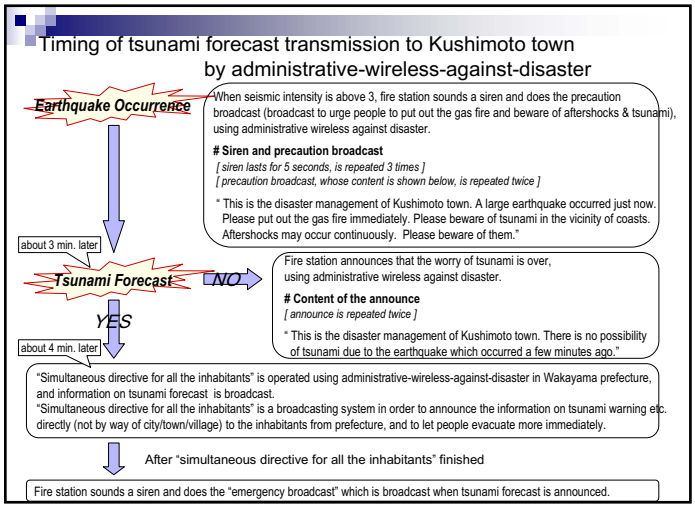
Left, example of NHK television earthquake and tsunami map that is automatically generated from JMA data. Below, Chart showing JMA tsunami forecast categories.

Category		Estimated tsunami height to be shown in the Forecast Message
Tsunami Warning	Major Tsunami	3m, 4m, 6m, 8m, 10m or higher
	Tsunami	1m, 2m
Tsunami Advisory	Tsunami Attention	0.5 m

JMA disseminates its local earthquake and tsunami messages to a wide range of customers, including the Cabinet Office (National Disaster Management Office), Prefectural and Municipal Disaster Management agencies, the media. For a detailed description of JMA operations, see *http://www.jma.go.jp/en/tsunami/*.

Wakayama Prefecture & Kushimoto City

Within the Wakayama Prefecture and Kushimoto Municipal Disaster Management Offices, the JMA



Kushimoto City presentation slide showing timeline of their local tsunami emergency response.

messages are received through multiple communication pathways (landlines and satellite) to 24/7 emergency command centers within about 4 minutes after earthquake origin time. At least three (3) locations can initiate public alerts using community siren towers with voice capability, and provide redundant, back up levels of organizational response. The 24/7 agencies are located within the Wakayama prefecture and Kushimoto municipal disaster management agencies, and the Kushimoto municipal fire department.

Three duty staff at the Wakayama Prefecture Disaster Management Office, and one person at the Kushimoto Municipal Disaster Management Office are working nights and on weekends. They are either government workers, or in the case of Wakayama Prefecture, employees of a communication company providing technical services to the agency.

Possibly the most unique feature of the area's SOP, is the amount of autonomy given the duty staff to respond to warning conditions. Staff on duty are delegated decision-making authority to immediately enact public notification SOP procedures.

Importantly, enactment of SOP's are based on (1) initial felt strong ground shaking conditions of JMA Seismic Intensity IV or greater (causing falling objects or violently swaying light fixtures); or when they feel a "slow earthquake" where there is low intensity ground shaking that lasts unusually long (a few minutes); and/or (2) the receipt of JMA official messages. The duty staff can initiate a "heads up" siren tower loudspeaker broadcast before the JMA domestic messages are received, based simply on felt earthquake ground shaking. This announcement tells people to be alert to turn off any gas valves and to be alert to the possiblity of a tsunami. It is not a formal evacuation order. This "heads up" announcement and siren alerts are broadcast to the

Wakayama, *continued*

community immediately, because media broadcasts may not otherwise reach coastal residents near the earthquake epicenter.

When formal JMA messages are received, the disaster management agencies take action. There exists at least a two tiered evacuation procedure associated with a JMA issued tsunami warning or advisory. A tsunami warning represents the highest level of tsunami evacuation, while a tsunami advisory is a lower level precautionary evacuation or alert. Then, those on duty begin contacting personnel on roster lists to report to work. Later, when JMA issues a tsunami cancellation message, evacuation orders are cleared.

Additionally, Kushimoto occasionally conducts tsunami "warm body" (peopled) evacuation drills within its 46 wards. The voluntary participation rate is about 120 persons per ward.

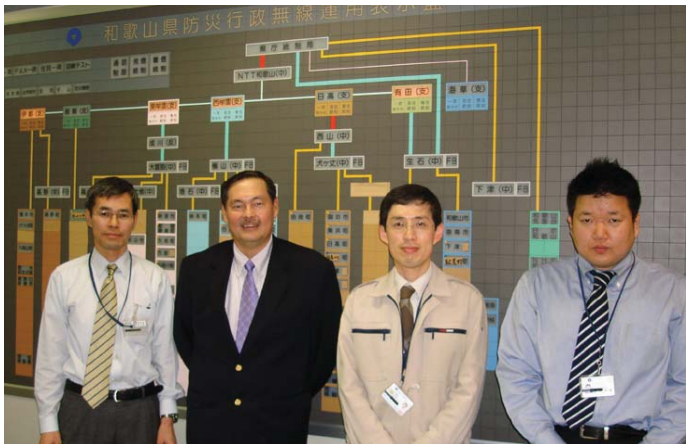
NHK

NHK public television, Japan's largest broadcasting company, has a cooperative agreement with JMA to immediately disseminate emergency broadcasts. NHK operates ten television channels and three radio stations. They are all employed in disaster situations with continuous and post event coverage.

JMA earthquake and tsunami data are automatically converted to NHK map graphics along with automatic broadcast scripts. There is a separate news anchor desk specifically designated for disaster news broadcasts on a 24/7 basis.

Moreover, NHK can engage over 400 remote controlled cameras throughout the country to observe disaster conditions. Helicopters can also be dispatched from eleven sites to provide aerial video coverage.

Top: JMA staff in a 24/7 operations room. Right, NHK Tokyo has a designated news anchor desk dedicated to disaster broadcasting on a 24/7 basis.



Wakayama Prefecture Disaster Management Office. Brian Yanagi, ITIC, second from the left, with Wakayama staff, standing in front of an emergency communications flow chart.

Tsunami Vertical Evacuation Shelters

The Japan National Cabinet Office issued tsunami vertical evacuation shelter construction standards. These standards were developed with structural engineering input, then compared and applied to existing buildings and structures within communities. The community can then designate any existing structures as tsunami vertical evacuation shelters based on the Cabinet Office policy and construction standards. The shelter standards are based on Japan seismic building codes to survive ground shaking; the presence of reinforced concrete construction materials; and the height of a building in relation to forecasted wave heights (i.e. for a one meter wave height, the building must be at least two floors high).

The Cabinet Office and other government agencies also provide funding to construct evacuation towers in locations where no inland evacuation routes are possible (*see photo backpage*). These evacuation towers are built with steel construction, with occupancy of 70–100 people. The evacuation towers can mount a siren, and can store supplies. Cost of construction per tower is $90,000 - $130,000 USD.

Water Hazard Countermeasures

Japan is famous for construction of water hazard countermeasures such as breakwaters, dikes, massive seawalls, water and lock gates (*see cover photos*). These structures protect communities from water hazards such as storm surge and tsunamis that can inundate a coastline and travel further inland through rivers or canals. The Ministry of Land, Infrastructure, and Transport (MLIT) administers the Japan Seacoast Management and Rehabilitation Program. Costs of

Wakayama, *continued*

various structural countermeasures were unavailable. However, about four percent of Japan's national budget is devoted to such multi-hazard structural countermeasures.

Disaster Countermeasures Basic Act

Japan has model national legistation, entitled the "Disaster Countermeasures Basic Act". Its purpose is to protect the national territory, and the lives and property of citizens. The Act's objective is to establish a mechanism that assigns disaster responsibilities, working through prefecture and local governments, and public corporations. Moreover, these governments are to formulate and fund multi-hazard disaster prevention plans and basic policies relating to preventive and emergency response and rehabilitation efforts. These actions help to ensure an effective and organized administration of comprehensive and systematic disaster prevention, with a view toward the preservation of social order and public welfare.

The Act also established a Central Disaster Management Council, chaired by the Prime Minister. The Council is a national coordinating body which includes relevant national agencies, the Red Cross, Public Television, and other semi-public agencies. For example, when there is earthquake ground shaking, many Japan utility companies (gas, electricity, etc.) and transport systems (railways, subways, etc.) initiate a voluntary shut down of their systems. The Cabinet Office is responsible for submitting an annual report on the status of disaster countermeasure activities to the National Diet. Furthermore, there is an annual "Disaster Prevention Day" public awareness program.

Left, an example of a Japanese tsunami vertical evacuation steel tower. Above, sign indicating elevation along a street in Kushimoto City.

More information on the Disaster Countermeasures Basic Act is available at *http://www.adrc.or.jp/nationframe.php?URL=./management/JPN/Japan_dcba.html&Lang=en&NationCode=392*.

Conclusion

In conclusion, Japan has a comprehensive and mature "end to end" Tsunami Early Warning and Mitigation System (TEWS). Japan offers many examples of "best practices" for local tsunami emergency response. JMA has effectively linked its TEWS operations to Japan disaster management agencies and media to rapidly alert the public. Japan relies on well written Tsunami Emergency Response Plans and Standard Operating Procedures to automatically implement its disaster activities. Japan is successfully engaged in comprehensive multi-hazard disaster planning at all levels of government.

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 30 Member States with official 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, Papua New Guinea, Peru, Philippines, Republic of Korea, Russian Federation, Samoa, Singapore, Thailand, Tonga, United States of America, and Vietnam.

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