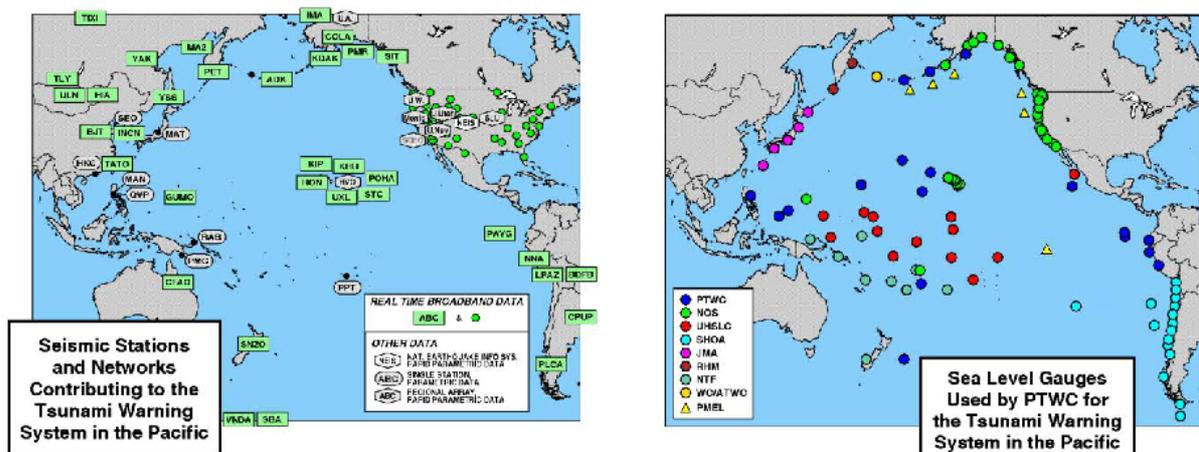


## GLOBAL AND REGIONAL TSUNAMI EARLY WARNING SYSTEMS

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With development in the Pacific accelerating as harbors and industrial infrastructures are developed to support commerce and the accompanying population increase, Pacific coastlines, encompassing at least 23 countries and 21 island states, are now more vulnerable than ever to tsunami disasters. In the 1990s, local tsunamis claimed more than 4200 lives and caused 100s of millions of dollars in property damage. The most destructive recent Pacific-wide tsunami was generated by a M9.5 earthquake off the Chile coast in 1960; all towns along 800-km of coastline were destroyed causing \$550 million in damage, killing 2000, and leaving 2 million people homeless. Moreover, the tsunami traveled across the Pacific, killing 61 people in Hawaii, and over 100 in Japan more than 20 hours later and 5000 km away from the tsunami source.

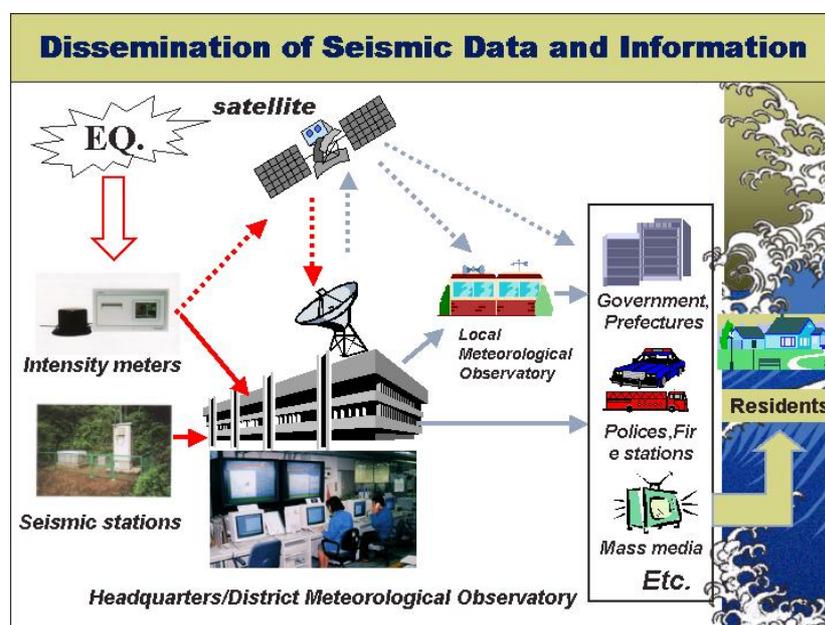
The Tsunami Warning System in the Pacific (TWSP) is a global international early warning system dedicated to the monitoring of tsunami hazards in the Pacific and dissemination of timely warnings on potentially destructive distant tsunamis. The International Tsunami Information Centre (ITIC), established in 1965 by the UNESCO Intergovernmental Oceanographic Commission (IOC), oversees many of its functions, including monitoring of the TWSP's effectiveness, and facilitating technology transfer to countries establishing national warning systems. Warning operations are headquartered at the Pacific Tsunami Warning Centre (PTWC); the USA hosts both ITIC and PTWC. A 25-member International Coordination Group for the TWSP (ICG/ITSU), established in 1968 by UNESCO/IOC, acts as the coordinating body for the system. The Tsunami Programme and ICG/ITSU are unique among the IOC activities as they oversee a fully operational and successful early warning system solely dedicated to saving lives and property. The early warning system is based on real-time earthquake data from over 100 stations to monitor global seismicity for initial warning, and water level data from over 100 stations for monitoring the tsunami.



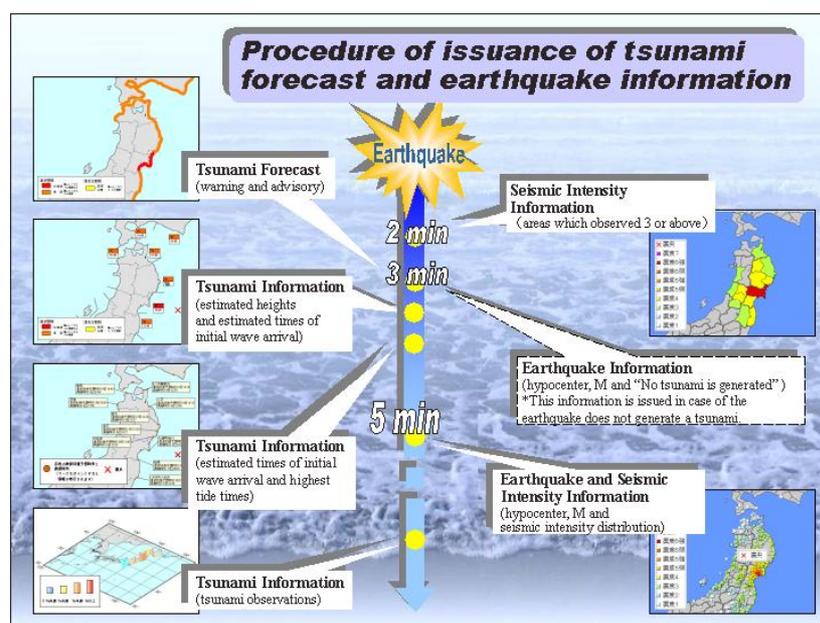
The warning must be rapid to allow local authorities to act, accurate so that warnings are issued for all destructive tsunamis while minimizing the economically-costly false warnings that undermine credibility, and reliable to enable continuous operations where messages are sent, received, and understood promptly by all. To ensure system robustness, the data and messages are relayed redundantly through various

telecommunication channels including dedicated telephone, radio, microwave, and satellite circuits and the Internet. Over the past 10 years, increases in the quality and quantity of data, and the implementation of automated processes and new scientific methodologies, have resulted in more than 60% decrease in the time required to issue an alert. For most events, warning system participants can now expect to receive tsunami potential information within 20 minutes of the earthquake's occurrence, much faster than the typical one hour or more in 1993.

National Tsunami Warning Systems are operated by a number of countries whose coastal communities are subject to the tsunami hazard. For a locally-generated tsunami, which can come ashore within minutes with deadly force, warnings must be immediate and the public must also be educated and prepared to respond automatically to the natural shaking caused by large earthquakes.

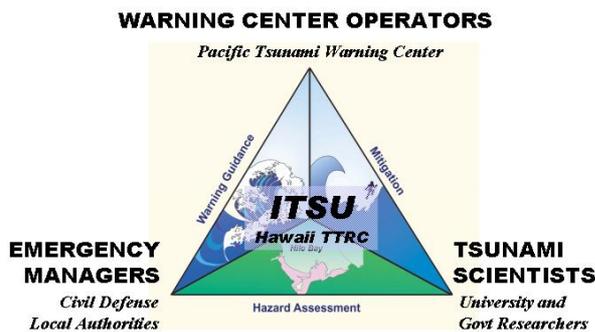


Among the most effective and advanced national tsunami warning systems is that of Japan, which has a long history of tsunami disasters. Operated by the Japan Meteorological Agency (JMA) and using hundreds of seismometers to locate the earthquake and measure the shaking intensity in real time, the system broadcasts seismic intensity information within two minutes and tsunami warnings within three minutes to the public.



National Tsunami Warning Systems are also in operation in Chile, French Polynesia, Russia, and the USA. Through ITSU coordination, regional and national warning systems are also being actively implemented in Central America with assistance from CEPREDENAC, in Indonesia and the Southwest Pacific and

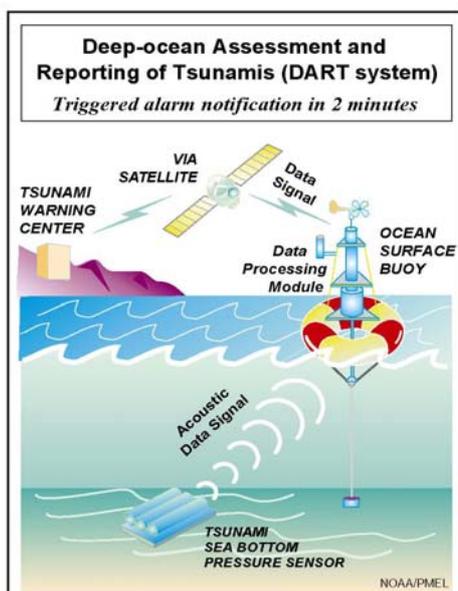
Indian Ocean, for the northwestern Pacific led by JMA, and in the Caribbean.



The PTWC also operates a regional early warning system for the State of Hawaii, USA. Urgent local tsunami warnings are issued within five minutes. The warning message content and protocols, and efficiencies in response by the civil defense authorities, have benefited significantly from close interdisciplinary relationships and warning response exercises between PTWC, civil defense, the science advisors, and other stakeholders. Like ITSU, the Hawaii Tsunami Technical

Review Committee (TTRC) acts as a central organizing committee for coordinating the implementation of projects and policies aimed at reducing the risk of tsunamis to the State of Hawaii. The TTRC consists of a broad cross section of scientists, engineers, planners, emergency managers, and public affairs personnel from Federal, State, and County government and non-government organizations. Hawaii tsunami warnings and protocols, and efficiencies in disaster response by civil defense authorities, have benefited significantly from close interdisciplinary relationships, warning response exercises, and collaborative tsunami awareness activities carried out by the PTWC, civil defense, tsunami advisors, and other stakeholders. Additionally, emergency agencies have made multi-sector mitigation efforts to build capacity through increased community and media preparedness education on the phenomena and how to respond to warnings; evacuation maps have been included in the telephone books since the early 1990s, and schools in inundation zones hold tsunami evacuation drills.

At the same time, new technologies have been developed by the research community to improve the detection of tsunamis. These include the TREMORS system, an automated single station earthquake detection and tsunami evaluation system, the DART system, which detects tsunamis in the open ocean, and the coastal runups gauge, a low-cost, rapid flood detection system aimed at detecting landslide-generated local tsunamis caused by smaller, non-alarm earthquakes.



### New Detection Technologies

Left: Tsunamis are detected in the deep ocean in real time by sea-bottom sensors. Below: Coastal runup gauges immediately trigger when flooded.

