Chapter 8

Dissemination and Notification

The tsunami warning system end-to-end chain of events, from collecting data to issuing an alert, will only protect the people within a center's area of responsibility (AOR) if individuals and groups receive the message in a timely fashion, understand its meaning, and take appropriate action. The initial link in the chain, earth data observations, requires partnerships between a tsunami warning center and the international community to access global seismic and sea level networks. Similarly, the dissemination and notification link requires partnerships between the center and the many national and local groups and individuals within its AOR. This chapter will discuss the distinctions between dissemination, (the process of physically getting the message to customers within a center's AOR) and notification (the understanding of the received message), along with the methods for each. Outreach and education focus on methods to increase the likelihood that customers will take appropriate actions. This chapter should be read by persons who need to understand this difference between dissemination and notification, and what a National Tsunami Warning Center (NTWC) or Regional Tsunami Watch Provider (RTWP) needs to do to be successful at these tasks.

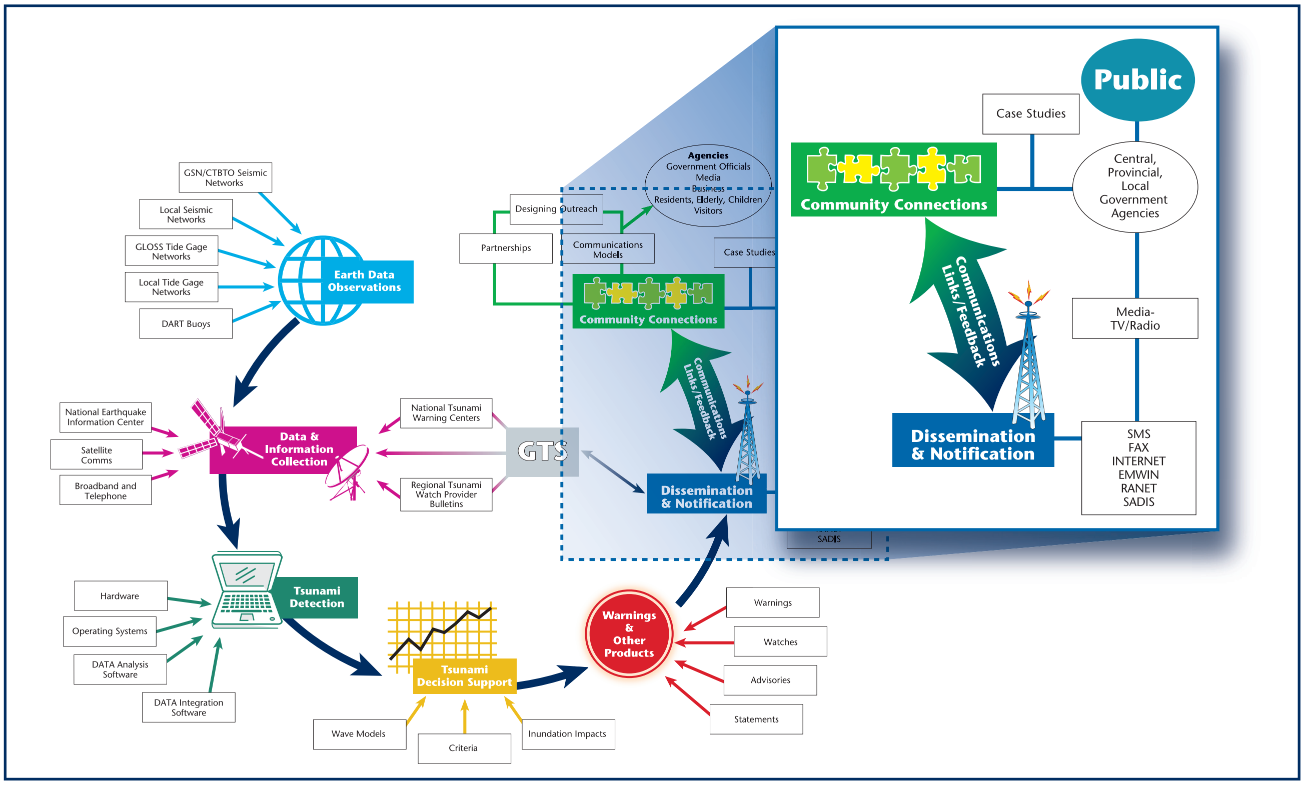


Figure 8-1. Notification and Dissemination Requirements for a Tsunami Warning Center

How Do Warnings and Other Products Fit into an End-to-End Tsunami Warning System?

As noted above, once a warning or other forecast/advisory product has been produced by a center, it must be conveyed to the many groups and individuals in the center's AOR. Once received, the product must be understood and acted upon appropriately. National and local emergency management officials and other government, academic, and private sector individuals usually play a major role in educating the populace, and helping local groups establish resilient communities, evacuation routes, and other procedures.

NTWCs and RTWPs play a significant and crucial role in this outreach and education effort too, especially with regard to receiving valuable feedback on product formats and dissemination methods. This feedback can assist the center in designing products that better meet customer needs. Feedback can also assist in identifying problems with dissemination channels.

What Is in this Chapter?

This chapter contains sections that discuss the following topics:

- **Regional dissemination methods**, including the Group on Earth Observations' (GEO) GEONETCast, Emergency Manager's Weather Information Network (EMWIN), and Radio and Internet for the Communication of Hydro-Meteorological and Climate-Related Information (RANET)
- **Notification procedures**, including warning system design, warning channels, and warning message content
- **Community preparedness**, including the TsunamiReady and Coastal Community Resilience programs
- **Training resources**

What Are the Most Important Points to Remember about Dissemination and Notification Requirements for NTWCs and RTWPs?

- Dissemination refers to the process of physically getting the message to partners and customers, while notification refers to the understanding of the received message by these same partners and customers.
- National and local emergency management officials and other government, academic, and private sector individuals usually play a major role in educating the populace.
- NTWCs and RTWPs also play a significant and crucial role in the outreach and education effort.

Dissemination

Dissemination refers to the process of physically getting the message to RTWP and NTWC customers. This is in contrast to notification, which is the understanding of the received message and, through outreach and education, customers taking appropriate actions. Warnings about events that are seconds, minutes, or hours away need to be disseminated rapidly through special warning systems using messages that have been designed during calmer times to encourage the desired behaviors. They may be for hazards that people can clearly perceive, such as a hurricane, or they may be for hazards that cannot be perceived without specialized equipment or access to intelligence information. In these latter cases, it is critical that the warning system and its operators have a high level of credibility so that people feel compelled to take action based solely on the warning message.

Some of the discussion in this section is based on the Partnership for Public Warning (PPW) publication, “Developing a Unified All-Hazard Public Warning System, a Report by the Workshop on Effective Hazard Warnings,” Emmetsburg, Maryland, November 25, 2002 (PPW Report 2002-02).

Warnings are primarily a local government responsibility. Disasters are local, and local government has the primary responsibility to look after the welfare of its citizens. Thus local government has the primary responsibility to warn its citizens and help them to prepare for, respond to, and recover from disasters. However, it is beyond the capability or capacity of local governments to see that a unified, multichannel, nationally standardized system is available to them for delivering warnings to their citizens.

Most warnings originate from government organizations. Some state and many Federal agencies develop warnings through extensive research and instrument or intelligence networks. In these cases, warnings are often issued by Federal agencies, but usually in close cooperation with state and local emergency managers. For example:

- National meteorological services issue warnings of severe weather and flooding focused on specific localities throughout their countries, and have done so for many years.
- National geological survey agencies issue warnings of earthquakes, volcanic eruptions, and landslides.

Most public disaster warnings are issued by government agencies because in the absence of clear standards of best practice, private organizations could incur significant liability. Many private organizations do issue warnings, for example for weather, but these are usually covered by contracts that limit liability. Media weathermen may refine local warnings for their community but must remain mindful of standards of best practice.

Warning systems require a national partnership between government and industry. Mass warning devices, such as sirens, are typically owned and operated by local government or managers of critical facilities. Warnings can be issued through telephones, pagers, computers, and many other personal communications devices, wired and unwired. The media play an important role in disseminating warnings. Thus, most warning delivery systems need government input, but are manufactured, owned, and operated by private industry and individuals. The government cannot afford to provide the devices that reach every person at risk. Industry can and will provide such devices, or include this capability in all types of devices sold primarily for other purposes, if there are clear national standards that create a national market. There must be an effective public-private partnership between government and industry to deliver warnings.

Tip

The **MEDIA** play a crucial role in disseminating warnings.

The private sector offers complementary resources and necessary infrastructure (e.g., telecommunications networks) that are needed for disseminating warnings. Civil society provides social infrastructure at the grass roots (from **http://www.lirneasia.net/2005/03/national-early-warning-system/**, National Early Warning System: Sri Lanka (NEWS:SL), A Participatory Concept Paper for the Design of an Effective All-Hazard Public Warning System (Version 2.1), Rohan Samarajiva, et al., LIRNE*asia*, Sri Lanka). The use of already existing capacities is not only cost-effective, but ensures the continuity and maintenance of the system during periods where there are no hazard events. The cost to the government of implementing a nationwide warning system is significantly less when all stakeholders shoulder the costs for maintenance, management, and service.

Successful partnerships can be fostered by identifying the key beneficiaries of a warning system, such as the hotel industry and the insurance industry, in addition to the general public. The government can work with such partners in developing and implementing a warning system. The government can provide authority for the system, while the private and civil society sectors provide the mechanisms to get the warning out as fast as possible to all the potentially affected people. There is an ongoing role that the private sector, especially the media, can play in raising education and awareness. The tasks of education and trust-building at the community level are often best done by civil society organizations like the International Red Cross, television channel and newspaper environmental reporters, etc.

Authority is something that has to come from the government. The government must take the ultimate responsibility for the issuance of a warning. People need assurance that a warning message is legitimate before making the sudden decision to abandon their possessions and evacuate the area. They cannot afford to waste precious minutes verifying warning messages to ensure that they are making the right decision. False alarms cost money, breed cynicism, and undermine the credibility of the warning organization.

Warning Message Timing

Centers should be prepared to disseminate specific warnings even if there is a high level of uncertainty about the threat, because the information needed to reduce that uncertainty might arrive only shortly before the incident occurs. In such cases, casualties could occur because an official warning could not be received and acted upon in time by all of those at risk.

Authorities must not withhold information because of concerns for public panic (which is commonly anticipated by authorities but almost never occurs). If authorities do not provide information, people will seek it from other—usually less reliable—sources.

Repeated warning messages at regular intervals ensure that those who missed an earlier warning will have another chance to receive it, and those who ignored an earlier warning will have another opportunity to respond. Repetition also provides those who did not understand an earlier warning another opportunity to comprehend it and those who did not believe an earlier warning another opportunity to reconsider.

Information must be updated quickly when conditions change significantly so that people can adapt their responses to the new situation.

Bulletin Dissemination

Each center needs to inventory all international, national, and local government agencies, and media that require timely receipt of its tsunami bulletin messages. Recipients and communication methods should be identified, established, and tested on a routine basis. Dissemination processes should not be manual; they should be automated as much as possible in order to improve efficiencies that decrease the time required to issue warnings. Automation also decreases elements of human error. Whenever possible, centers should use redundant communications paths to ensure the receipt of critical data and dissemination of important bulletins.

The center should establish protocols between domestic organizations for acquiring information in a timely manner. Improved protocols must be established for seamless transfer of information and data between agencies to ensure the warning system is efficient and effective.

Interagency coordination, operations, and policy issues must be addressed by the NTWC or RTWP. This includes, but is not limited to:

- Developing a “Matrix of Roles and Responsibilities for Key Agencies” supporting the center for tsunami forecasting
- Solidifying political commitment regarding interagency coordination to improve data sharing and agency support to the center
- Allocating sufficient personnel to develop and sustain the national early warning system

- Avoiding duplication by delineating clear lines of agency support. A Memorandum of Understanding between pertinent organizations is useful in delineating roles and responsibilities.

To meet international standards, the following national and local dissemination channels should be used to disseminate bulletins:

- Global Telecommunications System of the World Meteorological Organization (WMO GTS)
- Internet (Frame Relay)
- Internet email
- Telefax
- Internet websites
- RANET
- GEONETCast

The WMO Global Telecommunications Service is the backbone of the international hydrometeorological data dissemination system, but telefax and email are also widely utilized. Two levels of product are distinguished and given separate WMO identifiers:

> The International Civil Aviation Organization (ICAO) maintains an international network of global aeronautical telecommunications circuits for the relay of aeronautical and meteorological data, forecasts, and warnings, for the benefit of the aeronautical users. The Aeronautical Fixed Telecommunications Network (AFTN), used for collection and dissemination of aeronautical and meteorological information for aviation users, is being replaced by higher-speed aeronautical circuits that can be utilized for dissemination of multi-hazard warning messages.
>
> GEONETCast, a planned global multi-hazard dissemination system within the Global Earth Observation System of Systems (GEOSS), shows promise as a reliable primary dissemination method for tsunami products and warning messages.

Warning centers have found that it is important to limit the number of primary dissemination channels and steer customers to those methods. It is recommended that NTWCs and RTWPs use the WMO GTS as the primary dissemination channel for tsunami watch, warning, and advisory products, with secondary and complementary communications systems, such as the satellite-based GEONETCast, EMWIN, and RANET broadcasts as backup. Figures 8-2a and 8-2b show dissemination channels used by the West Coast/Alaska Tsunami Warning Center (WC/ATWC) and Pacific Tsunami Warning Center (PTWC), respectively.

Tip

Tsunami warning centers should strive to limit dissemination channels to a manageable number.

West Coast/Alaska Tsunami Warning Center Message Dissemination Routes

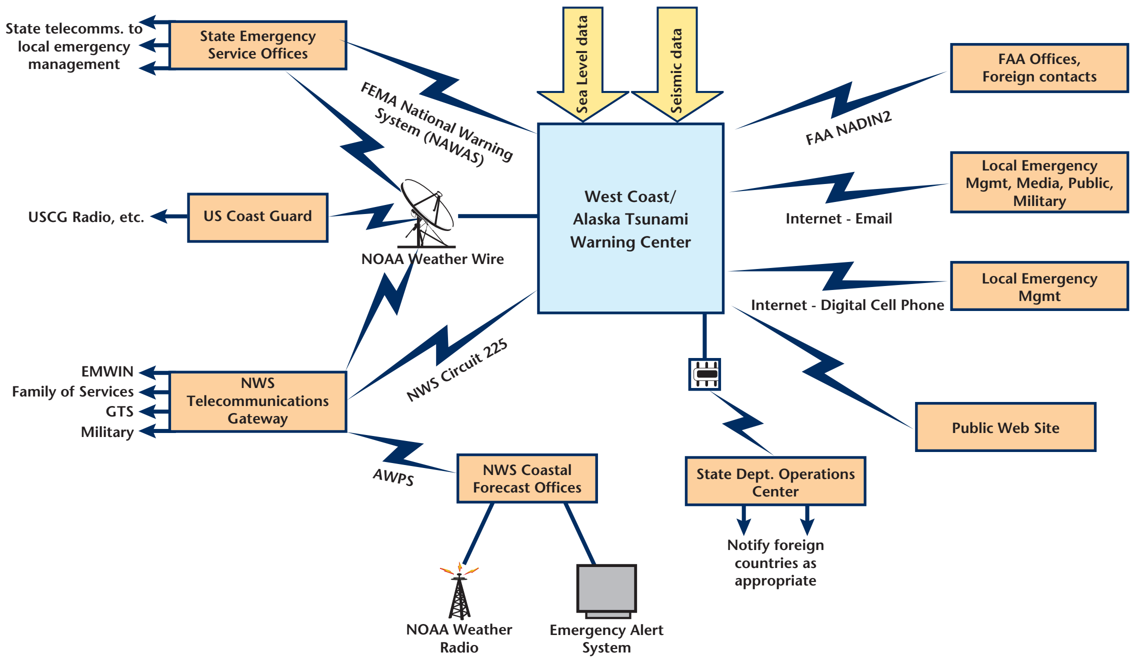


Figure 8-2a. WC/ATWC Dissemination Channels

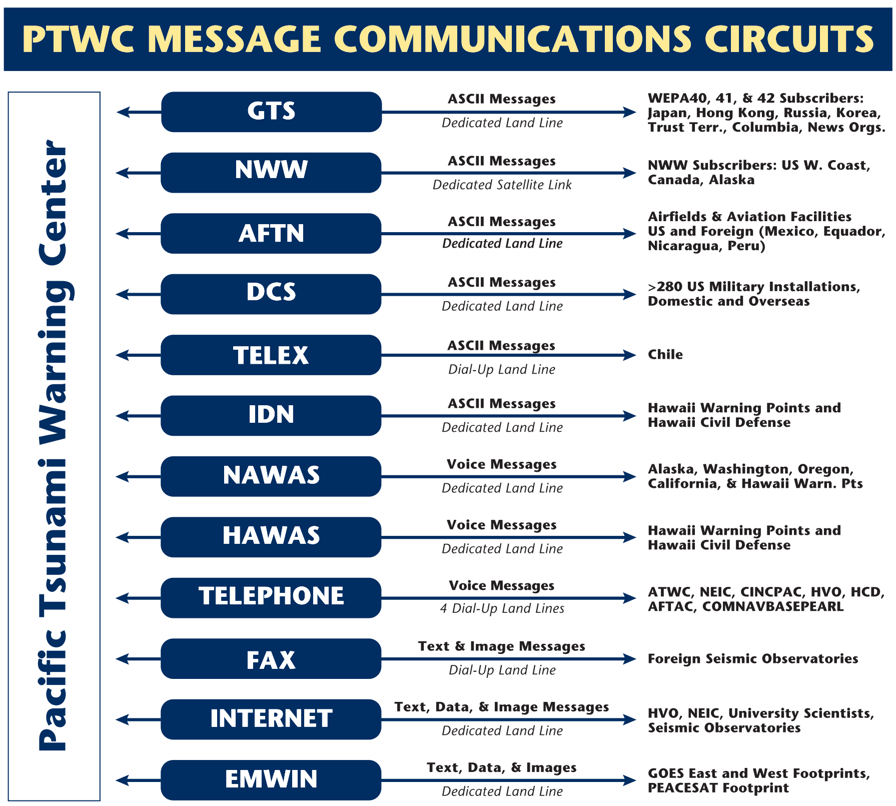


Figure 8-2b. PTWC Dissemination Channels

NTWCs should also strive to establish ways to confirm that both automatic and manual tsunami watch, warning, advisory, and test messages are received by responsible national, regional, and local government agencies. Dissemination techniques need to take advantage of new communications technologies, including cell phone text messaging via Short Messaging Service (SMS), syndicated news feeds via Really Simple Syndication (RSS), Extensive Markup Language (XML/CAP), and Enhanced Multilevel Precedence and Pre-emption Services (EMLPP).

Warning Receivers

Warning message electronic receivers should be used on a daily basis, or they will be put away and forgotten by the public. Ideally, warning capabilities will be found in commonly used appliances, such as radios, cell phones, and telephones, in the near future.

- Receivers must take into account the fact that many people are not adept in the use of advanced technology.
- Warning alerts must be distinct, attention grabbing, and not appear to be another common occurrence. Ideally the alert will provide an indication of the hazard threat level.
- Receivers should provide individuals with the opportunity to test the system themselves; for example, calling a toll free number which sends an alert message only to their receiver.

Warning System Reliability

Even the most carefully designed warning system requires continual maintenance to ensure that it will be effective. Critical phases of maintenance include training, evaluation, and development. Core elements must be used every day, with regular testing by the end user.

Important Points to Remember about Dissemination of Tsunami Warnings

- The WMO GTS is the backbone of the international dissemination of hydrometeorological data products and watch, warning, and advisory messages, and is both point-to-point, and point-to-multi-point. Telefax and email are also widely utilized. The International Civil Aviation Organization (ICAO) Aeronautical Fixed Telecommunications Network/Aeronautical Telecommunications Network (AFTN/ATN) is the backbone for dissemination of aeronautical and meteorological data, and because of its reliability for use by air traffic agencies, is suitable for dissemination of tsunami products to aeronautical users.
- Secondary and complementary communications systems, such as the satellite-based GEONETCast, EMWIN, and RANET broadcasts should be established as backup dissemination channels, although it is acknowledged that in some developing countries, they may be a primary means for receipt of tsunami messages.

- Centers have found that it is important to limit the number of primary dissemination channels and steer customers to those methods, if they are readily available.
- Dissemination techniques should take advantage of new communications technologies.
- The media play an important role in distributing warnings.
- Repeated warning messages at regular intervals ensure those who missed an earlier warning will have another chance to receive it, and those who ignored an earlier warning will have another opportunity to respond.
- The dissemination processes should be automated as much as possible to decrease the time required to issue warnings.

The Emergency Managers Weather Information Network (EMWIN)

Damage from powerful weather and tsunami events, and the threat of serious civil disasters, has illuminated the pressing need to keep the emergency management community up-to-date with the latest information. NOAA's National Weather Service, aided by the National Environmental Satellite Data Information Service (NESDIS) Geostationary Operational Environmental Satellite (GOES) satellites, is using EMWIN to supply vital information to computers throughout North and South America, the Caribbean, and much of the Pacific Ocean basin. The popularity of EMWIN has flourished from its inception, with support from public and private organizations.

What is EMWIN?

EMWIN is a weather warning and data broadcast system that provides rapid dissemination of warnings, forecasts, graphics, and imagery to a desktop computer. The goal of EMWIN is to give emergency managers the capability to respond faster to tsunamis, severe weather, and other threats. That means greater lead times to warn and possibly evacuate communities. Faster response time improves the likelihood of sparing lives and property. The primary dissemination method is an L-band broadcast via the GOES East and West satellites. This allows the EMWIN signal to cover over half of the earth's surface. EMWIN is used both nationally and internationally, and the use of both satellites allows signal redundancy for many areas. The primary audience of EMWIN is the emergency management community; however, its low cost, no recurring fees, and ease of use has made it widely used by the general public.

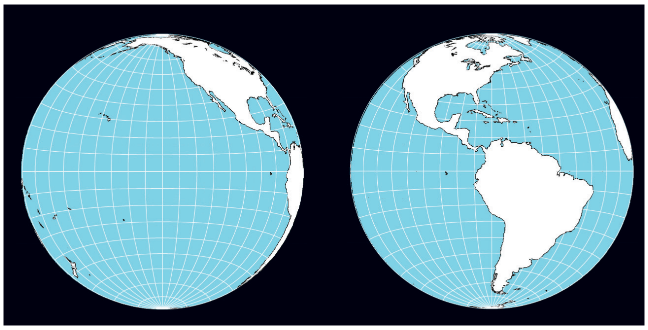


Figure 8-3. GOES West and East Satellites Coverage

How EMWIN Works

The National Weather Service (NWS) gathers live weather and emergency information from sources across the globe, and the EMWIN system broadcasts that data. As depicted in Figure 8-4, a satellite downlink enables users to access the EMWIN data stream of real-time weather information and other data. This provides a very reliable data receipt method that can function with little or no infrastructure, making it more reliable than wire and fiber optic systems in disaster situations. This fact has made EMWIN especially useful to island countries, prone to devastating hurricanes and tsunamis.

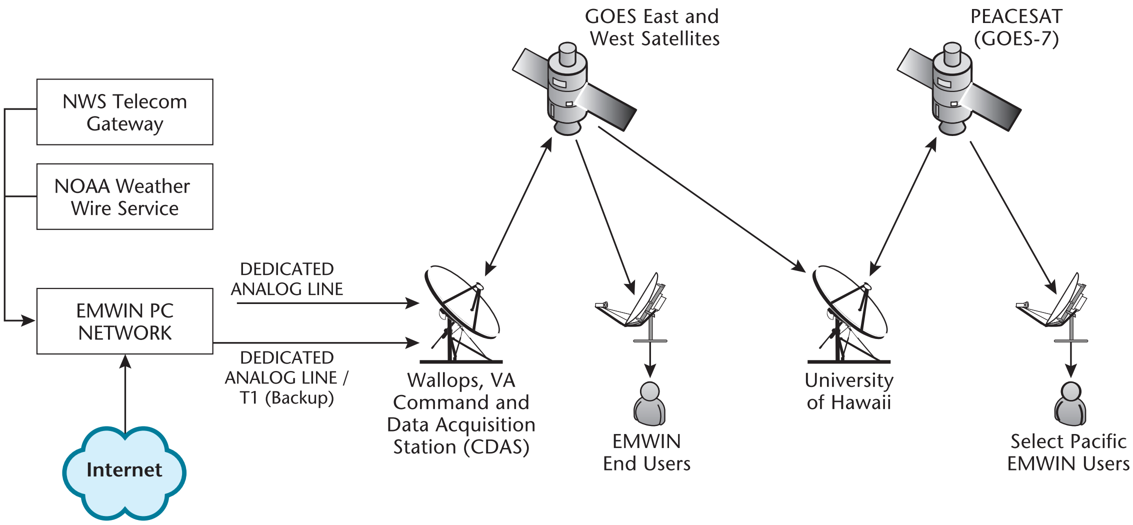


Figure 8-4. EMWIN Configuration

In addition to the GOES satellite broadcast, portions of the EMWIN data stream are also rebroadcast via very high frequency (VHF) radio by dedicated volunteers in certain areas. In the Pacific, the EMWIN signal is rebroadcast on the Pan-Pacific Education and Communication Experiments by Satellite (PEACESAT), operated by the University of Hawaii, thus extending the coverage to the eastern edge of Australia. The rebroadcast technologies allow local emergency management groups and municipal agencies to tailor the information to fit their specific area by filtering the products that do not apply and then allowing the insertion of additional products pertinent to the locality.

The broadcast is also available through the internet in its entirety via internet “push” technology. With this method, users with the appropriate software connect to one of the many EMWIN data servers and begin to receive the broadcast. They are then free to use the data and may also decide to allow connections to their personal computer (PC) if they wish to become part of the distributed network of EMWIN data servers.

Several vendors market EMWIN end user software with many outstanding features. The packages allow the users to display the text products, graphics, and imagery.

Some of the software packages allow users to configure their computer to trigger an alarm when a certain product arrives. Alarm features include automatic activation of lights, sirens, printers, pagers, electronic mail, and other forms of notification. The mail and paging options are extremely powerful. They allow users to receive email alerts and messages to telephones or handheld computers. One package even allows users to send mail to an internet paging service that will then convert the message to speech and call a list of phone numbers. Persons on the phone list will receive a call and a spoken alert.

International Use of EMWIN

A number of countries outside the United States have also begun to use EMWIN to assist with emergency management. This is particularly true in the Pacific Ocean, where EMWIN enjoys a robust partnership with many Pacific island nations through the dedication and coordination of the NWS Pacific Region. EMWIN is a major component of NOAA's contribution to assist the Caribbean region too. Part of the effort focuses on disaster preparedness and mitigation efforts to shield critical commercial and environmental infrastructure in the Caribbean from natural disasters, such as tsunamis and hurricanes.

Based on the feedback from countries initially utilizing the EMWIN capability, additional deployments throughout the Caribbean and South and Central America are planned. The Bahamas purchased a dozen EMWIN systems to ensure coverage for some of its 700 islands. Trinidad and Tobago also plans to deploy the EMWIN capability as part of its ongoing tsunami warning program. EMWIN can also be used as a template for other countries to develop a similar capability in order to tap into their own meteorological satellites.

Unfortunately, EMWIN satellite coverage on the NOAA GOES satellites does not reach into the Indian Ocean region. The orbital position of the GOES West satellite is 135° west longitude and the orbital position of PEACESAT is 175° west. As a result, the usable range of a global beam from GOES West extends to approximately 155° east, and a global beam from PEACESAT extends to approximately 110° east longitude for stations located near the equator. The longitude of Malé and Colombo are 73° 30' and 79° 52', respectively, so the EMWIN system does not provide coverage to these countries.

In addition on the current NOAA GOES satellites, there are brief satellite outages ranging from several minutes up to 60 minutes during each 3- to 4-day satellite eclipse period, each spring and fall. Since tsunami warning information is of a time-critical nature, such outages pose a threat to warning delivery of what is presumed to be the backup system for a terrestrial link. Any loss of terrestrial communications during the eclipse periods would potentially put a station at risk of not receiving a timely warning if EMWIN were to be used as the sole satellite backup to the terrestrial line. Of note is that EMWIN serves as the most reliable source of critical weather information for many Pacific Island countries.

The Future of EMWIN

EMWIN will undergo a transition to remain compatible with the next series of GOES satellites, the GOES-N through P constellation. A transponder dedicated for EMWIN use has been provided on this constellation. Sometime before 2011, the current GOES satellite will be replaced by the new series. All current EMWIN users will need to migrate to newer technologies due to frequency, power, and modulation changes. To meet these future needs, NWS has teamed with NESDIS to develop the EMWIN-N proof-of-concept receive system. Moving to the EMWIN-N broadcast will allow the NWS to make use of improved technologies and will double the current data rate, as well as allow for the use of additional product compression. The EMWIN team is also currently in discussions with NESDIS regarding specifications for the EMWIN broadcast in the GOES-R series of satellites. This collaboration will ensure EMWIN's continued availability well into the future.

Transmission Protocol

EMWIN is designed to be an open system. The format of the EMWIN data-stream transmissions is in the public domain and presented here. This format is intentionally simple to enable reception by a wide range of user hardware. This format, called the Quick Block Transfer protocol, is used across all of the EMWIN dissemination methods, whether radio, satellite, internet or direct cable.

The EMWIN data stream consists of NWS products and other data files. Each product or file, whether American Standard Code for Information Interchange (ASCII) text or binary data, is divided into 1-kilobyte (KB) packets and sent as a series of asynchronous (async) 8-bit bytes, N parity. For example, most current EMWIN radio broadcasts are receivable, when demodulated, as async 1200,8,N,1, while the satellite broadcasts are async 9600,8,N,1.

Each product or file is sent as one or more packets, which are numbered 1...N within the given product. Because the data is packetized, a particular product can be gracefully interrupted by a high-priority warning or alert product and then resume. Note that because the broadcast is receive-only, the receiver has no means of notifying the transmitter of any block errors or of requesting retransmission of individual blocks. Instead, each product is usually transmitted at least twice, to "fill in" any blocks received in error.

Each packet of data contains 1116 bytes, in the following fields:

1. 6 bytes of ASCII 0 (null) to clear the receiver buffer.
2. "/PF" followed by an 8-character file name, a period, and a 3-character file type.
3. "/PN" followed by the block number—the number of this block (1..N) within this file.
4. "/PT" followed by the total number of blocks (N) being sent for this file.

5. "/CS" followed by a checksum number—the sum of all bytes in the 1024-byte data portion of this packet, as a 16-bit unsigned decimal.
6. "/FD" followed by the date/time stamp of this file—in the format of: MM/DD/YY HH:MM:SS AM, without space padding.
7. ASCII 32 (SP) fill—to pad the total bytes in fields 2..8 to a full line of 80 bytes.
8. ASCII 13 (CR) and ASCII 10 (LF) to enhance readability.
9. The data, as a 1024-byte block; if the remaining data of the product is less than 1024 bytes, this block is null-filled so that each packet's data block is always 1024 bytes long.
10. 6 bytes of ASCII 0 (nullNUL) to clear the receiver buffer.

An example of a typical packet header is:

/PFZFPSFOCA.TXT/PN 3 /PT 5 /CS 63366 /FD2/10/95 5:24:26 PM

The content of the NWS products (in the 1024-byte blocks) may be plain ASCII text or graphics or imagery. The products are not encrypted, but will often be compressed. Interpretation of the content of the products is up to the receiver's software. Details of the particular text, graphics, imagery, and compression formats are given below.

Text. Text products are transmitted in English and are usually public forecasts. However, some products may contain a variety of abbreviations or weather-specific acronyms, or may simply be "readable" tables of computer-summarized data. The content is generally 7-bit printable ASCII text, but often also contains hex bytes C5, 80, 03, or 83.

The first line of text of a product is the "WMO" heading, which includes a 4- to 6-character product identifier, a 4-character source site code, and a 6-digit origination date/time in Coordinated Universal Time (UTC). The next line may contain an Advanced Weather Information Processing System (AWIPS) identifier, of 4 to 6 characters portion. In some products, the next line (or embedded lines) may be a Universal Generic Code (UGC) line, giving the specific states, zones, or counties to which the product applies, plus a product-purge date/time (UTC).

Graphics. Graphic products are transmitted in NWS Universal Transmission Format (UTF), a display-independent format. The UTF format includes vectors, characters, and gridded data, but not bitmaps or rasters. It was originally designed to be closely compatible with low end display monitors. The EMWIN UTF products are typically national or regional coarse radar images that can be zoomed by the display software.

Imagery. Satellite weather images (products from GOES) and other interesting pictures are transmitted in standard formats as indicated by the file type/extension. Currently, .GIF and .JPG are used.

Compression. Local data and watches/warnings/advisories are transmitted as clear text and not compressed. Other national data products, such as all surface observations (METARs) for a given hour, are first packed into one “file” and then compressed and transmitted. The EMWIN “UNPACKER” software task will decompress these files upon receipt, and then unpack the constituent data products as if received normally.

The compression/decompression software used is the standard PKUNZIP Data Compression format.

For more information. News updates and additional EMWIN background information can be found on the EMWIN website at: **http://www.nws.noaa.gov/emwin/index.htm**.

Important Points to Remember about EMWIN

- EMWIN is a warning and data broadcast system that provides rapid dissemination of warnings, forecasts, graphics, and imagery to a desktop computer.
- EMWIN can supply vital information to computers throughout North and South America, the Caribbean, and much of the Pacific Ocean basin.
- In addition to the GOES satellite broadcast, portions of the EMWIN data stream are also rebroadcast via VHF radio by dedicated volunteers in certain areas.
- The broadcast is also available through the internet in its entirety via internet “push” technology.

Radio and Internet Technologies for the Communication of Hydro-Meteorological and Climate-Related Information (RANET) to Rural and Remote Communities

RANET is a collaborative effort of many national hydro-meteorological services, non-governmental organizations (NGO), and communities. These varied partners come together to make weather and climate information available to rural and remote populations, which are often among the most in need of environmental forecasts, observations, and warnings. While significant advances have been made in our ability to predict and observe our environment, much of this valuable information remains inaccessible to those outside major cities.

RANET works with partners to identify new and existing technologies that can be utilized by rural communities in a sustainable way. RANET therefore engages in system development and network deployment, but also stresses training and community ownership to ensure that the networks it helps to create are long-lasting.

Tip

RANET has a simple mission: Help national and regional organizations get useful information that is locked in urban areas to rural and remote places in the hope of promoting sustainable development and reducing disaster impacts.

The RANET Approach

The concept and program of RANET was articulated by a number of national agencies and the African Center of Meteorological Applications for Development in the late 1990s. By 2001 the program had begun setting up networks and working with a number of communities. It began in Africa to address real infrastructure problems that face national meteorological and hydrologic services (NMHS) and the development community, but those working on RANET soon found that while the issue of rural communication may be pronounced in Africa, it is in fact a common challenge throughout the globe. As a result, RANET has been working in parts of Africa, Asia, and the Pacific for a number of years. New projects in the United States and elsewhere in Latin America and the Caribbean are likely to emerge in the future. While technology offers a number of solutions to the communication challenges in all these regions, RANET believes that its success is due to a community-based approached that stresses scalability, local ownership, and multi-purpose systems.

Many in the development community would refer to RANET as a "last mile" initiative from the hydro-meteorological community, meaning that the program attempts to deliver information directly to communities and bridge the access gap. There are many "last miles," so to be effective RANET has stressed scalability in its program. What does scalability mean? It means identifying solutions that are very inexpensive to initially deploy, that do not require much if any training, and that can be maintained and serviced with local resources. Whether it is a satellite ground station, a community FM radio station, an HF (High Frequency radio frequencies between 3 and 30 mega Hertz), email network, or other system, RANET works with partners to develop solutions that meet its scalability criteria.

Tip

SCALABILITY =

- inexpensive
- uncomplicated
- locally maintained

Local ownership is also key to sustainability. Simply put, equipment will not be maintained or utilized if ownership is not encouraged. To that end, RANET stresses community listening groups and encourages community associations be established that take on ownership and commitment to maintain equipment and networks. RANET may maintain the satellite platform as a public communications commons, but in the end the program is directed at the national level and equipment owned at the local level.

Finally, RANET encourages its networks to be utilized for other education and humanitarian purposes beyond that of earth science and services. Resources are too scarce to establish communication networks dedicated solely to weather, tsunami, and climate information. Moreover, often communities will not be interested in utilizing hydro-meteorological services and products until their other information needs in agriculture, health, and general education are met. RANET therefore seeks partnerships with organizations that provide useful information and that can share development of a joint network. While new technologies are helping to reduce barriers to knowledge, these technologies can only be of long-term use if community participation and dialogue are encouraged.

RANET Activity Areas and Programs

- **Training:** Communications technology has undergone significant change in just the last decade. Even in rural areas, new technologies allow for new ways of accessing knowledge. RANET provides training to the NMHS community on how to utilize these new systems and technologies.
- **Operations:** On behalf of the meteorological community, RANET maintains a number of operational systems that provide service to a number of countries and regions. These include satellite platforms and a mobile phone messaging infrastructure.
- **RANET Internet Presence Initiative (RIPI):** While the internet and World Wide Web does not reach rural communities, the technologies underpinning the internet are increasingly common across multiple platforms. Moreover, it is important for NMHSs to maintain a web presence that serves the regional and international communities. RANET therefore provides NMHSs with server capacity and training, such that they can maintain a web presence and build capacities utilizing such technologies.
- **RANET Satellite Broadcast Services (RSBS):** RANET works with national agencies to ensure that their information can be broadcast over various satellite platforms, which are appropriate for rural communities or intermediaries such as field extension workers. Traditionally, RANET has utilized capacity on the WorldSpace AfriStar and AsiaStar satellites through an agreement with First Voice International. Such capacity is used to send daily forecasts and agricultural bulletins, and even as part of a tsunami warning system.
- **RANET.mobi:** Mobile phones have become one of the most effective means to reach areas previously underserved by terrestrial communications. RANET is using mobile phone and has developed its own backbone infrastructure to support the collection of remote field data (under the Community Reporter Program), to send alerts to key decision makers, allow users to dynamically queue material on satellite broadcasts, and to allow NMHSs to provide forecasts and similar information through mobile messaging.
- **RANET Alert Watcher:** Utilizing mobile phone SMS (text messages) RANET is providing notification services to key emergency managers and other officials throughout Asia, the Pacific, and Caribbean regions. As a “heads up” system, RANET passes warnings, such as for tsunami, from regional centers to these key decision makers so that they know to seek additional information through official communications.

RANET Organization and Support

RANET is an international collaboration based upon the partnership and resources of many national weather services and related agencies, NGOs and private sector partners, as well as the communities in which RANET works. Base budgetary and technical support for RANET is provided by the U.S. Agency for International Development

(USAID) Office of U.S. Foreign Disaster Assistance (OFDA), the NWS, the Australian Bureau of Meteorology, the Australian Agency for International Development (AusAID), the New Zealand Meteorological Service Ltd., and New Zealand's international aid and development agency (NZAID). Many other donor nations and organizations have provided specific and significant project support. The communities in which RANET works, however, provide an invaluable resource of dedication and time, which in the end is what makes RANET work.

RANET is organized at the country level and most often through an NMHS. Each participant country appoints an individual or team to oversee the development and maintenance of communication infrastructure within the country. Additionally, the national points of contact work with communities to determine information needs and develop field sites. Eventual ownership of field equipment, however, is passed to the recipient community. Generally such ownership is through an existing local NGO or community association. RANET Global consists of a number of technicians and project managers who help to maintain common infrastructure, such as the satellite broadcasts, as well as coordinate resources to support national programs. Each region (Africa, Pacific, etc.) also organizes itself into leadership teams. Such teams consist of the national managers and other relevant individuals. The regional teams come together to mobilize resources, identify need, and articulate a shared vision forward.

News, updates, and further details on the RANET programs are available at **http://www.ranetproject.net**.

International Satellite Communications System (ISCS)

The ISCS is a satellite data distribution system operated by NOAA and the Federal Aviation Administration in support of the World Area Forecast System. The system is operated by MCI Corporation under a NOAA National Weather Service contract. The ISCS support of WAFS is on behalf of the ICAO program for distribution of data to support international civil aviation. ISCS/WAFS provides the worldwide aviation community with operational meteorological forecasts and information about meteorological phenomena required for flight planning and safe, economic, and efficient air navigation.

ISCS support for RMTN is part of a cooperative effort between U.S. NWS and WMO to improve the GTS in WMO Region IV (North and Central America). The RMTN allows for a two-way exchange of meteorological information between the United States and nations in the Caribbean and Central America. The GTS component of ISCS replaced the WMO Caribbean and Central America distribution and collection land line systems for Region IV and makes use of two-way (send/receive) Very Small Aperture Terminal (VSAT) satellite systems. Since the satellite protocols are proprietary, the receiving equipment (2.4-meter parabolic antenna and satellite receiver) must be purchased from MCI, and access to the satellite broadcast is controlled by the meteorological authority of each contracting state.

The system operates a Transmission Control Protocol/Internet Protocol (TCP/IP) multicast broadcast of data in BUFR (Binary Universal Form for the Representation of meteorological data)., GRIB (GRIdded Binary), and alphanumeric formats, with several daily scheduled pushes of large quantities of graphical WAFS data and model data. However, the system can be configured to interrupt the transfer of large, time-consuming files in order to insert high-priority messages such as a tsunami warning. The forward bandwidth of the IP multicast is 128 kilobytes per second (kbps) with capacity up to 512 kbps. The return VSAT links are a minimum of 4 kbps with capacity up to 128 kbps. The ISCS uses commercial C-band satellites operated by Intelsat to broadcast to the Atlantic Ocean Region and to the Pacific Ocean Region, including eastern Asia. The system originates meteorological information from the NWS Telecom Gateway (NWSTG) in Silver Spring, MD, which relays the data for uplink by MCI from Andover, ME, to Intelsat 903 over the Atlantic Ocean Region and from Yacolt, WA, to Intelsat 701. Figure 8-5 shows the ISCS configuration.

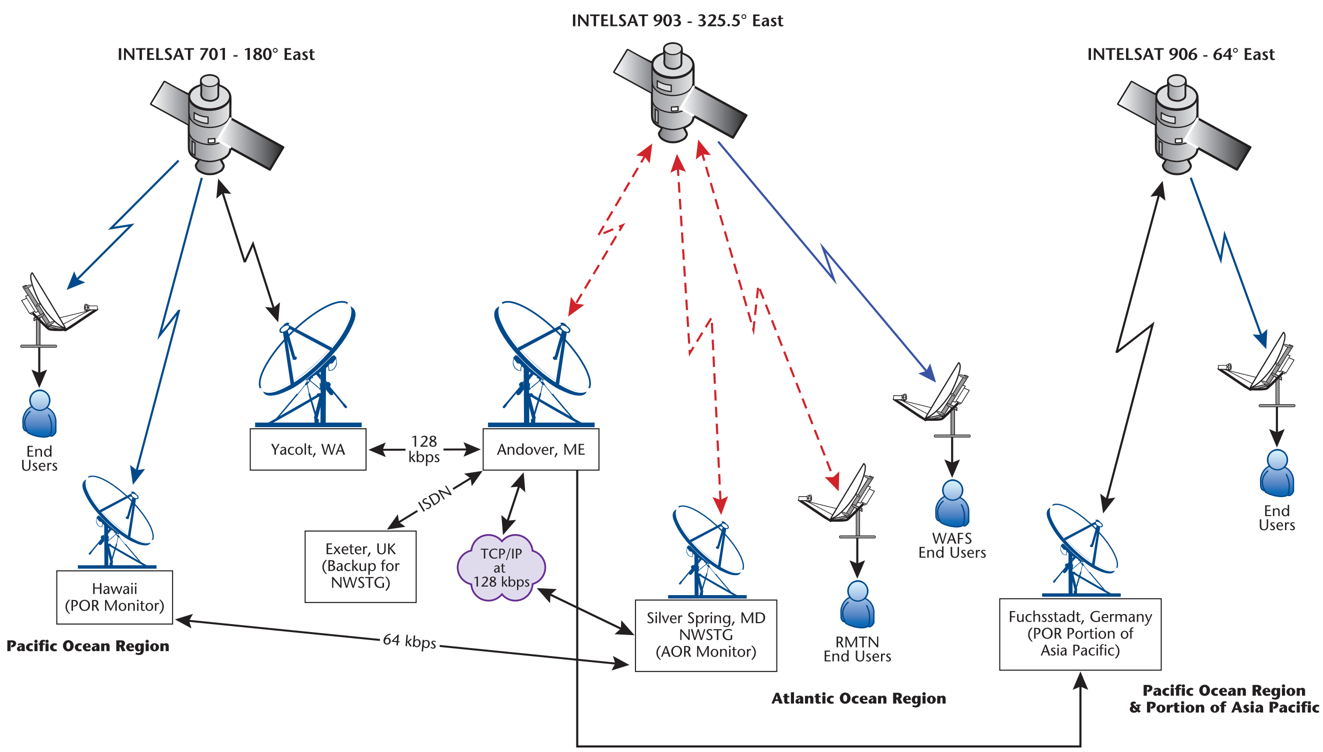


Figure 8-5. International Satellite Communications System (ISCS) Configuration

Important Points to Remember about the International Satellite Communications System

- ISCS is a satellite distribution system operated by NOAA to support WAFS and the WMO Region IV Meteorological Telecommunications Network.
- ISCS allows for a two-way exchange of meteorological information between the United States and nations in the Caribbean and Central America.
- The system can be configured to interrupt the transfer of large, time-consuming files in order to insert high-priority messages such as a tsunami warning.

UK Met SADIS and India Meteorological Department INSAT Satellite Distribution Systems

In addition to US satellite distribution systems like ISCS, EMWIN, and RANET, numerous other countries extend the footprint of areas served by supporting other satellite delivery programs. Two of those programs are the UK Meteorological Office's SADIS and India's INSAT system.

UK Met Office's Satellite Distribution (SADIS) System

The United Kingdom, on behalf of ICAO, operates the SADIS system to broadcast WAFS data to the European, African, Middle Eastern, and Indian Ocean regions not included in the coverage of the ISCS. The SADIS coverage area and the ISCS coverage area are intentionally overlapped to assure continuous worldwide coverage for WAFS. SADIS is uplinked from Whitehall, UK, to Intelsat 904 located at 60° east over the Indian Ocean, and is downlinked using the satellite's C-band global beam. Coverage is from the eastern Atlantic, Cape Verde (20° W) to central Australia (140° E), providing contiguous coverage of the Indian Ocean region.

The SADIS system is a fee-based system with the collected revenue going to offset costs incurred by the UK Met Office for personnel salaries, hardware and software maintenance and replacement, and satellite bandwidth. As with ISCS, the suite of data products may be excessive compared to what is necessary to fulfill the basic requirements for tsunami warning centers.

India's INSAT Distribution System

The Indian Space Research Organization operates several multipurpose satellites in its INSAT fleet. In addition to standard C-band and Ku-band data and video services, part of the INSAT fleet is equipped with S-band capabilities and meteorological observation payloads. In particular, in cooperation with the India Meteorological Department (IMD), INSAT 3A gathers observational data such as infrared and visual observations and distributes this data through the S-band downlink along with additional products uplinked by the IMD from New Delhi. This broadcast of meteorological information essentially constitutes an extension of the GTS throughout India via satellite.

The INSAT distribution system can carry tsunami warning information and may be a good option for satellite reception by national meteorological centers within its footprint. Available footprint plots indicate the satellite's power is concentrated on the country of India and falls off sharply outside the country.

The INSAT feed is also provided by the IMD to WorldSpace, which broadcasts it using the westernmost AsiaSat satellite. This offers a much wider potential distribution area, as this satellite was specifically designed to cover India, parts of Asia, and the Middle East. The general coverage footprint for the three operational AsiaSat satellites is shown in Figure 8-6. The WorldSpace system was designed to deliver multiplexed audio and data services to small, portable, inexpensive consumer receivers with small patch antennas. To receive the INSAT meteorological data feed via WorldSpace, the user needs a WorldSpace receiver, a small data interface unit that forwards data from the receiver to a PC, the associated PC software, and a WorldSpace subscription. In addition, the INSAT data feed is offered only to a closed user group, and authorization is required by the IMD.

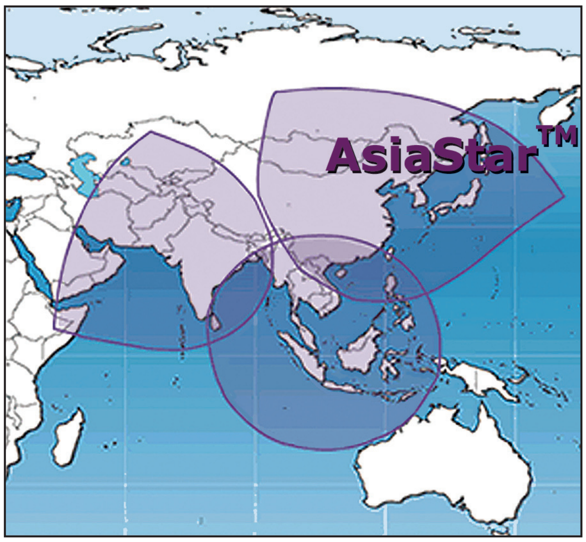


Figure 8-6. WorldSpace's AsiaSat Satellite Coverage Footprint

Important Points to Remember about SADIS and INSAT

- SADIS broadcasts WAFS data to the European, African, Middle Eastern, and Indian Ocean regions not included in the coverage of the U.S.-operated ISCS.
- The INSAT feed is provided by the IMD to WorldSpace, which broadcasts it using its AsiaSat satellite. This provides a wide distribution area, as this satellite was specifically designed to cover India, Asia, and the Middle East.

GEONETCast—the Dissemination Component of GEOSS

GEONETCast is an initiative within the United Nations' GEO framework. Led by NOAA, WMO, the Chinese Meteorological Agency (CMA), and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), GEONETCast addresses the global dissemination needs of the GEOSS environmental data in a coordinated way.

Based on discussions between EUMETSAT and the United States NOAA, U.S. Co-Chair retired Navy Vice Admiral Conrad C. Lautenbacher, Jr, Ph.D., undersecretary of commerce for oceans and atmosphere and NOAA administrator, presented the concept to the GEO Executive Committee on September 30, 2005. EUMETSAT and NOAA then presented it to the second GEO plenary meeting in December 2005, which adopted the concept in principle. GEO members and participating organizations recognized that GEO could add value to existing operational and prototype technological efforts that were already under way to enhance the delivery of data and information to users.

Tip

GEONETCast: a worldwide, operational, end-to-end Earth observation data collection and dissemination system.

Participation in GEONETCast as a data provider, end user, or dissemination infrastructure provider is voluntary. The intergovernmental GEO has defined the GEONETCast task as Capacity Building Task #CB-06-04, with oversight by the GEO Architecture and Data Committee. It is critical, however, that the task also work with the GEO User Interface and Capacity Building Committees and others to identify additional data, products, and services.

GEONETCast builds on the experience gained by EUMETSAT with the EUMETCast operational dissemination system, and on the WMO Integrated Global Data Dissemination Service (IGDDS) concept. GEONETCast is a truly global dissemination system by which environmental in situ, airborne, and space-based observations, products, and services posted to the GEOSS are transmitted to users through a global network of communications satellites, using a multicast, access-controlled, broadband capability.

Overview

GEONETCast uses the multicast capability of a global network of communications satellites to transmit environmental satellite and in situ data and products from providers to users within GEO (see Figure 8-7). Commercially available technology provides cost-efficient solutions with easy-to-implement terminals, which are widely used for direct-to-home digital television. The multicast capability allows different datasets to be handled in parallel, regardless of the source. The use of a key access capability enables the data policy of each data provider to be respected, and also allows for the distribution to individuals or groups of users, as appropriate, to be targeted within the footprint of each satellite (see Figures 8-8 and 8-9). This capability is especially useful in parts of the world where high speed land lines and/or internet are not available.

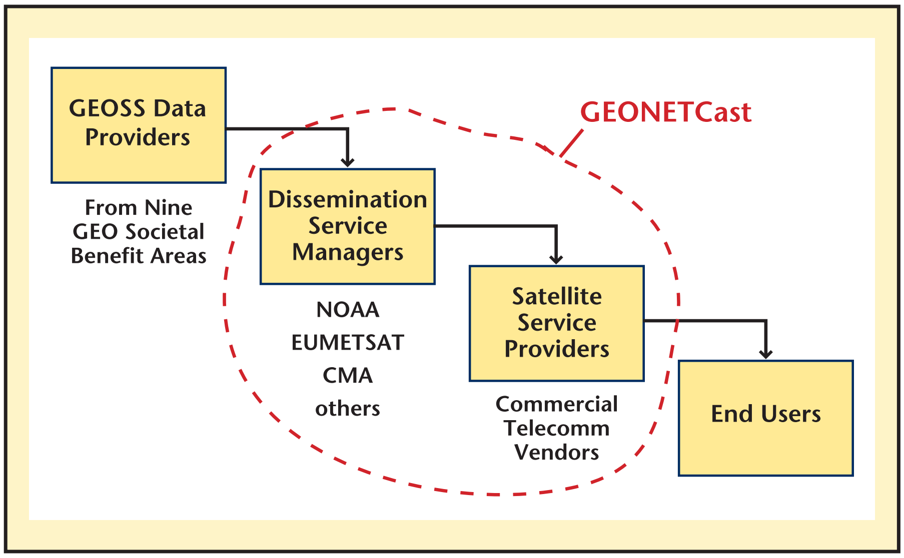


Figure 8-7. Structure of GEONETCast

GEONETCast consists of three major components:

- Existing dissemination infrastructure
- Data providers/sources
- The global environmental user community

Currently, EUMETCast, operated by EUMETSAT, provides the dissemination infrastructure that hosts GEONETCast. This provides geographic coverage of Europe, the Middle East, Africa, and South, Central and most of North America. The Chinese Meteorological Administration (CMA) is integrating FengYunCast into GEONETCast. This provides geographic coverage of the Asia/Pacific region. FengYunCast is planned as an evolution of an existing CMA-operated dissemination system that provides geographic coverage of China and a number of neighboring countries, including the Southwest Pacific. Additionally, NOAA is establishing a dissemination system that provides comprehensive coverage of the Americas, called GEONETCast Americas. The draft *GEONETCast in the Americas: A Vision and Concept Document* provides an overview of the GEONETCast Americas concept developed within NOAA. Users in the region will, with GEONETCast Americas, be provided with a long-term perspective for access to GEONETCast.

Together, these three regional systems (EUMETCast, FengYunCast, and GEONETCast Americas) form GEONETCast, and have the capability to provide near global geographic coverage as shown in Figures 8-8 and 8-9. The added value that GEONETCast brings is to facilitate and enhance access, particularly for developing countries, to key environmental data of GEO by applying standards across, and encouraging the development of, regional systems. These three regional systems are seen as the minimum required to establish global geographic coverage. Should additional regional systems

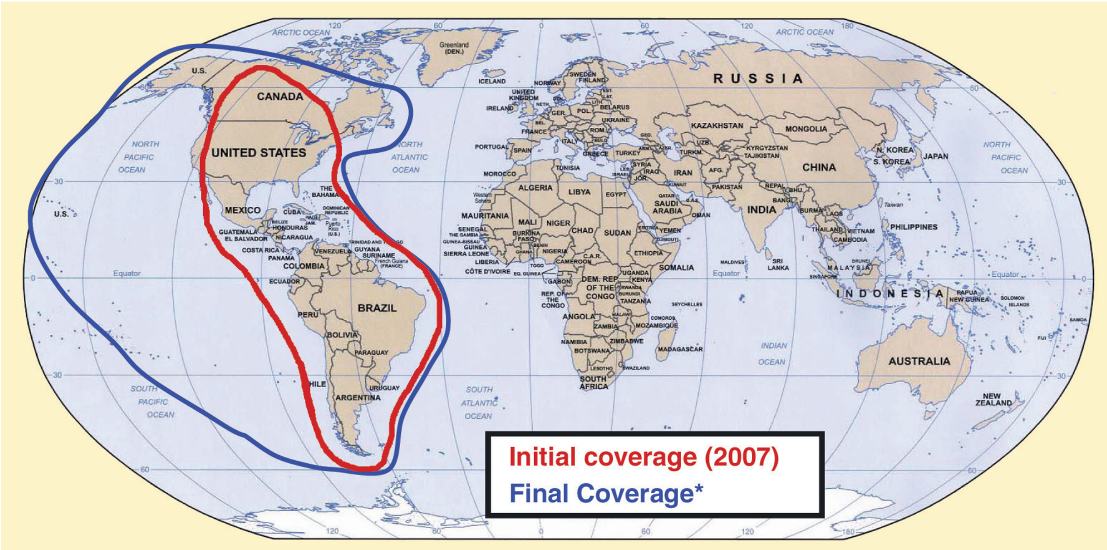


Figure 8-8. Initial and Final Coverage for GEONETCast Americas

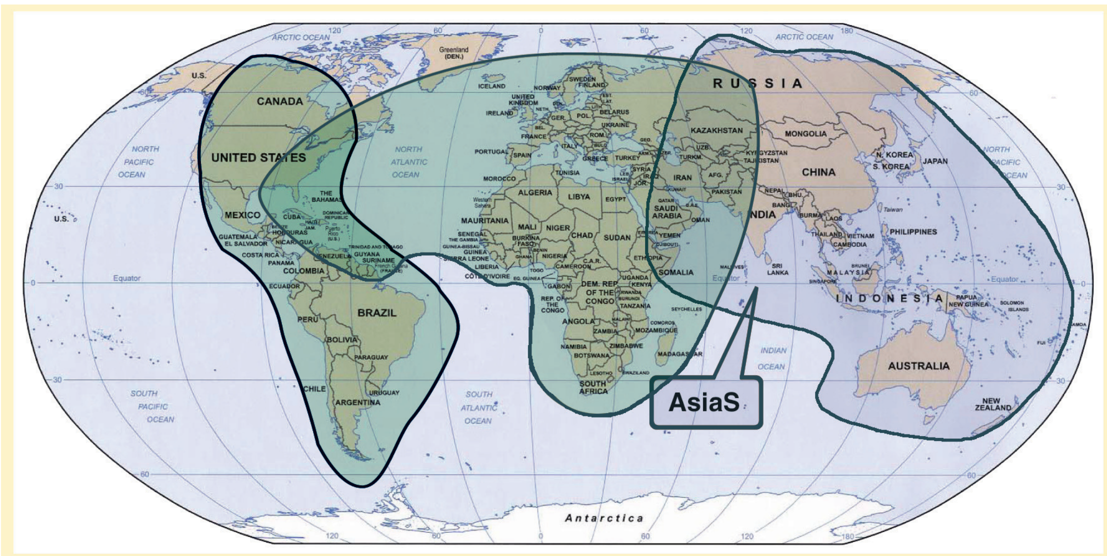


Figure 8-9. Coverage of EUMETCast and FengYunCast

be made available, the GEONETCast concept is flexible and scalable enough to easily accommodate them.

These systems will utilize uplink ground stations and available telecommunication technology from geostationary satellites so that costs can be kept affordable for users through the purchase of existing off-the-shelf equipment. Data from each region can be disseminated outside the originating region through the utilization of data-exchange links between the regions. This inter-region data exchange can take place using a number of possible methods such as dedicated data-exchange links, overlapping satellite footprints, or some existing network such as the GTS or the internet.

This satellite-based dissemination system is one component of a larger GEO data distribution network that may utilize the internet and/or high-speed fiber optic land lines; however, these methods are not specifically addressed by the current GEONETCast concept. The scope of GEONETCast may evolve over time to include these data distribution methods as a means to distribute data to users as required.

Service Standards

Each of the dissemination systems which together form GEONETCast (and any future regional systems) are recommended to comply with a number of service standards:

- Each regional system provides a single entry point, known as a network center.
- The network centers can be linked together to provide data exchange between them.
- Each network center should provide connectivity and system capacity to data providers from all GEO Societal Benefit Areas (SBA) within the region.
- Each network center should provide bandwidth to support data dissemination from outside the region.
- Network center operators are responsible for managing and interfacing with users in coordination with data providers located within the region.
- Network center operators are responsible for managing and interfacing with users in coordination with the other network center operators (who are representing the data providers of their respective regions).

Technical Standards

At the technical level, a number of standards have emerged as forming the baseline for dissemination systems that contribute to the GEONETCast infrastructure:

- Contributing dissemination systems should be generic, multi-service dissemination systems, based on standard Digital Video Broadcast (DVB) technology.
- Use of commercial broadcast channels on television, direct-to-home telecommunication satellites is encouraged.
- Use of commercial, off-the-shelf, commonly available reception equipment is encouraged.
- Use of IP is encouraged over DVB standard coding.
- Systems should support transparent transfer of files (files should be received exactly as sent).
- Use of standard, openly described file formats is encouraged; examples currently in use are L/HRIT, BUFR, GRIB, HDF, netCDF.

- Contributing systems should provide secure access control at individual file and user level.
- The systems should be open, flexible, and scalable at both the network center and user terminal levels.
- Quality of service should be ensured and regularly monitored.
- Catalogues of transmitted data should be maintained and made available for consultation by users in order to facilitate data discovery and subscription.
- Dissemination should be organized in multiple multicast channels corresponding to product categories, which are associated with Program Identifiers.

Important Points to Remember about GEONETCast

- GEONETCast is a truly global dissemination system by which environmental *in situ*, airborne, and space-based observations, products, and services from contributions to the GEOSS are transmitted to users through a global network of communications satellites, using a multicast, access-controlled, broadband capability.
- Commercially available technology provides cost-efficient solutions with easy-to-implement terminals, which are widely used for direct-to-home digital television.
- Three regional systems (EUMETCast, FengYunCast and GEONETCast Americas) form GEONETCast, and have the capability to provide near global geographic coverage.
- Inter-region data exchange can take place using a number of possible methods such as dedicated data-exchange links, overlapping satellite footprints, or some existing network such as the GTS or the internet.
- Dissemination systems are generic, multi-service dissemination systems, based on standard DVB technology.
- Countries being serviced by a GEONETCast distributor should initiate contact and establish communications paths for the uplink of their environmental data, including data and products used by NTWCs and RTWPs, as a reliable method to disseminate tsunami warnings, forecasts, and advisories.

Notification

Notification encompasses the understanding of the received message by the target audience, and additionally the implementation of appropriate actions by those at risk. In many ways notification is more difficult than dissemination, which involves simply physically getting the message to stakeholders.

Much of the discussion in this section is based on the Partnership for Public Warning publication, "Developing a Unified All-Hazard Public Warning System, a Report by the Workshop on Effective Hazard Warnings," Emmetsburg, Maryland, November 25, 2002 (PPW Report 2002-02).

Tip

The goal of warning is to prevent hazards from becoming disasters.

Warnings seek action. A warning system is an organized process for detecting a hazard and rapidly disseminating information about the threat and about appropriate protective actions. An effective warning system is one that causes the maximum appropriate protective actions to be taken for a given commitment of resources, because it has been designed to be compatible with the context in which it operates. Understanding this context requires knowledge of the other participants in the warning system for a given hazard, the other types of hazards faced by those participants, and the warning systems that are currently in use for those other hazards.

The warning process consists of people with information communicating with people at risk, and others such as emergency responders, in advance of or during a hazardous event, with the intent that those at risk will take appropriate action to reduce casualties and losses. The success of a warning is measured by what actions people take. A warning might recommend immediate action or it might simply encourage people to seek more information.

Many people are involved in the warning process. Warnings must be received and understood by a complex target audience including the general public, institutional decision makers (in business, state and local government, and NGOs), and emergency responders (firefighters, law enforcement officers, paramedics, public health workers, and emergency managers).

The news media and the emergency management community frequently act as intermediaries between those issuing warnings and households (or other information end-users). These intermediaries—together with independent experts in university research institutes, national laboratories, and other agencies—critically evaluate the information disseminated by the technical experts to determine if it is accurate, internally consistent, consistent with other sources' messages, complete, specific, timely, relevant, and important. If a warning is judged to be inadequate in any of these respects, it will be challenged, supplemented with additional information, or ignored.

Moreover, end users evaluate the warnings they receive from all sources in terms of their prior knowledge about the hazard and the recommended response actions. Finally, end users also evaluate the warnings they receive about any given hazard in terms of their knowledge about other safety and health hazards and recommended actions for those other hazards. It is also important to remember that "the general public" is really "publics" since it involves:

- Decision makers at all levels in the community
- People with many different levels of education

- People with many different levels of financial ability and responsibility
- People of different races and beliefs
- People with many different primary languages
- People with widely varying experience with the hazard
- People with varying levels of physical ability

It is critically important for centers to test their message dissemination communication channels frequently, and identify dissemination problems, so the tsunami messages reach the end users when a real tsunami event occurs.

Warning System Design

NTWCs and RTWPs should not assume that there will be immediate reception of a warning, unlimited attention to the warning message, perfect comprehension of message content based upon accurate prior knowledge about the threat, and perfect compliance with the recommended actions. None of these conditions will occur, even though reception, attention, comprehension, and personalization increase when there is an imminent threat. Consequently, warning systems and warning strategies must be carefully designed to make it more likely that warnings will be as effective as possible. Effective warning system design consists of four main steps:

- Define the desired message effects, especially the behavioral objectives of the system. What actions do authorities want the end-users to take?
- Identify any distinctively different segments of the target population. How do people differ in terms of their abilities to receive a warning, attend to it, comprehend its content, personalize the threat, choose an appropriate protective action, and implement that protective action?
- Identify the channels through which warning messages will be transmitted. What technologies and what intermediate sources are needed?
- Define who the initial message sources will be and develop their perceived credibility by taking steps to ensure their expertise and trustworthiness.

Warning Channels

As noted in the section on dissemination, centers should identify all the communications channels to which different segments of the population have access. It is especially important to identify the channels that people monitor routinely, as well as those that can reach people rapidly during emergencies. Use multiple methods and channels to disseminate messages. These include print and electronic media, the Internet, and even face-to-face presentations from credible original and intermediate sources. Encourage people to tune to reliable sources of local broadcast news.

Warning Message Content

NTWCs and RTWPs should be as specific as possible about the nature of the threat, the anticipated impact location, and the expected time of impact. Decision makers in business, government, and NGOs need to have as much information as possible so they can weigh the consequences of alternative actions (including inaction) before expending significant resources on protective measures.

> **Tip**
>
> Create standard forms for text messages and oral messages for use in times of emergency.

Recommend one or more specific protective actions. One of the major incentives is protection of persons and property from the hazard. Determine how to describe the hazard so that the message generates a high level of protection motivation. Explain to those who are not at risk why they are not believed to be at risk and why they do not need to take protective action. Use terminology in warning messages that is consistent across time for a given hazard and, to the greatest extent possible, compatible with the terminology that is used for other hazards Let people know when the threat has ended so they can resume normal activities as soon as possible. As much as possible, RTWPs and NTWCs should create standard forms for text messages and oral messages and store them for future use during events. Figure 8-10 provides an example of a preformatted message for watch standers to read directly on radio, television, etc.

Warning Sources

Centers must recognize that no single source has complete credibility regarding all aspects of the threat and protective actions. Federal, state, and local government agencies vary in their credibility, as do news media, business, and NGOs. Identify in advance which organizations (and individuals within those organizations) will be responsible for communicating with those at risk, as well as with other population segments that are not at risk. Identify procedures by which information from different sources can be combined to ensure that each individual source's messages are consistent with all other sources' messages and that, together, all official sources' messages are accurate, complete, specific, internally consistent, timely, novel, and relevant.

Recognize that source credibility can be established initially by credentials such as agency mission and educational degrees, but is enhanced by preparing objective (transparent) procedures in advance rather than improvising during an incident, by obtaining endorsement by external experts (peer review), and by establishing a satisfactory record of performance over time. Build credibility and understanding that the warnings are based on the best available professional practice. Develop credible, articulate authorities to use consistently.

> **Tip**
>
> Develop and utilize trusted personalities who the public know and respect.

LOCAL TSUNAMI INFORMATIN BULLETIN

Attention all stations.   Repeat.   Attention all stations.

This is the Pacific Tsunami Warning Center.

A local earthquake has just occurred.

---

epicenter location – for example, "on the southeast coast of the Big Island"

No tsunami is expected.   Repeat.   No tsunami is expected.

Once Again.

This is the Pacific Tsunami Warning Center.

A local earthquake has just occurred.

---

epicenter location – for example, "on the southeast coast of the Big Island"

No tsunami is expected.   Repeat.   No tsunami is expected.

A hardcopy message with more detailed information will be transmitted shortly.

State Warning Point, Contact All County Warning Points. Please Acknowledge.

Time Read on HAWAS: ___________________   Initial: _______

___ Notify State Civil Defense Duty Person (see current SCD Emergency Notification Sheet)

___ Notify ____

___ Notify ____

Source: Pacific Tsunami Warning Center Operations Manual

Figure 8-10. Example of a Preformatted Oral Message (Information Bulletin)

Warning System Context

Federal authorities who are responsible for warning frequently think only of disseminating threat information to the general public, but it is important to recognize that the target audience is much more complex than this. Centers need to recognize that "the public" is not a homogeneous entity. Households, businesses, government agencies, and NGOs vary in size, demographic composition, geographic location, and economic resources.

Centers should identify the ways in which population segments differ in their perceptions of the credibility of different sources, their access to different warning channels, their reactions to warning message content, and the incentives, disincentives, and constraints they are likely to experience in attempting to take protective actions.

Important Points to Remember about Notification

- An effective warning system is one that causes the maximum appropriate protective actions to be taken.
- The news media and the emergency management community frequently act as intermediaries between the center issuing warnings and a complex target audience including the general public, institutional decision makers, and emergency responders.
- It is critically important for centers to test their message dissemination communication channels frequently, and identify dissemination problems, so the tsunami messages reach the end users when a real tsunami event occurs.
- RTWPs and NTWCs should create standard forms for text messages and oral messages and store them for future use during events.

NTWC and RTWP Community Preparedness Programs

Community preparedness can be thought of as the advance capacity of a community to respond to the consequences of a tsunami (or other adverse event) by having plans in place so that people know what to do and where to go if a tsunami warning is issued or a tsunami is observed. This result can be achieved through the development of programs like the United States' TsunamiReady program, in which communities have plans, enhanced communications, and heightened awareness among their citizens. This type of program will increase resilience to tsunami events, reduce economic losses, and shorten recovery periods.

Tip

Preparedness is having plans in place to respond properly to a warning.

Effective community preparedness programs also address hazard mitigation: sustained actions taken to reduce or eliminate the long-term risk to human life and property based on tsunami risk assessments. This includes planning and zoning to manage development in areas particularly at risk for tsunami, embracing tsunami resistant construction, and protecting critical facilities and infrastructure. The United States' concept of tsunami resilient communities, and the Coastal Community Resilience (CCR) program are an example of this type of tsunami mitigation program.

Outreach and communication with the public is crucial to their understanding of the nature of the tsunami hazard, the risks to personal safety and property, and the steps to reduce those risks. Key components include raising public awareness and effecting behavioral change in the areas of mitigation and preparedness; the deployment of stable, reliable, and effective warning systems; and the development of effective messaging for inducing favorable community response to mitigation, preparedness, and warning communications.

Many tsunami warning system requirements (data communications, data processing, products, dissemination, etc.) are, in part, driven by the characteristics of a center's partners and customer base. Since partners and customers can vary significantly from center to center, it is difficult here to precisely identify these groups. However, some general guidelines and techniques apply to most situations, as described below.

Much of the discussion in this section is based on the publication, "Tsunami Risk Reduction for the United States: A Framework for Action by the National Science and Technology Council, A Joint Report of the Subcommittee on Disaster Reduction and the United States Group."

Identifying Partners and Customers

Partners are generally other government and nongovernmental groups that play some role in the end-to-end tsunami warning system chain. These will include:

- Domestic and international data providers
- Government and private groups (including the mass media) that serve as communications conduits for product dissemination
- Government and private-sector groups that train and educate other center partners and customers

Customers are those groups and individuals that rely on a tsunami warning center and its partners for timely and accurate tsunami watches and warnings for protection of their lives and the opportunity to minimize the impact on their property. Customers include:

- The general public
- NGOs and other private-sector groups that must respond to events
- Government agencies that must respond to events

A center's outreach and education program must recognize these two distinct classes of constituents since each has unique requirements. The center may even have to employ different techniques to identify and deal with the major groups that comprise each of these two categories.

Tip

A center needs a **PUBLIC AFFAIRS OFFICER** to coordinate with the media during events.

The goal and focus of outreach should be to educate the public and other partners about tsunami safety and preparedness and promote the center's tsunami warning program through public events, media workshops, and the public school system. During actual tsunami events, the center should have a designated public affairs officer to coordinate media response. During annual tsunami exercises, the public affairs officer is responsible for notifying the media.

A center's public affairs officer should also provide media training and guidance to agency representatives, respond to media requests, organize news conferences, coordinate briefings and tours at the warning centers, develop informational materials, assist with congressional briefings, and plan outreach activities.

Hawaii Tsunami Technical Review Committee

In Hawaii, for example, a Tsunami Technical Review Committee composed of tsunami experts from academia, government, and the private sector meets on a regular basis to review research, exchange information, and coordinate projects. Several committees have been formed, including a Public Affairs Working Group. The public affairs group meets regularly to plan and coordinate outreach events. Membership includes technical experts and public affairs, outreach, and education officers from government agencies, the Hawaii Tourism Board, the Pacific Tsunami Museum, and academia. This committee plays an important role in coordinating tsunami-related projects, community awareness events, etc., and could serve as a model forum for use in other countries.

Media training workshops should be held on a regular basis to keep media informed about changes and improvements in the tsunami warning program; help media understand the operations of the NTWC or RTWP and the end-to-end system, including the relationship between the warning center and emergency managers; and help media understand the differences in the watch and warning messages, and how the information should be presented to the public.

Well coordinated plans and procedures for working with the media and public/governmental officials are essential for the staff at a center. Providing media outreach training to the operational staff should be routine, and should not wait until a major tsunami has occurred. This may require coordination of public outreach/affairs personnel from within different agencies at all levels of government.

Important Points to Remember about Community Preparedness Programs

- Outreach and communication with the public is crucial to their understanding the nature of the tsunami hazard, the risks to personal safety and property, and the steps to reduce those risks.
- During actual tsunami events, a tsunami warning center should have a designated public affairs officer to coordinate media response.
- Well coordinated plans and procedures for working with the media and public/governmental officials are essential for the operational staff at a center.

U.S. TsunamiReady Program

The United States' TsunamiReady program promotes tsunami hazard readiness as an active collaboration among Federal, state and local emergency management agencies, the public, and the National Weather Service's tsunami warning system. This collaboration supports better and more consistent tsunami awareness and mitigation efforts among communities at risk.

TsunamiReady Program Objectives

The main goal of TsunamiReady is improvement of public safety during tsunami emergencies. To meet this goal, the following objectives need to be achieved:

- Create minimum standard guidelines for a community to follow for adequate tsunami readiness.
- Encourage consistency in educational materials and response among communities and states.
- Recognize communities that have adopted TsunamiReady guidelines.
- Increase public awareness and understanding of the tsunami hazard.
- Improve community preplanning for tsunami disasters.

TsunamiReady Benefits

Benefits of becoming a TsunamiReady community include:

- Increased community preparedness.
- Regularly scheduled education forums.
- Increased contact with experts (emergency managers, researchers, NWS personnel).
- Identification of community readiness resource needs.
- Improved positioning to receive State and Federal funds.
- Enhanced core infrastructure to support other community concerns.
- Transparency in hazard program use of public tax money.

TsunamiReady Community Requirements

TsunamiReady establishes minimum guidelines for a community to be awarded the TsunamiReady recognition. Communities that accept the challenge to become tsunami ready and meet requirements set by the program are designated as TsunamiReady communities. Table 8-1 presents the guidelines to achieve TsunamiReady recognition. Each guideline is discussed in detail following the table. Four community categories (based on population) are used to measure tsunami readiness.

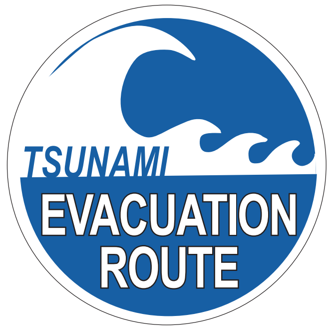
Table 8-1. Requirements for Recognition as a TsunamiReady Community

Guideline	Population			
	<2,500	2,500–14,999	15,000–40,000	>40,000
1: Communications & Coordination				
24 hr Warning Point (WP)	X[1]	X[1]	X	X
Emergency Operations Center (EOC)	X[1]	X[1]	X	X
2: NWS Warning Reception				
Number of ways for EOC/WP to receive NWS tsunami messages (If in range, one must be NWR with tone-alert, NWR-SAME is preferred)	3	4	4	4
3: Hydrometeorological Monitoring[2]				
Number of systems to monitor hydrometeorological data	1	2	3	4
4: Warning Dissemination				
Number of ways for EOC/WP to disseminate warnings to public	1	2	3	4
NWR tone-alert receivers in public facilities (where available)	X	X	X	X
For county/borough warning points, county/borough communication network ensuring information flow between communities	X	X	X	X
5: Community Preparedness				
Number of annual tsunami/weather safety programs	1	2	3	4
Designate/establish tsunami shelter/area in safe zone	X	X	X	X
Designate tsunami evacuation areas and evacuation routes, and install evacuation route signs	X	X	X	X
Provide written, locality specific, tsunami hazard response material to public	X	X	X	X
Schools: encourage tsunami hazard curriculum, practice evacuations, and provide safety material to staff and students	X	X	X	X
6: Administrative[2]				
Develop formal tsunami hazard operations plan	X	X	X	X
Yearly meeting/discussion by emergency manager with NWS	X	X	X	X
Yearly meeting/discussion by emergency manager with NWS	X	X	X	X

Notes:

1. For cities or towns with fewer than 15,000 people, a 24-hour warning point and EOC are required; however, another jurisdiction within the county may provide that resource. For smaller communities in Alaska and Pacific Regions with fewer than 2,500 residents and no county agency to act as a 24-hour warning point, the community must designate responsible persons who are able to receive warnings 24 hours per day and have the authority to activate local warning systems.

2. In 2002, the NWS approved a new TsunamiReady application form that combines both the U.S. NWS StormReady and TsunamiReady programs. Since that time, all communities applying for TsunamiReady recognition must pass both StormReady and TsunamiReady requirements. The StormReady requirements that were not part of the original TsunamiReady program are Guideline 3, and part of Guideline 6.



Guideline 1: Communications and Coordination Center

A key to effective hazards management is effective communication. This is especially true in tsunami emergencies, since wave arrival times may be measured in just minutes. Such a "short-fused" event requires an immediate but careful, systematic, and appropriate response. To ensure such a proper response, communities must have established the following:

1. *24-Hour Warning Point.* To achieve recognition under the TsunamiReady Program, an applying agency will need to have a 24-hour warning point that can receive NWS tsunami information and provide local reports and advice. Typically, this might be a law enforcement or fire department dispatching point. For cities or towns without a local dispatching point, another jurisdiction within the county could act in that capacity for them. For communities in the Alaska and Pacific Regions with fewer than 2,500 residents and no county agency to act as a 24-hour warning point, the community must designate responsible persons who are able to receive warnings 24 hours per day and have the authority to activate local warning systems. The warning point will need to have:

- 24-hour operations.
- Warning reception capability.
- Warning dissemination capability.
- Ability and authority to activate local warning system(s).

2. *Emergency Operations Center.* All agencies must have an emergency operations center (EOC). For communities with fewer than 15,000 residents, the EOC may be provided by another jurisdiction within the county. The EOC must be staffed during tsunami events to execute the warning point's tsunami warning functions. Tsunami-related requirements of an EOC include:

- Must be activated based on predetermined guidelines related to NWS tsunami information and/or tsunami events.
- Must be staffed with emergency management director or designee.
- Must have warning reception/dissemination capabilities equal to or better than the warning point.

- Must be able to communicate with adjacent EOCs/warning points.
- Must be able to communicate with the local NWS office or tsunami warning center.

Guideline 2: NWS Warning Reception

Warning points and EOCs each need multiple ways to receive NWS tsunami warnings. TsunamiReady guidelines to receive NWS warnings in an EOC or warning point require a combination of the following, based on population:

- NOAA Weather Radio (NWR) receiver with tone alert: Specific Area Message Encoding (SAME) is preferred. Required for recognition only if within range of transmitter.
- NOAA Weather Wire drop: Satellite downlink data feed from NWS.
- EMWIN receiver: Satellite feed and/or VHF radio transmission of NWS products.
- Statewide Telecommunications System: Automatic relay of NWS products on statewide emergency management or law enforcement system.
- Statewide warning fan-out system: State authorized system of passing message throughout warning area.
- NOAA Weather Wire via internet NOAAport Lite: Provides alarmed warning messages through a dedicated Internet connection.
- Direct link to NWS office: e.g. amateur or VHF radio.
- Email from tsunami warning center: Direct email from warning center to emergency manager.
- Pager message from tsunami warning center: Page issued from warning center directly to EOC or warning point.
- Radio/TV via Emergency Alert System: Local Radio/TV or cable TV.
- U.S. Coast Guard broadcasts: EOC/warning point monitoring of Coast Guard marine channels.
- National Warning System (NAWAS) drop: Federal Emergency Management Association (FEMA)-controlled civil defense hotline.

Guideline 3: Hydrometeorological Monitoring

This Guideline relates solely to the StormReady requirements for the combined Storm/TsunamiReady program. While receipt of warnings is crucial to the success of any EOC or warning point, there should also be a means of monitoring weather information, especially radar data. To obtain combined Storm/TsunamiReady recognition, each EOC/WP (based on population) should have some combination of the following recommended means of gathering weather information:

- Internet
- Television/Cable TV/Radio

- Two-way radio
- EMWIN
- Local systems for monitoring weather

Guideline 4: Warning Dissemination

Upon receipt of NWS warnings or other reliable information suggesting a tsunami is imminent, local emergency officials should communicate the threat with as much of the population as possible. To be recognized as Storm/TsunamiReady, a community must have NOAA Weather Radio in the following facilities (when in range of an NWR transmitter):

Required Locations:

- 24-hour warning point
- Emergency operations center
- City Hall
- School superintendent office

Recommended Locations:

- Courthouses
- Public libraries
- Hospitals
- All schools
- Fairgrounds
- Parks and recreation areas
- Public utilities
- Sports arenas
- Transportation departments

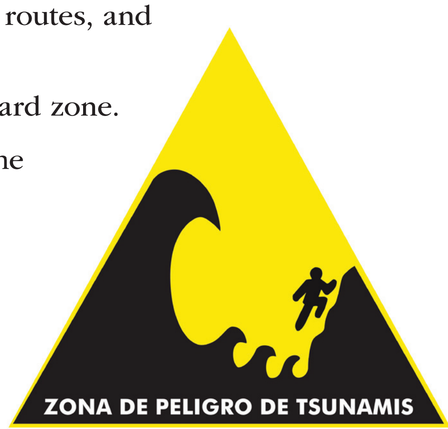
In addition, recognition will be contingent upon having one or more of the following means (based on population) of ensuring timely warning dissemination to citizens:

- Cable television audio/video overrides.
- Local flood warning systems with no single point of failure.
- Other locally controlled methods like a local broadcast system or sirens on emergency vehicles.
- Outdoor warning sirens.
- Phone messaging (dial-down) systems.
- Counties only: A countywide communications network that ensures the flow of information between all cities and towns within its borders. This would include acting as a warning point for the smaller towns.

Guideline 5: Community Preparedness

Public education is vital in preparing citizens to respond properly to tsunami threats. An educated public is more likely to take steps to receive tsunami warnings, recognize potentially threatening tsunami events, and respond appropriately to those events. Communities seeking recognition in the Storm/TsunamiReady Program must:

- Conduct or sponsor tsunami and weather safety awareness programs in schools, hospitals, fairs, workshops, and community meetings (number of talks per year is based on population). These may be part of multi-hazard presentations affecting local communities or regions (e.g., flood, tsunami, wildfire).
- Define tsunami evacuation areas and evacuation routes, and install evacuation route signs.
- Designate a tsunami shelter area outside the hazard zone.
- Provide written tsunami hazard information to the populace, including:
  - Hazard zone maps
  - Evacuation routes
  - Basic tsunami information



These instructions can be distributed through mailings (e.g., utility bills and within phone books), and posted at common meeting points such as libraries and public buildings throughout the community.

In addition, local schools should be encouraged to meet the following guidelines:

- Include tsunami information in primary and secondary school curriculums. (NWS will help identify curriculum support material.)
- Practice tsunami evacuation drills at least once every 2 years when located within the defined hazard zone.
- Provide written safety material to all staff and students.

Guideline 6: Administrative

No program can be successful without formal planning and proactive administration. To be recognized in the StormReady/TsunamiReady Program:

1. Tsunami warning and hazardous weather plans must be in place and approved by the local governing body. These plans must address the following:
   - Hazard/risk assessment.
   - Warning point procedures.

- EOC activation guidelines and procedures.
- Tsunami hazard zone map with evacuation routes.
- Procedures for canceling an evacuation for less-than-destructive tsunamis.
- Procedures for reporting storm and tsunami damage to the local NWS office in near real-time.
- Storm spotter activation criteria and reporting procedures, if applicable.
- Storm spotter roster and training record, if applicable.
- Guidelines and procedures for activation of sirens, cable TV override, and/or local system activation in accordance with state Emergency Alert System (EAS) plans, and warning fan-out procedures, if necessary.
- Annual exercises.

2. Local community officials must conduct a biyearly visit/discussion with local NWS Forecast Office Warning Coordination Meteorologist or tsunami warning center personnel. This can be a visit to the NWS office, phone discussion, or email contacts.

Why Do We Need a TsunamiReady Program?

- To create minimum standard guidelines for a community to follow for adequate tsunami readiness.
- To encourage consistency in educational materials and response among communities and states.
- To recognize communities that have adopted TsunamiReady guidelines.
- To increase public awareness and understanding of the tsunami hazard.
- To improve community pre-planning for tsunami disasters.

Who Decides if a Community Is TsunamiReady?

- In the United States, oversight of the TsunamiReady program is accomplished within the NWS by the National StormReady Board.
- The Board is responsible for changes in community recognition criteria. Proposed criteria changes shall be directed to the Board for action.
- Local boards decide if a community has attained Storm/TsunamiReady status. The local board consists of the local NWS office Meteorologist-in-Charge and Warning Coordination Meteorologist, the tsunami warning center Director, a representative from the state department of emergency services, and a representative from the National Tsunami Hazard Mitigation Program.

Important Points to Remember about the TsunamiReady Program

- TsunamiReady promotes tsunami hazard readiness as an active collaboration among Federal, state and local emergency management agencies, the public, and the NWS tsunami warning system.
- TsunamiReady creates minimum standard guidelines for a community to follow for adequate tsunami readiness.
- TsunamiReady encourages consistency in educational materials and response among communities and states.

Coastal Community Resilience Program

The US Indian Ocean Tsunami Warning System (US IOTWS) Program as part of it's contribution to an end-to-end warning system for the Indian Ocean region worked with partner organizations to enhance coastal community resilience in the region. Enhancing coastal community resilience requires integrating and maintaining an optimal balance of three community-based frameworks typically viewed as independent and separate domains: community development, coastal management, and disaster management. Community development provides the enabling governance and socioeconomic and cultural conditions for resilience. Coastal management establishes the environmental and natural resource conditions for resilience and its relationship to the human and built environment. Disaster management focuses on preparedness, response, recovery and mitigation to reduce human and structural losses from disaster events.

Coastal community resilience serves as a unifying framework for community-based plans and programs. One of the products of the US IOTWS Program is a guide to coastal community resilience (US IOTWS 2007). This section describes the resilience elements and tools used in the program and Guide.

Elements of Coastal Community Resilience

Resilient coastal communities take deliberate action to reduce risk from coastal hazards with the goal of avoiding disaster, accelerate recovery in the event of a disaster, and adapt to changes through experience and applying lessons learned. A resilient coastal community is one that can carry out recovery activities in ways that minimize social disruption and mitigate the effects of future events and impacts. Eight elements of resilience are considered essential for coastal community resilience. Enhancing resilience in each of these elements is needed to reduce risk from coastal hazards, accelerate recovery, and adapt to change. The desired outcome or overarching vision for each element of coastal community resilience can be described as follows:

A. **Governance:** Leadership, legal framework, and institutions provide enabling conditions for resilience through community involvement with government.

B. **Society and Economy:** Communities are engaged in diverse and environmentally sustainable livelihoods resistant to hazards.

C. **Coastal Resource Management:** Active management of coastal resources sustains environmental services and livelihoods and reduces risks from coastal hazards.

D. **Land Use and Structural Design:** Effective land use and structural design compliment environment, economic and community goals and reduce risks from hazards.

E. **Risk Knowledge:** Leadership and community members are aware of hazards risk and the risk information is utilized when making decisions.

F. **Warning and Evacuation:** Community is capable of receiving notifications and alerts of coastal hazards, warning at-risk populations, and acting on alert.

G. **Emergency Response:** Emergency response mechanisms and networks are established and maintained to respond quickly to coastal disasters and address emergency needs at the community level.

H. **Disaster Recovery:** Plans are in place to accelerate disaster recovery, engage communities in the recovery process, and minimize negative environmental, social, and economic impacts from recovery.

Each resilience element is associated with benchmarks that define four core capacities of resilient communities: policy and planning, physical and natural features, social and cultural conditions, and technical and financial resources. These benchmarks serve as the basis for conducting assessments of coastal community resilience.

CCR Assessment

A coastal community assessment can serve as a powerful tool that allows the stakeholders of a given community together with government, nongovernmental organizations, and other stakeholders to begin the process of enhancing resilience. Assessment is the first step in providing inputs to planning to address one or more of the primary issues of concern of a community. Keeping the eight elements of resilience in the forefront during the assessment and planning process ensures that a balanced approach to development implementation will ensue. For example, if a community is primarily concerned about minimizing the impacts of storm surge to which it is vulnerable, by assessing the elements of resilience, all the factors that can minimize the impact of storm surge will be brought into the planning discussion.

Mangroves may be at risk from various forces that need to be addressed to restore their role in minimizing storm surge and inundation.

A coastal community resilience assessment provides an opportunity to initiate dialogue among key stakeholders in the area. Dialogue is crucial to encourage the stakeholder community to recognize the need for better resilience and to better understand what forces need to be addressed to lessen vulnerability through planning. Such dialogue is also an educational process whereby the various stakeholders can learn together through a guided assessment of coastal community resilience.

The CCR Guide provides an assessment approach to evaluating coastal community resilience. CCR assessments are conducted to highlight strengths and identify weaknesses and gaps in resilience that can be addressed by the community together with government and nongovernmental organizations.

Reasons to Conduct an Assessment of Coastal Community Resilience

- Initiate a dialogue between the community, government and non-governmental institutions, and other stakeholders on the goals and key elements of coastal community resilience
- Increase awareness and understanding of the risks associated with both episodic and chronic coastal hazards and the need to build resilience capacity at the community level
- Characterize the resilience status and trends at the community level
- Determine the capacity of your organization to provide assistance in each resilience element
- Provide input to local and national planning for community development, coastal management, and disaster management measures to enhance the resilience of coastal communities
- Identify strengths, weaknesses, and gaps in resilience capacity that need to be addressed to achieve the long-term desired outcome of coastal community resilience

Community Vulnerability Assessment Tool

The NOAA Community Vulnerability Assessment Tool (CVAT) is a peer-reviewed methodology for conducting multi-hazard risk and vulnerability assessments at the community level. The general methodology of CVAT is a tutorial that steps the user through a “community-level” process of analyzing the vulnerability factors with respect to multiple hazards: physical, social, environmental, and economic. In addition to demonstrating the vulnerability assessment methodology, GIS is illustrated as a valuable resource for conducting hazards-related analyses in a case study format. CVAT follows a seven-step process:

1. Hazard identification
2. Hazard analysis
3. Critical facilities analysis
4. Societal analysis
5. Economic analysis

6. Environmental analysis
7. Mitigation opportunities analysis

These tools have been applied at various NOAA Coastal Services Center funded assessments, such as:

- Maui County, Hawaii, USA–County-wide Assessment
- Oregon and Washington, USA–Community Assessment focused on Ports and Harbors
- Rhode Island, USA–Statewide Assessment
- Brevard and Volusia Counties, Florida, USA–County-wide Assessments
- Tutuila, American Samoa–Island-wide Assessment

And in various independent assessments such as:

- Caribbean–Grenada and Barbuda National Assessments
- New Hampshire, USA–Statewide and County-wide Assessment
- Hawaii, USA–Statewide and County-wide Assessments

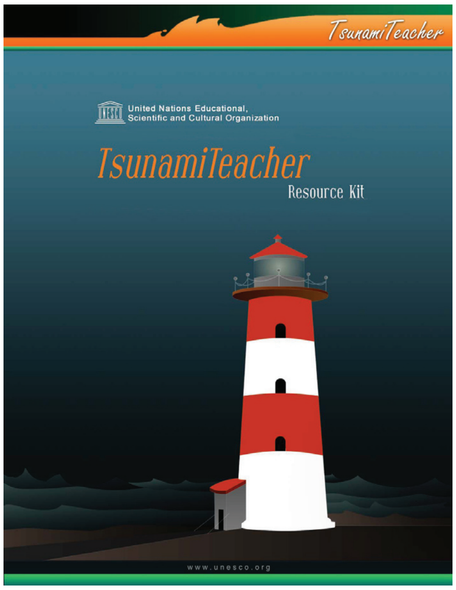
Important Points to Remember about the Coastal Community Resilience Program

- Under the USAID-funded IOTWS Program, CCR promotes tsunami and other hazard readiness as an active collaboration among national, provincial, and local emergency management agencies and the local communities.
- A resilient coastal community is a community with the ability to mitigate tsunamis and other hazards and recurring coastal risks.
- The NOAA CVAT is a methodology for conducting multi-hazard risk and vulnerability assessments at the community level.

Training Materials for Outreach and Education

There are several excellent sources of training information that are invaluable to NTWC and RTWP education and outreach efforts. The most comprehensive training comes at the international level through the UNESCO/IOC International Tsunami Information Center (ITIC) "Tsunami Teacher" program.

As a contribution to the building of training to support the communication of tsunami risk to the public, the IOC of UNESCO has developed the TsunamiTeacher Information and Resource Toolkit. The Toolkit brings together a wealth of new and existing information on tsunamis into a single, reliable, and verified global resource that is widely accessible to people, groups, and governments around the world. TsunamiTeacher aims to build awareness and capacity to respond and mitigate the impact of tsunamis through the sharing of knowledge, research, and best practices.



Materials are available that can be adapted to develop locally relevant responses. A feature of the Toolkit is the ability to customize training modules for different audiences.

Training modules target the media, educational systems, and the public and private sectors, including governments, NGOs, businesses, and community groups. Within the government sector, a large amount of training material has been assembled on earthquake and tsunami science and research, tsunami events, and the building of tsunami warning and mitigation systems. These topics include hazard and risk assessment; operational warning and dissemination systems; tsunami emergency response, alerting, and preparedness; environmental and engineering mitigation and policy; and education and outreach. Resource materials are provided as examples and guidance for decision-makers.

TsunamiTeacher is supported both as a dynamic, electronic, on-line resource **(http://ioc.unesco.org/TsunamiTeacher**) that will be continually reviewed, updated, and added to by experts, and as an off-line set of DVDs which will run on PC and Macintosh platforms. The base language is English, with translations presently planned into Bahasa Indonesia, Bangladesh Bangla, French, Spanish, and Thai. Other training materials are also available on the ITIC website at **http://www.tsunamiwave.info**. This site also has a searchable library of training materials. Additionally, ITIC has produced a CD with educational materials. The CD can now be downloaded directly from **http://ioc3.unesco.org/itic/printer.php?id=349**.

ITIC partnered with Servicio Hidrografico y Oceanografico de la Armada de Chile to publish a high school level text book titled “Earthquakes and Tsunamis.” This book is also available on-line for downloading.

At the national level, several nations, including the Japan Meteorological Agency, the Chilean Navy, and NOAA have on-line training materials. Some websites include:

- **http://www.tsunami.noaa.gov/education.html**
- **http://www.jma.go.jp/en/tsunami/**
- **http://www.shoa.cl/**

At state and local levels, several western U.S. states have extensive outreach and training materials. The state of Washington has published a media training guidebook titled "Broadcasters Tsunami Emergency Guidebook" which contains, in addition to definitions and examples of warning products, detailed inundation maps for major towns and cities on the Washington coast. Additional information can be found on numerous websites. Here are a few:

- **http://emd.wa.gov/5-prog/prgms/eq-tsunami/tsunami-idx.htm**
- **http://www.dnr.wa.gov/geology/hazards/tsunami/evac/**
- **http://www.oregon.gov/OOHS/OEM/plans_train/tsunami_in_or.shtml**
- **http://wsspc.org/tsunami/OR/Ore_wave.html**
- **http://www.redcross.org/services/disaster/0,1082,0_592_,00.html**
- **http://www.pep.gov.bc.ca/hazard_preparedness/Tsunami_Brochure/Prepare_for_Tsunami.html**
- **http://www.seismic.ca.gov/Tsunami.htm**
- **http://www.cityofsitka.com/lepc/tsunami.html**
- **http://www.pdc.org/iweb/tsunami.jsp**
- **http://www.honolulu.gov/ocda/**

Important Points to Remember about Training Materials for Outreach and Education

- The UNESCO/IOC International Tsunami Information Center has developed excellent outreach and education materials called the "Tsunami Teacher" program.
- At the national level, several countries have training materials posted on the internet.
- Training materials are also available at the state and local levels. One example is the state of Washington, USA, "Broadcasters Tsunami Emergency Guidebook."