NOAA Tsunami Program Strategic Plan

2012-2021

April 2014

Executive Summary

Tsunamis are potentially high impact natural events with high potential for loss of life. It is not a question of if, but when damaging tsunamis will impact U.S. coastlines. As illustrated by the extensive damage and casualties inflicted by the 2009 American Samoa tsunami, the moderate damage in California triggered by the 2010 Chile tsunami, and the greater damage in Guam, Hawaii, and the West Coast from the Japan tsunami of March 2011, U.S. coasts are subject to loss of life and economic disruption, infrastructure damage, and coastal damage due to tsunamis.

Since 1867, well over 200 tsunami events (mostly earthquake generated) have affected the coasts of the United States and its territories, resulting in more than 500 deaths. Millions of people live in U.S. coastal communities at risk from a destructive tsunami. In addition, millions vacation along our coasts and are equally susceptible to tsunami impacts. It is estimated that U.S. coastal communities contribute as much as 60 percent to the National Gross Domestic Product. As the trends for coastal economic growth and population density increases continue, the potential for death and economic damage will climb. As demonstrated by the 2004 event in Indonesia and the 2011 event in Japan, a destructive ocean-wide tsunami can affect the United States and many nations, causing global impact.

An effective NOAA Tsunami Program will result in the following outcomes:

- Significant saving of lives and property through timely, accurate, and effective tsunami warnings and forecasts
- Tsunami products, warnings, and forecasts that are understandable, clear, concise and usable by customers
- Resilient communities that are educated and prepared to take appropriate actions to protect the lives and property of both residents and visitors
- A sustainable NOAA Tsunami Program supported by a dedicated and properly trained staff
- Data acquisition, management, and exchange that supports the tsunami mission
- Continuous, robust research to enhance NOAA Tsunami Program capabilities
- Global, national, and regional collaboration and operational integration with other relevant national and global ocean and coastal observation, warning, and mitigation systems

This plan describes the 10-year (2012-2021) strategy to achieve these outcomes.

The NOAA Tsunami Program's mission is to provide timely, reliable, and accurate tsunami forecasts and warnings and to promote community resilience.

Our vision is for the United States to become a tsunami-resilient nation by minimizing the loss of life and disruption to our economically vital coastal communities from tsunamis.

Introduction

Tsunamis can cause thousands of deaths and significantly disrupt our nation's economy. The 2004 Sumatra tsunami killed 227,898 people (NOAA/National Geophysical Data Center Historical Tsunami Data Archive) and caused more than $10B in economic losses to the Asian economy (Munich Re, 2005). The 2009 Samoa tsunami resulted in 192 deaths (34 in American Samoa) with $150M in damage. The 2011 Japan Tohoku Tsunami resulted in more than 15,000 deaths and damage of over $200B in Japan. In the United States, the Tohoku tsunami caused one death and millions of dollars in damage. This was a stark reminder of the catastrophic impacts that can result from tsunamis. Long-term environmental damage is also a significant concern, as illustrated by the Japan 2011 tsunami debris that continues to be deposited on coastlines in 2014.

In Alaska, Puerto Rico, and the U.S. Pacific territories and on the U.S. West Coast, there are geological features similar to the fault systems off Sumatra, Chile, and Japan. Estimates of the cost of the economic disruption resulting from a major tsunami damaging ports, communities, or other interests along the U.S. coasts are significant. For example, strong currents from the 2010 Chile tsunami resulted in $30M in damage to U.S. property recorded in at least seven locations in central and southern California. Damage could have been much more significant. For example, closing the ports of Los Angeles and Long Beach, California, would result in an estimated loss of $1B each day of port closure (Borrero, 2005). This estimate does not include any required repair of infrastructure impacted by a tsunami. The risk of significant economic impacts due to the tsunami hazard will increase in the coming decades based on more concentration of U.S. population and industry along coastlines.

This is an update to the original NOAA Tsunami Program Strategic Plan published in 2008. This updated plan includes results from the 2010 reports of the Government Accountability Office (GAO) and the National Research Council reports concerning the program. This plan describes the long-term vision for the NOAA Tsunami Program for the next ten years (2012-2021) and the strategies identified to achieve the desired outcomes.

The NOAA Tsunami Program is comprised of four overarching capabilities: warning guidance, mitigation, research, and international coordination. This includes monitoring and observing systems, as well as interdisciplinary research. Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters. Education is one of the most important mitigating factors, since it encourages preparedness and awareness. This includes recognizing and reacting appropriately to nature's warning signs, which may be the only warning of locally generated tsunamis. NOAA also promotes other mitigation efforts including outreach, preparedness, and inundation modeling studies for communities at risk.

The NOAA Tsunami Program contributes to the Department of Commerce and NOAA goals and the National Ocean Policy by serving society's needs for a hazard-ready nation and works toward building resilient coastal communities. NOAA's National Weather Service accomplishes The NOAA Tsunami Program mission by providing reliable tsunami forecast and warning services to coastal populations, visitors, customers, and emergency responders within the Tsunami Warning System's (TWS) Area of Responsibility (AOR).

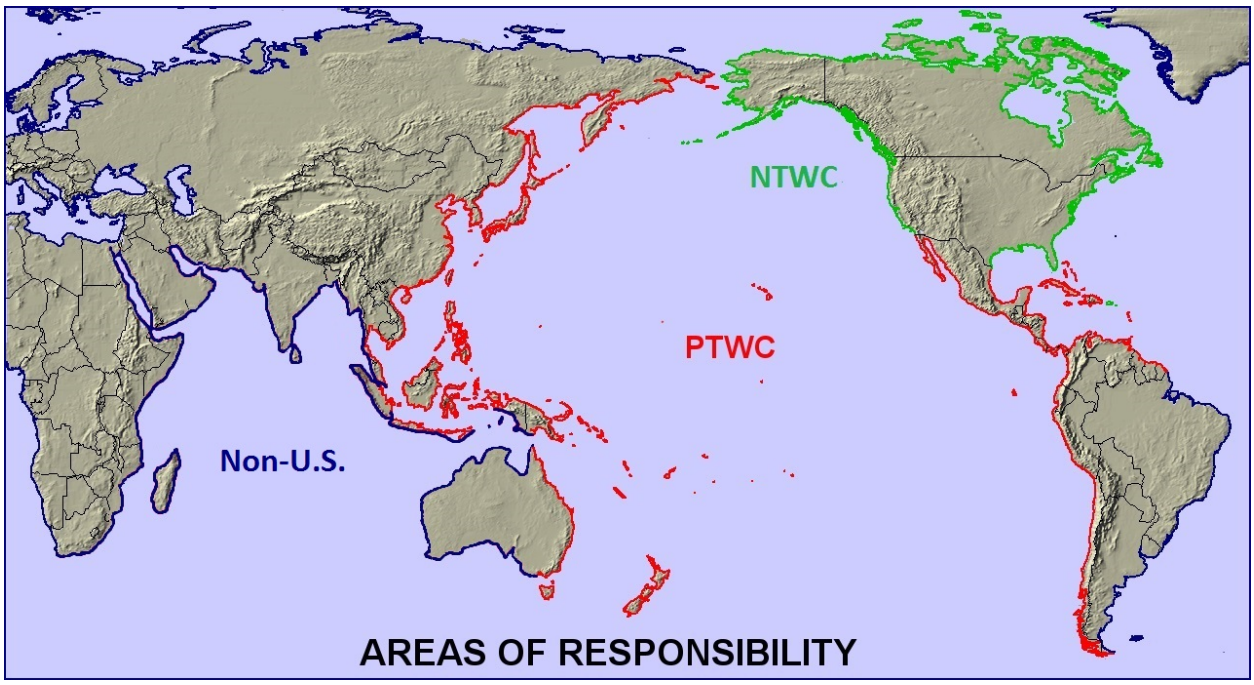

Figure 1. TWC Areas of Responsibility – the coastal and offshore areas for which each Tsunami Warning Center has the responsibility to issue operational tsunami products

The Tsunami Warning System's primary operational tasks are to rapidly locate, size, and otherwise characterize tsunami sources and resultant waves, forecast coastal impacts, and assess potential hazards. The TWS provides guidance through text and graphical products to emergency responders and the public, allowing them to make well-informed decisions. A robust tsunami mitigation system relies on the open and unrestricted exchange and long-term management of high quality data, including real-time observational and historical data. It is complemented by a proactive preparedness and outreach program to ensure communities are educated and ready to respond to the tsunami threat.

Figure 2: Main components of the U.S. Tsunami Warning System

The NOAA Tsunami Program involves the activity of multiple NOAA line offices. The program includes two National Weather Service Tsunami Warning Centers (TWC): the Pacific Tsunami Warning Center (PTWC) in Ewa Beach, Hawaii, and the National Tsunami Warning Center (NTWC) in Palmer, Alaska. The NWS also operates the Caribbean Tsunami Warning Program (CTWP) and NOAA's International Tsunami Information Center (ITIC). The TWCs work in cooperation with other NOAA and National Weather Service units, including:

- National Ocean Service (NOS)
- Office of Oceanic and Atmospheric Research (OAR)
- National Environmental Satellite, Data, and Information Service (NESDIS)
- NOAA's Office of International Affairs
- National Geophysical Data Center (NGDC)
- National Data Buoy Center (NDBC)
- Pacific Marine Environmental Laboratory (PMEL)

NOAA Tsunami Program Matrix

	Line Office			
	NWS	OAR	NOS	NESDIS
Warning Guidance				
Program management	×			
Hazard mapping, inundation forecast modeling and mapping applications, vulnerability and risk planning	×	×	×	×
Seismic/sea level (e.g. NWLON) O&M	×		×	
Data archiving – sea level, DART®, bathymetry, topography			×	×
DART® System R&D, O&M, and transition from research to applications	×	×		
Warning center operations: PTWC, NTWC	×			
Mitigation and Preparedness				
TWC and WFO outreach	×			
National Tsunami Hazard Mitigation Program	×	×	×	×
TsunamiReady™	×			
ITIC	×			
Research				
Tsunami science, inundation modeling and mapping, sensor development, digital elevation models	×	×	×	×
International Coordination				
Warning system development and capacity building – Global: GEO, United Nations (UNESCO/IOC, WMO, ISDR, UNDP); Regional Intergovernmental: ICGs (Pacific, Indian, Caribbean, North East Atlantic, and Mediterranean) international tsunami survey teams (post-tsunami assessments); technology transfer, training, data/information exchange, system design and integration	×	×	×	×
ITIC	×			
CTWP	×			
Interagency Coordination				
ITIC	×			
Interagency partnerships – USAID, USGS, USTDA USFS, State Department, FEMA, DHS, USACE, NIST, NSF, Sea Grant	×	×	×	×
Technical and scientific partnerships – IUGG/Tsunami Commission, AGU, GSA, BSSA	×	×	×	×
Regional and global seismic networks	×			
GLOSS O&M		×	×	
Bathymetry, topography, hydrography, coastal survey, ocean exploration, Vdatum		×	×	
Coastal community resilience and coastal zone management programs			×	×

Figure 3: NOAA Tsunami Program Matrix

Collaboration between NOAA organizations is crucial to the success of the NOAA Tsunami Program. NOAA's Tsunami effort is not only matrixed across NOAA, but is dependent on partnerships with federal, state, territorial, international, regional, and local organizations.

Customers and Partners

Customers

The NOAA Tsunami Program serves all coastal interests of the United States, including residents, visitors, state and territorial decision makers, and international partners and communities.

Customers include:

- Coastal residents and visitors
- State, territory, commonwealth, and local county emergency managers
- Businesses in tsunami-prone areas
- Local and tribal emergency responders
- Local, state, territory, commonwealth, and local and tribal land use/planning authorities
- Members of the private sector and academia involved in tsunami hazard risk assessment, community resiliency, and research
- U.S. government agencies (e.g., military, State Department, FEMA)
- Educational institutions
- Other designated tsunami national contacts and tsunami focal points
- United Nations organizations such as IOC and WMO

Partners

U.S. partners include:

- National Tsunami Hazard Mitigation Program (NTHMP) member agencies, states, territories, and commonwealths (the NTHMP is led by the NOAA Tsunami Program)
- National Earthquake Hazard Reduction Program (NEHRP) member agencies (NEHRP is led by the Department of Commerce's National Institute of Science and Technology (NIST))
- National Emergency Management Association (NEMA) member agencies
- Integrated Ocean Observing System (IOOS) member agencies and regional alliances
- Department of Interior, U.S. Geological Survey (USGS), including Advanced National Seismic System (ANSS), National Earthquake Information Center (NEIC), and Volcano Observatories
- Global Seismographic Network (IRIS GSN) and regional seismic networks and UNAVCO Consortium
- University of Hawaii Sea-Level Center (UHSLC)
- U.S. and international universities and research institutions
- Department of Homeland Security's (DHS) Federal Emergency Management Agency (FEMA)
- U.S. Navy (USN): Commander, Naval Meteorology and Oceanography Command (CNMOC) and Joint Typhoon Warning Center (JTWC)
- U.S. Coast Guard (USCG)
- Nuclear Regulatory Commission (NRC)
- U.S. Army Corps of Engineers (USACE)

- Department of State: Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Office of Disaster Assistance, U.S Agency for International Development (USAID), and USAID Office of Disaster Assistance (OFDA)
- Universities and scientific organizations, such as American Geophysical Union (AGU), Geological Society of America, Seismological Society of America, and Tsunami Society
- USDHS/FEMA National Disaster Preparedness Training Center
- Media

In addition, the NOAA Tsunami Program provides international warning, training, and data exchange assistance. Further, the NOAA Tsunami Program depends on international data, international communications, and international scientific exchange to carry out its mission.

International partners include:

- United Nations Educational, Scientific, and Cultural Organization (UNESCO)
- UNESCO's Intergovernmental Oceanographic Commission (UNESCO/IOC), including its Intergovernmental Coordination Groups (ICGs) ICG/CARIBE-EWS, ICG/IOTWS, ICG/NEAMTWESNEAMS, and ICG/PTWS; JTIC, CITIC; IOCARIBE IOC (UNESCO) Sub-Commission for the Caribbean, WESTPAC IOC (UNESCO); and the ITIC and the Pacific Tsunami Warning Center (PTWC) hosted and operated by NOAA
- United Nations World Meteorological Organization (WMO)
- World Meteorological Organization WMO/Intergovernmental Oceanographic Commission (IOC) Joint Commission for Oceanography and Marine Meteorology (JCOMM)
- International Council for Science (ICS) and its World Data System (WDS), including the WDC for Geophysics and Marine Geology (NOAA NGDC) and the WDC for Solid Earth Geophysics (USGS NEIC)
- International Atomic Energy Agency (IAEA)
- United Nations Environmental Programme (UNEP)
- IOC/WMO/ICSU/UNEP Global Ocean Observing System (GOOS) and its components, including the Global Sea Level Observing System and Data Buoy Co-operational Panel
- United Nations International Strategy for Disaster Reduction (ISDR)
- World Bank
- United Nations Development Programme (UNDP)
- United Nations University
- Group of Earth Observations (GEO)
- International Union of Geology and Geophysics (IUGG) – International Association of Seismology and Physics of the Earth's Interior (IASPEI), International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), including the Joint Tsunami Commission and International Federation of Digital Seismographic Networks (FDSN)
- International Association of Emergency Managers (IAEM)
- Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO)
- Environmental Canada's Atlantic Storm Prediction Center and Canadian Provincial Emergency Program

10-Year Strategy

Below are the outcomes necessary to achieve the basic mission to minimize the tsunami threat to life and property.

Outcome 1: Significant saving of lives and property through timely, accurate, and effective tsunami warnings and forecasts

The TWCs operate on a 24/7 basis and they continuously monitor and analyze seismic and sea-level (coastal and deep-sea) data from a wide variety of sources. When a potential or confirmed tsunami event is detected and monitored, the TWCs issue warning, advisory, watch, and/or information messages for coasts within their area of responsibility. These messages may include threat levels, recommended actions, tsunami observations, forecast information, instructions on where to get more information, and when to expect the next message. All customers and partners must be able to receive, understand, and respond appropriately to TWC forecast and warning products. To improve the timeliness, accuracy, and effectiveness of TWC tsunami forecast and warning products, the following strategies will be employed:

- Improve or implement new techniques for more timely and accurate detection and characterization of potential tsunami sources. These sources are primarily earthquakes but can include landslides and volcanic eruptions
- Access additional or improved data from national/foreign/international shared observation networks to improve the speed, accuracy, and reliability of tsunami detection and evaluation (e.g., seismic, sea level, other such as GPS)
- Maintain, monitor, support, and improve design and functionality of critical observation networks of the NOAA Tsunami Program
- Help establish performance standards and develop reporting protocol with data providers (e.g., USGS/NTHMP)
- Help establish standard IT systems, protocols, and products to ensure interoperability between TWCs, to include standardized and tested back-up capabilities between centers, and full integration with NOAA's IT service model
- Enhance data collection and processing/analysis capabilities
- Improve tsunami products and dissemination
- Extend and/or improve tsunami forecasting capabilities to all coasts in TWC AORs
- Develop and improve modeling and tools, as well as education, for short-fused warnings for near-source tsunami events
- Continue to develop and enhance inundation forecast modeling for high-risk locations
- Engage intra- and inter-agency scientists and the broader research community

Outcome 2: Tsunami products, warnings, and forecasts that are understandable, clear, concise, and usable by customers

An effective tsunami warning system is dependent not only on the ability of the TWCs to forecast tsunamis and warn the public, but also on the public receiving, understanding, and responding correctly to warning and forecast products. In the United States, NWS WFOs disseminate warnings and forecasts via NOAA All-Hazards Weather Radio and the Emergency Alert System (EAS) in coordination with emergency managers. The NOAA Tsunami Program is committed to ensuring all customers and partners can receive, understand, and respond appropriately to forecast and warning products. To improve product utility and accuracy, the following strategies will be employed:

- Ensure consistency in real-time warning information and services issued by TWCs
- Issue products that help guide appropriate community response
- Enhance graphical products with geographic information systems capability
- Collaborate with the Warning Coordination Subcommittee of the NTHMP and appropriate working groups of the IOC and its Intergovernmental Coordination Groups (ICGs) to improve existing products and develop next generation capabilities
- Work with international partners to enhance global tsunami warning systems
- Integrate social science best practices into warning/advisory/watch products

Outcome 3: Resilient communities that are educated and prepared to take appropriate actions to protect the lives and property of residents and visitors

Promote community preparedness and resilience

Integrating the National Weather Service's forecast and warning activities with state and community response systems will help the nation's increasingly vulnerable coastal communities prepare for, respond to, and rebound from natural disasters (*Advancing NOAA's Priorities Through Regional Collaboration*, 2007). Through the NTHMP, NOAA works with federal, state, territorial, tribal, and local emergency managers, urban planners, decision makers, international partners, and coastal resource managers to develop assessment and decision-support tools for at-risk communities. This also involves increasing public awareness of tsunamis via outreach and education activities. To promote community preparedness and resilience, the following strategies will be employed:

- Define inundation hazard assessment model standards
- Endorse national standards for inundation and evacuation mapping
- Support NTHMP efforts in inundation mapping by providing access to coastal relief data and information
- Support the NTHMP to improve community resilience
- Collaborate with NOAA coastal community hazard resilience and coastal zone management programs
- Implement improvements to tsunami preparedness and education efforts, including TsunamiReady™

Establish domestic and international training programs

The NOAA Tsunami Program must effectively train domestic and international partners to ensure a full understanding of the hazard and mitigation techniques needed to build community resiliency. To meet this objective, the following strategies will be employed:

- Support sustainable tsunami education efforts for domestic and international partners and customers
- Support ITIC's ongoing U.S. and international tsunami training programs
- Actively participate in and provide leadership in UN and other international organizations' coordination efforts for the global tsunami warning system such as GEO, IOC, and Caribbean Tsunami Warning Program

Outcome 4: A sustainable NOAA Tsunami Program supported with a dedicated and properly trained workforce

Ensure adequate and sustainable staff levels

The program's success depends on staff technical expertise and the ability to work effectively with an increasingly diverse clientele. To meet this objective, the following strategies will be employed:

- Sustain a sufficient workforce necessary to achieve the NOAA Tsunami Program mission
- Establish job enrichment and growth opportunities to maintain technical excellence
- Continually assess TWC staffing, organization, facilities, and physical location in order to ensure maximum mission effectiveness and efficiency in support of U.S. interests in the following regions:
    - Pacific
    - United States West Coast and coastal Alaska
    - Atlantic/Caribbean basin

Improve organizational communications

An effective NOAA Tsunami Program requires clear, efficient, and effective organizational communication. To meet this objective, the following strategies will be employed:

- Improve communication between NOAA line offices
- Improve communication and education with respect to international activities
- Update outreach materials to communicate a NOAA-wide program

Outcome 5: Data acquisition, management, and exchange that supports the NOAA Tsunami Program's mission

Ensure integration of data and information systems

To provide forecasts and warnings, NOAA/NWS relies on real-time access to global data including seismic and sea-level data. Some of these monitoring networks operate in support of a variety of applications, including tsunami forecast and warning. For example, coastal sea-level stations operated by NOS are multi-purpose stations, providing both real-time and long-term water level data, with an established set of standards, deliverable data, and operating procedures. The observations required to meet the NOAA Tsunami Program's performance measures are documented in the NOAA Consolidated Observations Requirements List database and TWC requirements documents. Each observation requirement is associated with the performance measures it supports, providing direct traceability to the program's outcomes.

As the number and source of observing systems expand, so does the need for protocols to ensure interoperability at the TWCs. In addition to real-time data, tsunami history and modeling are taken into account when determining the extent of tsunami risk and potential impact, requiring global exchange and coordination on past event data.

Full and open access to these data is essential for tsunami forecasts and warnings, research, hazard mitigation, and enhancing community resilience efforts.

To ensure interoperability and integration of data and information systems, the following strategies will be employed:

- Encourage all nations to support full and open exchange of data in real time
- Encourage all nations to contribute data to regional and international data centers for tsunami research
- Encourage use of common protocols and formats for real-time and retrospective data
- Participate in appropriate data and information standards development
- Develop standards-based web services
- Develop and maintain standards for archiving, metadata, and management of data, both nationally and internationally

Extend and improve the World Data Center's Tsunami and International Bathymetric Databases

The NOAA Tsunami Program relies on real-time and retrospective access to global data for issuing warning products and product validation. Research to develop the next generation models and products requires data for model verification. The NOAA Tsunami Program supports an open and unrestricted exchange of data with other nations and organizations. NOAA operates the ICSU World Data Center (WDC) for Geophysics and the International Hydrographic Organization Data Center for Digital Bathymetry (IHO DCDB) in Boulder, Colorado (both collocated with NOAA's NGDC). The WDC manages data from the ocean bottom and solid earth, including geological hazards. Digital data includes historical tsunamis, earthquake

epicenters, and volcanic eruption data. The WDC emphasizes the economic impact and damage from significant past hazard events.

The IHO DCDB maintains a global digital data bank of bathymetric soundings, gridded compilations, digital contours, and products on behalf of its member states. The IHO DCDB collaborates with various international organizations in the development of infrastructure, exchange formats, training, and standards to expedite bathymetric data sharing.

To support an open and unrestricted exchange of data with other nations, the following strategies will be employed:

- Ensure end-to-end management of tsunami data
- Incorporate regional tsunami databases into the WDC database
- Enhance the IHO DCDB's ability to obtain, ingest, archive, and make available international bathymetric data
- Enhance international and intergovernmental collaboration

Outcome 6: Robust research to enhance NOAA Tsunami Program capabilities

Tsunami events teach scientists and planners vital lessons about the hazard. Tsunamis are an infrequent, but high impact phenomenon. Considering the potential for immense destruction, tsunami research is required to better understand tsunami processes and impacts, develop more accurate models and detection techniques, and advance efficient and effective warning and mitigation measures. To strengthen NOAA's tsunami research capability, the following strategies will be employed:

- Support basic and applied research, including the evaluation of emergent technologies to improve tsunami forecast and warning products
- Support transfer of tsunami research to operations activities, including technologies and methodologies to reduce research-based operational costs
- Establish and maintain technical standards for the designation of tsunami hazard zones, tsunami forecasting, education, and other areas in need of uniformity to ensure public safety
- Support tsunami risk and hazard assessment research
- Conduct research into resilience product development aimed at improving community resilience
- Publish research findings to share with the scientific community
- Investigate the use of emerging technology to improve forecasts and warnings
- Coordinate post-event tsunami surveys to collect physical and socio-economic data for inclusion in the WDC tsunami archive

Outcome 7: Global, national, and regional collaboration and operational integration with other relevant national and global ocean and coastal observation, warning, and mitigation systems

The global tsunami warning and mitigation system is being built through many existing and emerging national and regional systems and initiatives, including the U.S. Tsunami Warning System. U.S. agencies, including NOAA/NWS, are ensuring interoperability and compatibility by developing standards and protocols, identifying and strengthening existing capacities, defining the components contributing to the GEOSS/IOC design for an end-to-end multi-hazard system, harmonizing observation and communication methods, and promoting interoperability arrangements, including data management. The NOAA Tsunami Program will employ the following strategies:

- Participate in the UNESCO IOC intergovernmental coordination bodies
- Provide technical assistance and training to IOC/ICGs and their IOC member states
- Provide warning services to IOC member states as requested
- Provide global technical assistance, outreach and education, and capacity development
- Promote an open and unrestricted exchange and archival of data by IOC member states
- Promote increased international tsunami forecast capabilities
- Support ITIC in its role to assist countries and sub-regions with establishing national tsunami warning systems
- Participate in and provide leadership within international working groups associated with key UN organizations such as IOC and WMO
- Support international tsunami research and researchers

Implementation Strategy

The success of The NOAA Tsunami Program Strategic Plan will be measured by how effectively outcomes are achieved. NOAA offices, centers, and laboratories that support the NOAA Tsunami Program (e.g., TWCs, PMEL, ITIC, NGDC) will provide semi-annual reports to the NOAA Tsunami Program Director. These reports will reflect the status of their respective actions and progress toward the performance goals outlined in Appendix 1. The NOAA Tsunami Program Director will use these semi-annual reports to keep NOAA/NWS leadership apprised of the program's ability to achieve the desired strategic outcomes.

Appendix 1: NOAA Tsunami Program Performance Goals

Strategic Outcomes	Program Strategies	Performance Goal	Primary Line Office	Contributors
Outcome 1: Significant saving of lives and property through timely, accurate, and effective tsunami warnings and forecasts	1) Implement techniques to identify non-tectonic sources 2) Maintain, monitor, and improve design and functionality of critical observational networks (e.g., seismic, sea level) 3) Establish performance standards and develop reporting protocol with data providers (e.g., USGS, NTHMP) 4) Establish standard IT systems, protocols, and products to ensure interoperability of the TWCs 5) Enhance data collection and processing/analysis capability 6) Improve tsunami products and dissemination 7) Implement geographically comprehensive tsunami forecasts	Achieve 100% probability of detection for a destructive tsunami within the United States	NWS	NOAA, USGS, states and territories
		Achieve 100% probability of detection for a destructive tsunami that impacts an area of 100 km or larger within the TWCs international Areas of Responsibility	NWS	NOAA, USGS, states and territories/other nations
		Achieve average time from earthquake to initial tsunami product issuance for international source events of under 15 minutes	NWS	NOAA, USGS, states and territories
		Achieve average time from earthquake to initial tsunami product issuance for domestic events of under 5 minutes	NWS	NOAA, USGS, states and territories
		Reduce average time from earthquake to issuance of a cancellation product for a U.S. tsunami warning, advisory, or watch for non-destructive U.S. events to 1 hour by 2016	NWS	NOAA, USGS, states and territories
		Reduce average time from earthquake to issuance of a cancellation product for a tsunami warning, advisory, or watch for non-destructive international and U.S. Pacific territory and commonwealth events to 2 hours by 2016	NWS	NOAA, USGS, states and territories
		Reduce geographical extent of unnecessary warnings by implementing the capability to set international alert levels with expected tsunami height, versus using only travel time, by 2016	NWS	OAR, NOS
		Achieve each TWC's level of operational system reliability at a minimum of 99.9%	NWS	NOAA

Strategic Outcomes	Program Strategies	Performance Goal	Primary Line Office	Contributors
		Accurately estimate average domestic AOR earthquake locations within 12 km of epicenter and magnitude within .17 (compared to final USGS location and magnitude product) by 2016	NWS	USGS, NOAA, states and territories
		Increase data availability from NOAA-funded observational networks to 90% by 2016	NWS, NOS, OMAO	NOAA, USGS, states and territories
		Achieve percentage of response at 90 % or greater from primary domestic recipients to monthly communications tests	NWS	NTHMP partners
		Implement fully operational tsunami forecast inundation capability at the TWCs by 2015	NWS	OAR, NESDIS
		Increase number of international locations where tsunami wave height forecasts are provided	NWS	OAR
		NWS WFOs to disseminate tsunami warning information over the Emergency Alert System (EAS) via NOAA Weather Radio within 1 minute of receipt of TWC product issuance	NWS	N/A
		NWS WFOs to disseminate tsunami product information over NOAA Weather Radio within 3 minutes of receipt of a TWC tsunami advisory and/or information statement	NWS	N/A
		Improve average accuracy of domestic tsunami height forecasts (as compared to tide gauge observations) to 75% by 2016	NWS	OAR
Outcome 2: Tsunami products, warnings, and forecasts that are understandable,	1) Provide consistent TWC real-time warning information and services 2) Issue products that guide	Implement integrated TWC website to display real-time information	NWS	OAR
		Conduct review of TWC products at annual WCS meeting and update products accordingly	NWS	NTHMP

Strategic Outcomes	Program Strategies	Performance Goal	Primary Line Office	Contributors
clear, concise, and usable by customers	appropriate community response 3) Enhance graphical products with geographic information systems capability 4) Collaborate with the Warning Coordination Subcommittee of the NTHMP and appropriate working groups of the ICGs to improve existing, and develop next generation, products	Participate in regular review of TWC international products through the IOC ICG working groups and relevant task teams and global TOWS-WG task team, and update and improve products per their recommendations	NWS	IOC tsunami groups
Outcome 3: Resilient communities that are educated and prepared to take appropriate actions to protect the lives and property of residents and visitors	1) Define inundation model standards 2) Endorse national standards for inundation and evacuation mapping 3) Support NTHMP efforts in inundation mapping by providing access to coastal relief data and information 4) Support NTHMP in improving community resilience 5) Collaborate with NOAA coastal community hazard resilience and coastal zone management programs 6) Develop comprehensive communication strategies 7) Update outreach materials to communicate a NOAA-wide program 8) Implement improvements to tsunami preparedness and	Increase the number of TsunamiReady™ communities from 90 in 2011 to 142 by 2016 (complete)	NWS	NTHMP partners
		Develop a standard review for TsunamiReady™ communities that will capture best practices and lessons learned to demonstrate the value of the TsunamiReady™ Program	NWS	NOS, OAR, NESDIS, NTHMP partners
		Conduct an annual national tsunami table-top exercise to ensure response plans to tsunamis are integrated and effective	NWS	NTHMP partners
		Implement national education plan and guidelines	NWS, OAR	NTHMP partners, NEMA, IAEM, social science partners
		Implement an international training plan and guidelines	NWS	OAR, NOS, NTHMP

Strategic Outcomes	Program Strategies	Performance Goal	Primary Line Office	Contributors
	education efforts, including TsunamiReady™ 9) Support a sustainable tsunami education effort for domestic and international partners and customers 10) Support ITIC's ongoing U.S. and international tsunami training programs 11) Actively participate in and provide leadership in the UN and other international organization's coordination efforts for the global tsunami warning system			
Outcome 4: A sustainable NOAA Tsunami Program supported with a dedicated and properly trained workforce	1) Sustain a sufficient workforce necessary to achieve the mission 2) Establish job enrichment and growth opportunities to maintain technical excellence 3) Improve in-reach within NOAA 4) Improve internal training of NOAA Tsunami Program staff	Increase number of online tsunami courses from 0 in 2010 to 4 by 2012 (complete)	NWS	
		80% of all NOAA Tsunami Program staff will complete the web-based tsunami training modules offered by COMET by 2015	NWS, OAR, NESDIS, NOS	
		Support the maintenance and expansion of accredited tsunami courses offered by the Department of Homeland Security (DHS/FEMA) for the tsunami community	NWS	OAR, NOS, DHS, NTHMP
Outcome 5: Data acquisition, management, and exchange that supports the NOAA Tsunami Program's mission	1) Encourage all nations to support full and open exchange of data 2) Encourage use of common protocols and formats for real-time and retrospective data 3) Participate in appropriate data and information standards	Increase the operation and maintenance efficiency for archiving and distribution of historical tsunami data (ratio of operation and maintenance cost (dollars) to data (gigabytes) archived and available) to a ratio of 50 by 2016	NOS, NESDIS	NWS, NOS
		Make TWC-operated sea-level station data publicly accessible and available at the NOS CO-OPS website	NWS, NOS	NESDIS

Strategic Outcomes	Program Strategies	Performance Goal	Primary Line Office	Contributors
	development 4) Develop standards-based web services 5) Ensure end-to-end management of tsunami data 6) Incorporate regional tsunami databases into the WDC database 7) Enhance international and intergovernmental collaboration	Collaborate with international and intergovernmental bodies to improve the historical tsunami database	NESDIS	NWS, IOC
		TWC-operated sea-level data will be displayed on the NOS CO-OPS website within 10 minutes of the observation	NOS	NWS, NESDIS
		Implement web-services to improve access to NOAA tsunami sea-level data via CO-OPS website (for tide gauge data) and NGDC (for DART® data)	NOS, NESDIS	NWS
Outcome 6: Robust research to enhance NOAA Tsunami Program capabilities	1) Support basic and applied tsunami research, including the evaluation of emerging technologies to improve tsunami forecast and warning products 2) Support transfer of tsunami research to operations activities, including technologies and methodologies to reduce operational costs 3) Establish and maintain technical standards for the designation of tsunami hazard zones, tsunami forecasting, education, and other areas in need of uniformity to ensure public safety 4) Support tsunami risk and hazard assessment research 5) Conduct research, to include social science, into resilience product development aimed at	Increase the number of inundation forecast locations to eventually cover all U.S. coastlines Conduct research on next generation propagation and inundation models for forecasting Conduct research on next generation tsunami detection technology Conduct research on local tsunami forecasts and warnings	OAR	NWS, NESDIS
		Revise and publish the IOC Post-Field Survey Manual	NWS	NWS, NESDIS, IOC
		Develop U.S. Post-Tsunami Field Survey protocols in coordination with the NTHMP, FEMA, and other federal, state, territorial, and local government agencies	NWS	NWS, OAR, NESDIS, USGS, FEMA, NTHMP
		Reduce DART® operations costs and investigate lower cost DART® alternatives	NWS, NDBC, OAR	NWS, NOS, NESDIS, NSF, research partners

Strategic Outcomes	Program Strategies	Performance Goal	Primary Line Office	Contributors
	improving community resilience 6) Publish research findings to share with the scientific community 7) Investigate the use of alternative technology to improve forecasts and warnings 8) Coordinate post-event tsunami surveys to collect physical and socio-economic data			
Outcome 7: Global, national, and regional collaboration and operational integration with other relevant national and global ocean and coastal observation, warning, and mitigation systems	1) Provide technical assistance and training to IOC International Coordination Groups (ICGs) and their member states 2) Provide warning services to IOC regional tsunami warning network member states, as requested 3) Provide global technical assistance, training, and capacity development 4) Promote full and open exchange of data by all member states 5) Promote increased international tsunami forecast capabilities	Expand international partnerships by providing technical assistance and training, including information on forecast, warning, and mitigation systems	NWS	NESDIS
		Expand international partnerships by providing and receiving forecast and/or warning services when requested	NWS	
		Actively provide leadership and participate in UN working groups at IOC and WMO to ensure continued coordination and meet international customer needs	NWS	NOS

Appendix 2: NOAA Tsunami Program Legislative Authorities

Legislative mandates directing NOAA to invest in development and operation of warning systems include:

i. Tsunami Warning and Education Act (TWEA), 33 U.S.C. §§ 3201 *et seq*. – Authorizes and strengthens the tsunami detection, forecast, warning, and mitigation program of the National Oceanic and Atmospheric Administration, to be carried out by the National Weather Service, and for other purposes. [TWEA expired in 2012.]

ii. Weather Service Organic Act, 15 U.S.C. § 313. - Sets forth the primary duties of the National Weather Service, including the requirements that the Secretary of Commerce shall: forecast the weather; issue storm warnings; display weather and flood signals for the benefit of agriculture, commerce, and navigation; gauge and report the flow of rivers; maintain and operate the seacoast telegraph lines and collect and transmit marine intelligence for the benefit of commerce and navigation; report temperature and rain-fall conditions for the cotton interests; display of frost and cold-wave signals; distribute meteorological information in the interests of agriculture and commerce; and take the meteorological observations that may be necessary to establish and record the climatic conditions of the United States, or that are essential for the proper execution of the foregoing duties.

iii. Provision of Data for Navigation of Marine, Air Commerce, and Research into Geophysical Sciences, 33 U.S.C. §§ 883a - 883i. This provides the basis for NOS [NOAA] navigation service programs as well as OAR and NWS coastal seismic and sea-level monitoring duties, including the TWCs, and related data management responsibilities of NESDIS. Sec. 883a authorizes the Secretary of Commerce to conduct hydrographic and topographic surveys, tide and current observations, geodetic-control surveys, field surveys for aeronautical charts, and geomagnetic, seismological, gravity, and related geophysical measurements to provide charts and other information for safe marine and air navigation. This information is collected, analyzed, assimilated, and distributed by the Department of Commerce. NOS is designated as the central depository for geomagnetic data, and the Secretary is authorized to collect, correlate and disseminate such data. The Secretary is authorized to conduct developmental work for the improvement of surveying and cartographic methods and instruments and to conduct investigations and research in geophysical sciences (33 U.S.C. § 883d). The Secretary is authorized to enter into cooperative agreements with states, federal agencies, public or private organizations or individuals for surveying, mapping, and publication activities and to contract with qualified organizations for National Geodetic Survey functions (33 U.S.C. § 883c). There is a permanent authorization of appropriations for activities detailed within 33 USC 883a et seq. (33 U.S.C. § 883i).

Note further, that specific duties of the Coast and Geodetic Survey included operation of the National Geomagnetism Program and Honolulu Geomagnetic Observatory (established 1902) and the U.S. Seismic Sea Wave Warning system established at the

Honolulu Observatory (established in 1946). In 1949 the Pacific Tsunami Warning Center (PTWC) in Ewa Beach, Hawaii, was established to provide warnings from teletsunamis to most countries in the Pacific Basin as well as to Hawaii and all other U.S. interests in the Pacific outside of Alaska and the U.S. West Coast.

The Palmer Observatory, under the auspices of the Coast and Geodetic Survey, was established in Palmer, Alaska, in 1967 as a direct result of the great Alaskan earthquake that occurred in Prince William Sound on March 27, 1964. This earthquake alerted state and federal officials that a facility was necessary to provide timely and effective tsunami warnings and earthquake information to the coastal areas of Alaska. Congress provided funds in 1965 to construct two new observatories and establish a tsunami warning system in Alaska. The first observatory constructed was at the U.S. Naval Station on Adak Island in the Andreanof Islands in the Central Aleutians. The City of Palmer, in the Matanuska Valley 42 miles northeast of Anchorage, was selected as the site for the primary observatory due to its proximity to bedrock for instrumentation and to communications facilities. Construction of the observatory installations, the task of engineering and assembling the data systems, and the hookup of the extensive telecommunications and data telemetry network was completed in the summer of 1967. With the dedication of the Palmer Observatory on September 2, 1967, the Alaska Regional Tsunami Warning System (ARTWS) became operational.

Originally, the tsunami warning responsibility for Alaska was shared by the three observatories located at Palmer, Adak, and Sitka. Sitka, a seismological observatory since 1904, and Fairbanks were the only two seismic stations operating in Alaska in 1964. The responsibilities of Adak and Sitka were limited to issuing a tsunami warning for events occurring within 300 miles of their location. In later years, the responsibility to provide tsunami warning services for Alaska was transferred from the Adak and Sitka observatories to the Palmer Observatory. Sitka and Adak observatories were eventually closed in the early 1990s, although the seismic instrumentation is still maintained.

In 1973, the Palmer Observatory was transferred to the National Weather Service's Alaska Region and changed its name to Alaska Tsunami Warning Center (ATWC). In 1982, its area of responsibility (AOR) was enlarged to include the issuing of tsunami warnings to California, Oregon, Washington, and British Columbia for potential tsunamigenic earthquakes occurring in their coastal areas. In 1996, the responsibility was again expanded to include all Pacific-wide tsunamigenic sources that could affect the California, Oregon, Washington, British Columbia, and Alaska coasts, and the name was changed to the West Coast/Alaska Tsunami Warning Center (WC/ATWC) to reflect those new responsibilities. In 2013, the name was changed to the National Tsunami Warning Center (NTWC) in order to more accurately reflect its area of responsibility.

The NOAA Administrator has been delegated the authority to perform these functions by Department Organization Order, DOO 10-15, Section 3.

Appendix 3: Strategic Plan Reference Documents

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National Science and Technology Council, *Tsunami Risk Reduction for the United States: A Framework for Action.* Joint Report of the Subcommittee for Disaster Reduction and the United States Group on Earth Observations, December 2006.

NOAA's Tsunami Program Charter. http://www.ppi.noaa.gov/Weatherand_Water/ww_pdfs/Tsunami

Program Assessment and Rating Tool Guidance Manual for NOAA Programs.

P.L. 109-479: Tsunami Warning and Education Act, approved December 2006. http://frwebgate/access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_public_laws&docid=f;publ424.109.pdf

Tsunami Program Data Management Plan: An Initial Report on the Management of Environmental Data Required to Minimize the Impact of Tsunamis in the United States. National Oceanic and Atmospheric Administration, December 2006.

Resolution IV-6 International Aspects of the Tsunami Warning System in the Pacific (ICG/ITSU). IOC Fourth Session of the Assembly, Paris, 3-12 November 1965.

Resolution X-6 Mandate and Functions of the International Tsunami Information Centre (ITIC), IOC Tenth Session of the Assembly, Paris, 1977.

Resolution EC-XXXIX.8 (ICG/PTWS), IOC Thirty-ninth Session of the Executive Council, Paris, 21-28 June 2006.

Resolution XXIII-12 (ICG/IOTWS), Resolution XXIII-13 (ICG/CARIBE-EWS), Resolution XXIII-14 (ICG/NEAMTWS), IOC Twenty-third Session of the Assembly, Paris, 21–30 June 2005.

U.S. Government Accountability Office Report: *U.S. Tsunami Preparedness – NOAA Has Expanded Its Tsunami Programs, but Improved Planning Could Enhance Effectiveness.* U.S. Government Accountability Office, April 2010.

United States Group on Earth Observations, *Improved Observations for Disaster Reduction: Near-Term Opportunity Plan,* September 2006.

"U.S. Announces Plan for an Improved Tsunami Detection and Warning System," *NOAA News Online*, January 14, 2005. http://www.noaanews.noaa.gov/stories2005.s2369.htm

White House Council on Environmental Quality: *Final Recommendations of the Interagency Ocean Policy Task Force*, July 2010.

Appendix 4: Alignment to NOAA's Next Generational Strategic Plan (NGSP)

NGSP Goal	NGSP Objective	Tsunami Outcomes
Weather-Ready Nation	Reduced loss of life, property, and disruption from high-impact events	Timely, accurate, and effective tsunami forecast and warnings *(Outcome 1)*
	A more productive and efficient economy through environmental information relevant to key sectors of the U.S. economy	Timely, accurate, and effective tsunami forecast and warnings *(Outcome 1)*
Resilient Coastal Communities and Economies	Resilient coastal communities that can adapt to the impacts of hazards and climate change	Resilient communities inhabited by a public that is prepared to take appropriate actions *(Outcome 3)*
	Comprehensive ocean and coastal planning and management	Integration with other relevant national, regional, and global ocean and coastal observation, warning, and mitigation systems *(Outcome 7)*
NOAA's Science and Technology Enterprise	A holistic understanding of the Earth system through research	Robust research to enhance NOAA Tsunami Program capabilities *(Outcome 6)*
	Accurate and reliable data from sustained and integrated Earth observing systems	Data acquisition, management, and exchange that supports the tsunami mission *(Outcome 5)*
NOAA's Engagement Enterprise	An engaged and educated public with an improved capacity to make scientifically informed environmental decisions	Resilient communities prepared to take appropriate actions *(Outcome 3)*
	Full and effective use of international partnerships and policy leadership to achieve NOAA's mission objectives	Integration with relevant national, regional, and global ocean and coastal observation, warning, and mitigation systems *(Outcome 7)*
NOAA's Organization and Administration Enterprise	Diverse and constantly evolving capabilities in NOAA's Workforce	A sustainable NOAA Tsunami Program supported by a dedicated and properly trained staff *(Outcome 4)*
	A modern IT infrastructure for embracing a scientific enterprise	Timely, accurate, and effective tsunami forecast and warnings *(Outcome 1)*

Appendix 5: Alignment to 33 U.S.C. §§ 3201 et seq., Tsunami Warning and Education Act

Tsunami Strategies	**33 U.S.C. §§ 3201** et seq. **Citation**
Outcome 1: Significant saving of lives and property through timely, accurate, and effective tsunami warnings and forecasts	Sec. 3203 (b)(2) – utilize and maintain an array of robust tsunami detection technologies Sec. 3203 (b)(3) – maintain detection equipment in operational condition to fulfill the detection, forecasting and warning requirements of this Act Sec. 3203 (b)(4) – provide tsunami forecasting capability based on models and measurements, including tsunami inundation models and maps for use in increasing the preparedness of communities, including through the TsunamiReady™ Program Sec. 3203 (b)(5) – maintain data quality and management systems to support the requirements of the program Sec. 3203 (b)(6) – include a cooperative effort among the Administration, the USGS, and the NSF under which the USGS and NSF shall provide rapid and reliable seismic information to the Administration from international and domestic networks Sec. 3203 (b)(7) – provide a capability for the dissemination of warnings to at-risk States and tsunami communities through rapid and reliable notification to government officials, and the public, including utilization of and coordination with existing federal warning systems, including the NOAA Weather Radio All-Hazards Program Sec. 3203 (c) (1) and (2) – warning system capable of forecasting tsunami anywhere for the Pacific system and for the Atlantic Ocean Caribbean Sea, and Gulf of Mexico
Outcome 2: Tsunami products, warnings, and forecasts that are understandable, clear, concise, and usable by customers	Sec. 3203 (b)(7) – provide a capability for the dissemination of warnings to at-risk States and tsunami communities through rapid and reliable notification to government officials, and the public, including utilization of and coordination with existing federal warning systems, including the NOAA Weather Radio All-Hazards Program Sec 3206 (a) – NOA NWS, in coordination with other NOAA, USAID, and NTHMP, to provided technical assistance and training to IOC, WMO, and other international entities, as part of international efforts to develop a fully functional global tsunami forecast and warning system Sec 3206 (b) (2) ITIC responsibilities include to assist member states in establishing national warning systems, and make information available on current technologies for tsunami warning systems

Outcome 3: Resilient communities that are educated and prepared to take appropriate actions to protect the lives and property of residents and visitors	Sec. 3203 (b)(4) – provide tsunami forecasting capability based on models and measurements, including tsunami inundation models and maps for use in increasing the preparedness of communities, including through the TsunamiReady™ Program Sec. 3203 (b)(3) – provide recommendations to the NWS on how to improve the TsunamiReady™ Program, particularly on ways to make communities more tsunami resilient through the use of inundation maps and other mitigation practices Sec. 3203 (c)(2) – promote and improve community outreach and education networks and programs to ensure community readiness including the development of comprehensive coastal risk and vulnerability assessment training and decision support tools, implementation of technical training and public education programs, and providing for certification of prepared communities Sec. 3204 – NOAA NWS shall conduct a community-based tsunami hazard mitigation program to improve tsunami preparedness of at-risk areas in the U.S. and its territories, called the National Tsunami Hazard Mitigation Program. Program components include inundation mapping, community outreach and education to ensure community readiness, and tsunami preparedness and mitigation programs integrated into warning, risk management, emergency response, and mitigation programs in affected areas at the federal, states, territorial, tribal, and local government and non-government jurisdictions Sec 3206 (b) – NOAA NWS, in cooperation with IOC, shall operate an International Tsunami Information Center to improve tsunami preparedness for all Pacific Ocean nations.., and may also provide such assistance to other nations participating in a global tsunami warning system established through the IOC
Outcome 4: A sustainable NOAA Tsunami Program supported with a dedicated and properly trained workforce	33 U.S.C. §§ 3201 *et seq.*
Outcome 5: Data acquisition, management, and exchange that supports the tsunami mission	Sec. 3203 (d)(2)(F) – making data gathered under this Act and post-warning analyses conducted by the NWS or other relevant Administration offices available to researchers Sec. 3203 (e)(1)(B) – develop and execute a plan for the transfer of technology from ongoing research described in Sec 6 into the program under this Sec. Sec. 3206 (d) – Data-Sharing Requirement… when deciding to provide assistance under this section, may take into consideration the

	data sharing policies and practices of nations proposed to receive such assistance, with a goal of encourage all nations to support full and open exchange of data
Outcome 6: Robust research to enhance NOAA Tsunami Program capabilities	Sec. 3203 (d)(2)(F) – making data gathered under this Act and post-warning analyses conducted by the NWS or other relevant Administration offices available to researchers Sec. 3205 (1) – consider other appropriate research to mitigate the impact of tsunami Sec. 3205 (2) – coordinate with the NWS on technology to be transferred to operations Sec. 3205 (3) – include social science research to develop and assess community warning, education, evacuation materials Sec. 3204 (4) – ensure that research and findings are available to the scientific community
Outcome 7: Global, national, and regional collaboration and operational integration with other relevant national and global ocean and coastal observation, warning, and mitigation systems	Sec. 3203 (b) (8) – allow, as practicable, for integration of tsunami detection technologies with other environmental observing technologies Sec. 3206 (a), (b), (c), (d) – NWS and NTHMP shall provide technical assistance and training to IOC, WMO, et.al., to develop a fully functional global tsunami forecast and warning system comprising regional tsunami warning networks such as the PTWS. ITIC, in cooperation with IOC, shall improve tsunami preparedness for all Pacific Ocean nations, and other IOC participating nations

Appendix 6: Acronyms

AOR	Area of Responsibility (for Tsunami Warning Centers)
CARIBE-EWS	UNESCO IOC Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
CO-OPS	Center for Operational Oceanographic Products and Services
CTWP	Caribbean Tsunami Warning Program
DART®	Deep-ocean Assessment and Reporting of Tsunamis
EAS	Emergency Alert System
FEMA	Federal Emergency Management Agency
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
IAEM	International Association of Emergency Managers
ICG	Intergovernmental Coordination Group
ICSU	International Council for Science
IHO	International Hydrographic Organization
IHO DCDB	International Hydrographic Organization Data Center for Digital Bathymetry
IOC	Intergovernmental Oceanographic Commission
IOOS	Integrated Ocean Observation System
IOTWS	Indian Ocean Tsunami Warning and Mitigation System
ISDR	International Strategy for Disaster Reduction
ITIC	International Tsunami Information Center
MGG	Marine Geology and Geophysics
NEAMTWS	Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas
NEMA	National Emergency Management Association
NESDIS	National Environmental Satellite, Data, and Information Service
NGDC	National Geophysical Data Center
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NSF	National Science Foundation
NTHMP	National Tsunami Hazard Mitigation Program
NTWC	National Tsunami Warning Center
NWR	NOAA Weather Radio All Hazards
NWS	National Weather Service
O&M	Operations and Maintenance

OAR	Office of Oceanic and Atmospheric Research
OMAO	Office of Marine and Aviation Operations
PMEL	Pacific Marine Environmental Laboratory
PTWC	Pacific Tsunami Warning Center
PTWS	UNESCO IOC Pacific Tsunami Warning and Mitigation System
TWC	Tsunami Warning Center
TWS	Tsunami Warning System
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USAID	United States Agency for International Development
USGS	United States Geological Survey
WC/ATWC	West Coast and Alaska Tsunami Warning Center
WCM	Warning Coordination Meteorologist
WDC	World Data Center
WFO	Weather Forecast Office
WMO	World Meteorological Organization

Appendix 7: State, Territorial, and Commonwealth Partners

- Alabama
- Alaska
- American Samoa
- California
- Connecticut
- Delaware
- Florida
- Georgia
- Guam
- Hawaii
- Louisiana
- Maine
- Maryland
- Massachusetts
- Mississippi
- New Hampshire
- New Jersey
- New York
- North Carolina
- Northern Marianas Islands
- Oregon
- Puerto Rico
- Rhode Island
- South Carolina
- Texas
- U.S. Virgin Islands
- Virginia
- Washington