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Good morning Chairman Chaffetz, Ranking Member Tierney, and Members of the Subcommittee. My name is Mary Glackin and I am the Deputy Under Secretary for Operations for the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). Thank you for the opportunity to testify at this hearing about natural hazards, including tsunamis, and our Nation's warning, preparedness, and response programs.

NOAA plays a critical role to ensure our Nation is warned of natural and man-made hazards, and is prepared to respond when these events occur. While probably best known for our role in hurricane, flood, and tornado forecasts and warnings, today I will focus my testimony on NOAA's forecasting, preparedness, and response role for tsunamis.

The March 11, 2011 Japan earthquake and tsunami serve as a stark reminder of human vulnerability to natural hazards. Japan is arguably one of the best prepared nations in the world for these two types of hazards, yet they have had severe challenges coping with the aftermath of the event. While the physical devastation wrought by the double punch of natural hazards is tremendous and the estimated loss of over 20,000 lives tragic, if not for Japan's extensive preparedness, the toll in human lives lost would have been far more catastrophic.

Of all Earth's natural hazards, devastating tsunamis may be among the most infrequent - but they pose a major threat to populous coastal regions, particularly in the seismically active Pacific Ocean Basin. One reminder of our Nation's own vulnerability is the Cascadia subduction zone – a geologic fault that runs just 50 miles off the coast of the Pacific Northwest from northern California to southern British Columbia in Canada. Other areas of concern for the U.S. are similar subduction zone faults within 70 miles of coasts of Alaska and Puerto Rico. A rupture along any of these faults could set off powerful ocean waves relatively close to shore, with the first waves impacting coastal communities in mere minutes. NOAA is working to ensure our Nation is prepared for such catastrophes, and for other environmental hazards both natural and man-made.

A comprehensive and effective tsunami warning process requires three parts:

- Observations to detect a tsunami and models to forecast path and impact,
- Timely and accurate alerts, and
- Proper response to the notifications as a result of ongoing community education and awareness activities.

Today, I will discuss how NOAA integrates all three components to form an effective tsunami warning, preparedness and response program.

NOAA'S ROLE

NOAA provides a host of products and services that minimize the impacts from tsunamis, from advanced preparedness of coastal communities, to detection and warning services, to post-event response and recovery efforts. NOAA operates a suite of instruments and tools including an array of ocean buoys and monitoring stations moored to the sea floor, sea level gauges along the coast, orbiting satellites, and advanced computer modeling. NOAA's services include around-the-clock forecast and warning centers and extensive public outreach and education efforts, providing the essential detection and warnings necessary to alert emergency officials and the public about the threat of tsunamis as well as information to help communities prepare for those threats.

With more than 40 years of experience building effective observation and warning systems, NOAA has operational responsibility for the U.S. Tsunami Warning System. NOAA's National Weather Service (NWS) issues tsunami warnings, advisories, and watches for the entire coastline of the U.S., its territories and commonwealths, and many nations in the Pacific and Caribbean, to alert emergency managers and the public to take life-saving actions. Tsunami alerts and warnings are issued by two warning centers: NOAA's Pacific Tsunami Warning Center (PTWC) in Ewa Beach, Hawaii, and NOAA's West Coast and Alaska Tsunami Warning Center (WC/ATWC) in Palmer, Alaska.

Within minutes of the Japanese earthquake, NOAA's PTWC issued tsunami warnings for Japan, Russia, Marcus Island, and the Northern Marianas Islands based on analysis of accessible global seismic data. Using readily-available seismic data, NOAA's WC/ATWC issued tsunami information statements assessing the potential preliminary threat for Alaska, British Columbia, Washington, Oregon, and California. After assessing the potential threat, both centers issued tsunami warnings and alerts for Hawaii, Alaska, Washington, Oregon, and California. These alerts and warnings provided lead times of seven hours for Hawaii, four hours for Alaska, and nine hours for the West Coast. Local NWS Forecast Offices that serve the U.S. coastline issued localized tsunami impact statements for areas such as Crescent City, California, which was heavily impacted by waves, rising waters, and tsunami generated currents for more than 24 hours following the initial tsunami wave that reached that area.

NOAA's initial tsunami warnings were expanded to include Hawaii and portions of Alaska and the West Coast, based on warnings that were updated with more specific observational data as the tsunami wave moved across the Pacific Ocean. For example, about 25 minutes after the earthquake, the tsunami was detected by one of NOAA's

Deep-ocean Assessment and Reporting of Tsunami (DART) stations located off the east coast of Japan. The information from the DART station along with coastal sea-level data was fed via satellite into NOAA's tsunami models that simulate the generation, propagation, and inundation of the tsunami. Coupled with data defining the shape of the ocean floor, the tsunami models provided predictions of arrival times, wave heights, and inundation areas for specific U.S. coastal locations to augment the original tsunami warnings and forecasts.

NOAA monitored the tsunami as it traversed the globe, largely through a global network of water-level gauges, in which NOAA's National Ocean Service's (NOS) gauge capacity plays a key role. NOS' tsunami-capable tide stations provide complete coverage for the U.S. coastline (see http://tidesandcurrents.noaa.gov/tsunami/ for locations). These data were rapidly relayed from these remote gauges via NOAA's Geostationary Operational Environmental Satellites (GOES) to tsunami warning centers. The U.S. Integrated Ocean Observing System, a NOAA-led interagency-regional collaboration to deliver ocean and coastal information, also provided real-time water level measurements for various Pacific locations through its partners in the Pacific islands. Together, these leveraged and complementary observation networks helped emergency managers and local officials evaluate the ongoing threat from follow-on waves until all warnings and advisories were finally dropped over 36 hours following the initial earthquake.

In the aftermath of the earthquake and tsunami, NOAA continues to perform critical roles in areas most impacted by the tsunami. NOS deployed navigation managers to interface directly with and help assess the needs of the commercial maritime community. Navigation Response Teams conducted hydrographic surveys to assist with submerged debris detection in critical marine transportation arteries, such as the port areas of Santa Cruz and Crescent City, California. The results of these surveys gave decision makers the information needed to safely reopen the ports to fishing and commercial shipping interests. NOS also provided the U.S. Coast Guard and California authorities with scientific support services for responding to existing and potential chemical and oil spill situations as a result of damaged vessels and infrastructure. For all tsunamis, NOS and NOAA's Office of Marine and Aviation Operations have the ability to provide geo-referenced, high-resolution aerial imagery of tsunami-affected areas of the U.S. in coordination with the Federal Emergency Management Agency (FEMA) to support detailed damage assessment, recovery and rebuilding efforts.

NOAA also supports response activities related to Japan's compromised nuclear facilities. Atmospheric dispersion models developed at NOAA's Office of Oceanic and Atmospheric Research (OAR) helped predict the airborne transport of radioactivity. These results are used by the International Atomic Energy Agency (IAEA), Environmental Protection Agency, U.S. Army Public Health Command, among others, to help understand the potential impacts from increased radioactivity. Twice a day, NWS is providing wind and precipitation forecasts for Fukushima and Tokyo, forecast discussions and a seven-day weather outlook for Fukushima. NOAA was recently named co-lead with the White House Office of Science and Technology Policy of a working group that will develop an ocean plume model for currents and worst case radiological

effects on the ocean. NOAA's National Marine Fisheries Service supports the Food and Drug Administration and the U.S. Department of Agriculture in ensuring a continuous safe supply of seafood to the American public, including monitoring of imports that may have been impacted by radioactivity.

THE GROWTH OF THE U.S. TSUNAMI WARNING SYSTEM

In December 2004, the catastrophic effects of the Indian Ocean tsunami focused the world's attention on the very real threat of tsunamis world-wide, and underscored the value of a comprehensive warning system and an educated public. Congress acted swiftly after that natural disaster and provided needed funding to improve the Nation's tsunami program – from preparedness to detection and prediction. NOAA thanks Congress for the important investment that was made in improving the Nation's tsunami capabilities.

Prior to the Indian Ocean tsunami, NOAA had been steadily developing and improving the Nation's tsunami observing and prediction capabilities for decades, during a time when the threat of tsunamis was not recognized as publicly. In 1995, OAR developed the DART stations to provide crucial information on tsunami strength in the open ocean. OAR also developed advanced tsunami models that employ DART data to provide accurate tsunami inundation predictions for entire ocean basins.

NOAA uses the U.S. Geological Survey's (USGS) national earthquake monitoring network and the Global Seismic Network to analyze the earthquakes which can trigger tsunamis. NOAA also uses its NWS local operational seismic networks in Alaska and Hawaii to supplement USGS global data. NWS installed these networks after devastating earthquakes and local tsunamis before the global USGS network was established. The USGS received supplemental funds since the Indian Ocean tsunami to improve its seismic network and the smaller NWS networks. Together, NOAA and USGS leverage the resources and assets of each agency to increase the density of the seismic network to move closer to the density of Japan's state-of-the-art network. A denser network allows for quicker earthquake detection, warning and intensity determination, allowing NOAA to issue its tsunami warnings more quickly.

NOAA monitors and maintains an extensive water level observation network in coastal states and territories and has access to the global network of stations to detect and observe coastal water levels critical to understanding and predicting tsunamis. The data from these stations are used in NOAA's tsunami forecast models provide estimates of tsunami arrival times and the maximum tsunami wave height for areas at-risk to tsunami and surge events, assisting federal, state and local emergency managers in decisions about the need for evacuations and other safety measures.

Since receiving $17 million of emergency supplemental funding in fiscal year 2005 associated with the Indian Ocean tsunami, NOAA has made dramatic improvements to the Nation's tsunami warning program. These improvements included upgrading its detection capability by installing a global network of 39 DART stations (see Figure 1) that are operated and maintained by the NWS, and moving to 24x7 operations of its

tsunami warning centers. Efficiency of critical tsunami-related information delivery via satellite communications was also improved with these funds.

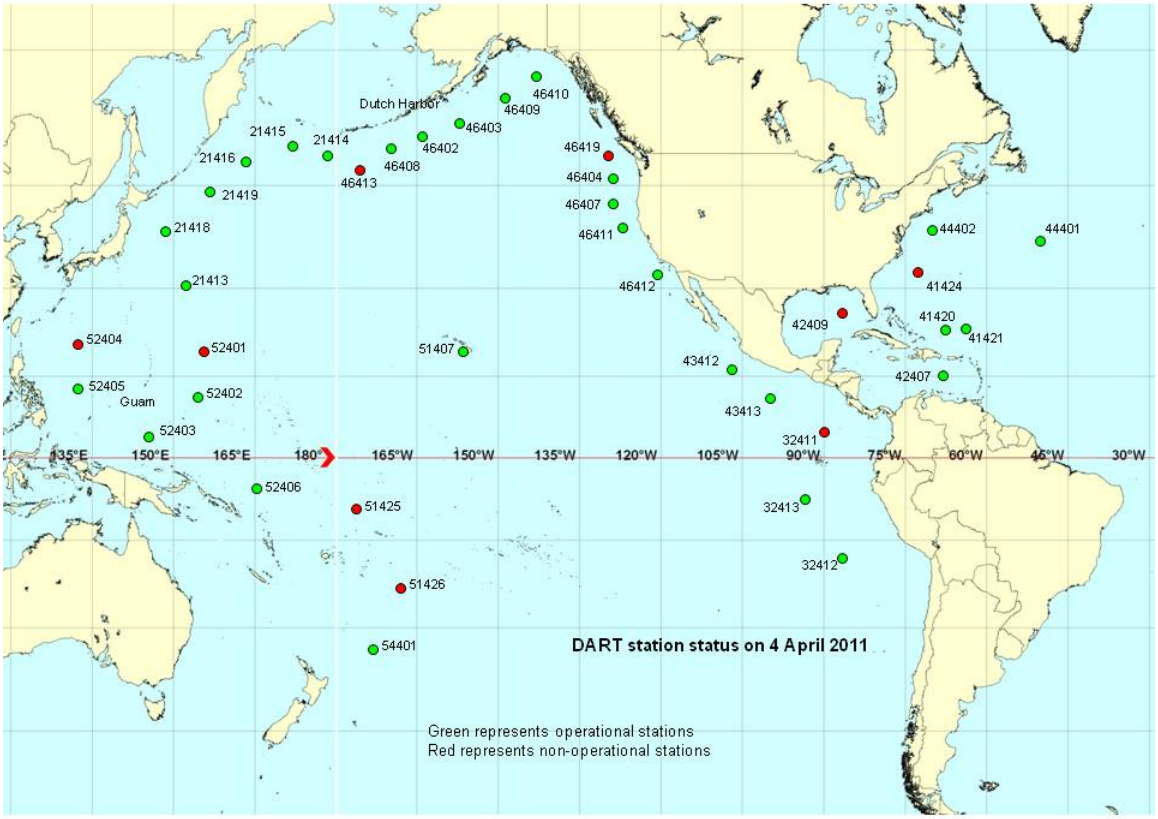

Fig. 1 Locations and operational status of the DART buoys

The funding Congress invested in NOAA has proven to be money very well spent. The warnings issued by NOAA's Tsunami Warning Centers were timely and very accurate (see Figure 2). Coupled with an effective education and outreach campaign, NOAA's response to the Japan tsunami saved countless lives and prevented property damage. NOAA has been operationally forecasting tsunami height for only the past few years, with much of the improved modeling capability driven by supplemental funding and funding provided by the 2005 Deficit Reduction Act. Only ten years ago, predicting the timing and height of tsunamis was a limited and speculative capability. NOAA has come a long way since then, but still has room to improve forecast accuracy.

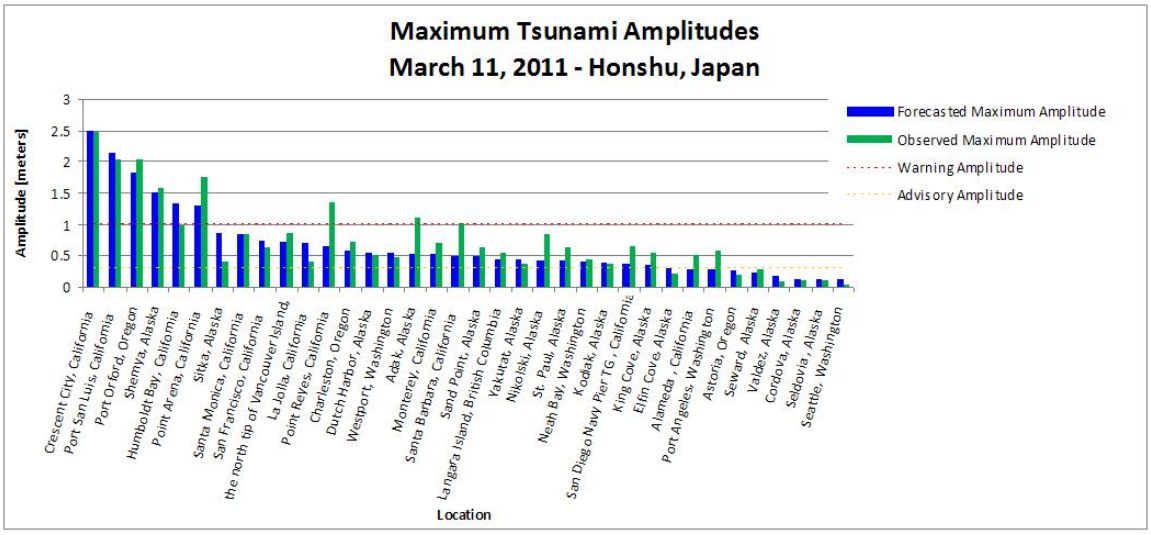

Fig. 2 Forecast and observed tsunami amplitudes

OUTREACH AND EDUCATION

In addition to providing accurate observations and alerts for natural hazards, an educated and responsive public is critical to achieving community preparedness for any natural hazard and in particular a rare and unpredictable event such as a tsunami. Simply knowing the precursors to a tsunami – strong coastal earthquakes or rapidly receding water – and having a pre-defined action plan for moving rapidly to a higher location, have the potential to save countless lives even in areas where warnings are not received. To achieve this level of public awareness, NOAA has engaged in an extensive array of outreach and education efforts.

Globally, NOAA supports outreach and education through the International Tsunami Information Center in Hawaii, operated by NOAA's National Weather Service for the United Nations Educational, Scientific and Cultural Organization's Intergovernmental Oceanographic Commission. On the national level, NOAA and our Federal partners work with local and state governments through the National Tsunami Hazards Mitigation Program (NTHMP), which is designed to reduce the impact of tsunamis on U.S. coastal communities. The NTHMP consortium includes all 28 U.S. coastal States, Territories and Commonwealths, USGS, FEMA, and NOAA. It is a model program for how government at all levels can work together to improve hazard resilience in the United States.

Led by the NWS, with additional support from OAR, the NTHMP is the Nation's community-focused program to improve tsunami mitigation and preparedness of at-risk areas within the United States and its territories. While the United States is not subject to frequent tsunamis, the impact of just one destructive tsunami can be truly catastrophic. To reduce the social and economic effects of a tsunami, the NTHMP takes actions to improve preparedness and response of U.S. coastal communities.

With the passage of the Tsunami Warning and Education Act in December 2006, the mission of the NTHMP has been further focused on:

- Improving the quality and extent of coastal inundation mapping,
- Promoting and improving community outreach and education networks and programs to ensure community readiness,
- Integrating tsunami preparedness and mitigation programs, and
- Promoting the adoption of tsunami warning and mitigation measures by Federal, state, tribal, and local governments and non-governmental entities.

One component of the NTHMP and NOAA's mitigation and education preparedness activities is NOAA's TsunamiReady™ program. TsunamiReady™ is a voluntary partnership between NOAA, state, and local emergency management agencies. The TsunamiReady™ program strives to increase public awareness of the threat that tsunamis pose, improve hazard planning, and strengthen warning communication linking the emergency management community and NWS with the public. The current goal of TsunamiReady™ is to create tsunami resilience in communities by better integrating tsunami hazard preparedness into coastal community culture, and providing coastal jurisdictions with a level of "minimal readiness" for the tsunami hazard.

To support proper response to tsunamis, local NWS forecast offices and other NOAA resources work with coastal counties, cities, and "communities," which may include schools, businesses and public venues, to become TsunamiReady™. For communities to achieve this recognition they must have the ability to receive NOAA's tsunami alerts, further warn the public, identify evacuation zones and conduct tsunami education activities. Currently, there are 83 TsunamiReady™ communities, including all four counties in Hawaii, seven communities in Alaska and 42 along the west coast. NOAA's goal is to recognize 105 TsunamiReady™ communities by 2013. The NWS TsunamiReady™ program and other outreach efforts such as the first National Tsunami Awareness Week (March 20-26, 2011) educate local communities on how to properly respond to tsunamis.

NOAA'S FUTURE IMPROVEMENTS

With our integrated, agency-wide program, NOAA has demonstrated the capability to help formulate accurate and timely warnings and has made tremendous progress in educating vulnerable communities in preparing for and responding to tsunami warnings. However, as the Japan tsunami has shown, tsunamis near coastal earthquake epicenters can cause catastrophic local damage to even the most well prepared nations. NOAA recognizes the important role our Federal and State partner agencies play in improving our understanding of, preparation for, and response to all types of tsunamis. We are working together with these partners to provide vital information tools and services to help prevent and mitigate the security, economic, and public health risks our country faces from catastrophic near-source tsunamis.

NOAA is currently working on several actions to further improve the U.S. capabilities and preparedness for future tsunamis including:

- Developing tsunami inundation forecast models for harbors in Hawaii, the Pacific Islands, and the U.S. west coast that do not already have them,
- Working with our agency and state partners in the NTHMP to accelerate local tsunami preparedness capabilities, and
- Working with the international community on tsunami research and leveraging of assets.

SUMMARY

The dual goals of preparing for and mitigating natural hazards requires the continuous commitment and partnership of many individuals and sectors - from Federal, state, tribal, and local to public, private, and academic. The investments made by Congress and the Administration in NOAA's Tsunami Warning System and the National Tsunami Hazard Mitigation Program *directly* saved lives in the U.S. during last month's Pacific-wide tsunami disaster and during the American Samoa tsunami of September 2009. NOAA remains committed to leading U.S. efforts to save lives and property through tsunami preparedness, detection, and forecasting efforts. Although nothing can eliminate the physical threat that tsunamis and natural hazards pose, NOAA has demonstrated success in better predicting their onset, reducing their impact, and helping vulnerable communities become more resilient to the devastating effects tsunamis pose – and will work to continuously improve its natural hazards products and services to the Nation.

Mary M. Glackin, Deputy Under Secretary for Operations

Mary M. Glackin has been the Deputy Under Secretary for Operations since December 2007. In this role she is responsible for the day-to-day management of NOAA's national and international operations for oceanic and atmospheric services, research, and coastal and marine stewardship.

Mary has worked at NOAA 33 years with nearly 20 years of senior executive level experience working in numerous NOAA line offices. She served as the acting Assistant Administrator for Weather Services and Director, National Weather Service in 2007. Before that, she was the Assistant Administrator for the National Oceanic and Atmospheric Administration's (NOAA) Office of Program Planning and Integration. From 1999 until 2002, she served as the Deputy Assistant Administrator for the National Environmental Satellite, Data, and Information Service of NOAA.

From 1993 to 1999, she worked as the Program Manager for the Advanced Weather Interactive Processing System (AWIPS) with the National Weather Service (NWS), NOAA. Prior to this, Ms. Glackin was both a meteorologist and computer specialist in various positions within NOAA where she was responsible for introducing improvements into NWS operations by capitalizing on new technology systems and scientific models.

She has twice received the Presidential Rank Award (2001 and 2009). She also is the receipient of the Charles Brooks Award for Outstanding Services to the American Meteorological Society, the NOAA Bronze Medal (2001), the Federal 100 Information Technology Manager Award (1999), the NOAA Administrator's Award (1993), and the Department of Commerce Silver Medal Award (1991). She is a Fellow of the American Meteorological Society and a member of the National Weather Association and the American Geophysical Union.

Ms. Glackin has a B.S. degree from the University of Maryland.