Order Code RL32739

Tsunamis: Monitoring, Detection, and Early Warning Systems

Updated February 23, 2006

Wayne A. Morrissey
Information Research Specialist (Science & Technology)
Knowledge Services Group

Tsunamis: Monitoring, Detection, and Early Warning Systems

Summary

Some in Congress are concerned about the possible vulnerability of U.S. coastal areas to tsunamis and about the adequacy of early warning for coastal areas of the western Atlantic Ocean. This stems from the December 26, 2004, tsunami that devastated many coastal areas around the northern Indian Ocean, where few tsunami early warning systems currently operate. Caused by a strong underwater earthquake off the coast of Sumatra, Indonesia, the earthquake and ensuing tsunami together are estimated to have claimed as many as 300,000 lives. Affected nations, assisted by others, are pursuing multilateral efforts through the UNESCO's Intergovernmental Oceanographic Commission (IOC) to develop a regional tsunami detection and warning network to alert coastal populations around the Indian Ocean. Those efforts coincide with President Bush's plan for upgrading and expanding U.S. tsunami detection and early warning capabilities, which was released in December 2005.

Some developed countries bounded by the Indian Ocean already have operating tsunami warnings systems. However, in some areas of these and in neighboring countries, there is no emergency management infrastructure to receive tsunami warnings. Local officials are incapable of rapidly alerting the public to evacuate or to take other safety precautions. However, most disaster management experts assert that an emergency management infrastructure is not just issuing tsunami warnings but also educating indigenous people and visitors about the potential dangers in the area; communicating evacuation options clearly; adapting to potential risks through construction of public shelters; conducting periodic evacuation drills; and producing tsunami inundation maps for guiding future land-use planning.

Although the cost of the expanded network for the United States will run into millions of dollars for instrumentation and long-term maintenance, some suggest the benefits would far outweigh the costs. Others have questioned whether the risks of tsunamis outside the Pacific Basin justify the investment. To leverage costs international science agencies have suggested that global or regional warning networks be built upon existing ocean data collection systems, marine data buoys, tide gauge networks, coastal and ocean observation networks, the global seismic network, and use international telecommunications systems. Still, a global tsunami warning system would be most useful in countries that also have expansive national emergency management capability.

President Bush pledged $37.5 million for upgrading the U.S. tsunami early warning system through 2007, which would expand a network of 10 deepwater tsunami detection buoys now operating to 32 for the Pacific and Atlantic Oceans, Gulf of Mexico, and Caribbean Sea. P.L. 109-13 provided emergency appropriations for FY2005 to procure, deploy, and maintain a comprehensive U.S. tsunami early warning network, and is supplemental to FY2006 appropriations. Tsunami-related legislation in the 109th Congress would support long-term systems operations and maintenance, public education, and modes of adaptation. Administration officials and some in Congress consider an upgraded U.S. system a first step toward building a global tsunami warning capability. This report will be updated as warranted.

Contents

List of Figures

Tsunamis: Monitoring, Detection, and Early Warning Systems

Introduction

The 109th Congress has raised questions about (1) the possibility of tsunamis occurring in U.S. coastal areas; (2) the extent to which these areas are currently monitored; (3) how tsunamis can be detected; and (4) whether there is a national capacity to issue evacuation warnings for tsunamis.[1] Such concerns stem from the December 26, 2004, tsunami disaster that was triggered by an underwater earthquake off the west coast of northern Sumatra in Indonesia. Based on physical evidence of displacement of the sea floor, U.S. seismologists have since determined that earthquake to have been M_w 9.2.[2] The ensuing tsunami devastated many coastal areas around the northern Indian Ocean and caused an economic upheaval in other areas. International disaster agencies estimate that as many as 300,000 people may have lost their lives.

On January 5, 2005, the House Science Committee, House Coastal Caucus, and House Oceans Caucus co-sponsored a briefing organized by the U.S. Geological Survey (USGS) of the Department of the Interior. The purpose of the briefing was to consider the possible implications of the Indian Ocean tsunami for the United States. Experts from USGS and the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce delivered presentations on the scientific circumstances surrounding that tsunami disaster and discussed existing capabilities for monitoring, detection, and early warning around the globe.[3]

Scientists studying the tsunami disaster at NOAA and at other international science agencies found that there were few, if any, tsunami early warning systems monitoring the Indian Ocean on December 26, 2004. Some of those same nations affected by the tsunami and bounded also by the Pacific Ocean, including Australia

---

[1] A tsunami is a seismic sea wave (or a series of waves) usually generated by an underwater earthquake or landslide, but occasionally is caused by volcanic eruption or major landslide *into* the ocean. Tsunami is translated from Japanese as "harbor wave".

[2] M_w, the moment of magnitude, is a way to measure the force of an earthquake's total seismic energy released as a function of rock rigidity in the fault, the total area of contact where friction occurs, and the amount of slippage (or displacement). It is used for earthquakes greater than M8.2 on the Richter scale.

[3] Presenters at that briefing included, David Applegate, Science Advisor for Earthquake and Geological Hazards at the USGS; General David Johnson, Assistant Director of NOAA's National Weather Service; Gregg Withee, Assistant Director for NOAA Satellite and Information Services; and, Eddie Bernard, Associate Director of NOAA's Pacific Marine Environmental Laboratory (teleconferencing from Seattle, WA).

and Indonesia, had tsunami early warning systems monitoring their Pacific shores where they perceived the greatest threat.[4] Because of the geographic proximity of human settlements to where the tsunami was generated, and no ability to receive tsunami warnings rapidly, post-disaster assessments indicate that for Indonesia's Indian Ocean coastal populations, emergency communications were useless in many cases. In other cases, it was found that indigenous people and tourists were not educated about the possible dangers of tsunamis. They were not aware of the physical warning signs of an onset of a tsunami. There were no alternative procedures included in local or regional emergency plans for issuing evacuation alerts in the event important "lifelines" such as electric utilities and telecommunications were disrupted.[5]

On January 29, 2005, the House Committee on Science, and on February 2, 2005, the Senate Committee on Commerce, Science, and Transportation, held hearings about providing expanded tsunami early warning protection for the United States and its possessions. Legislation introduced by Senator Lieberman (S. 34) and Senator Inouye (S. 50), among others, prior to these hearings would have provided for a rapid U.S. response to upgrade existing capacity for warning in the Pacific and an expansion of operations to include the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea. Senator Inouye's bill was closely aligned with President Bush's proposal for U.S. tsunami protection released on January 14, 2005. However, in addition, S. 50 addressed related social issues such as disaster education and local emergency preparedness and adaptation. (See "Legislation" section, below.)

Although most deadly tsunamis have occurred historically in the western Pacific Ocean, there are examples of recorded events in the eastern Pacific and North Atlantic Oceans. For example, In 1692, a tsunami generated by massive landslides in the Atlantic Puerto Rican Trench reached Jamaica's coast, causing an estimated 2,000 deaths. In 1775, a tsunami struck in the eastern Atlantic Ocean on the coast of Portugal, killing an estimated 60,000 people. More recently, in 1929, a tsunami generated in the Grand Banks region of Canada hit Newfoundland, killing 51. It was the third lethal tsunami for Canada's Atlantic Coast within 150 years.[6]

---

[4] General David L. Johnson, "NOAA Tsunami and Natural Disaster Information," Jan. 5, 2005 House briefing.

[5] Lifelines are emergency response services, hospitals, other care facilities, energy and water delivery systems, telecommunications, and electronic commerce. See U.S. Congress, Senate Committee on Commerce Science and Transportation, *Earthquake Hazards Reduction Act*, report to accompany S. 910,105th Cong., 1st sess., S.Rept. 105-59 (Washington: GPO, 1997), p. 3.

[6] Statistics on deaths resulting from tsunamis were compiled by CRS from online sources, and include data from the Tsunami Laboratory of Novosibirsk, NOAA's National Geophysical Data Center, the University of Southern California, Tsunami Research Group, and others. See [http://geology.about.com/library/bl/bltsunamideathtable.htm].

A Global Tsunami Early Warning System?

Most international scientific agencies agree that considerable challenges must be overcome to establish an extensive tsunami early warning network in the Indian Ocean and other earthquake-prone areas such as the Black Sea. In some respects, developed nations that currently have the resources and capability to establish their own regional emergency management networks, warning capabilities, and disaster plans have been able to avoid some of these challenges.

Challenges

Development of truly global system with a capability for issuing regional and local tsunami warnings will require involving many nations with widely varying technological capabilities and financial resources. Reports would indicate that international political leaders expect most of the responsibility for paying for such a system will fall on the wealthiest nations. The costs of procuring, operating, and maintaining instruments and platforms, and the challenge of obtaining international cost sharing, are likely to be the most critical factors in sustaining a long-term international effort for detection and early warning.

A few Members of Congress and representatives of international science agencies under the auspices of the United Nations have called for an inventory of existing capacity for tsunami monitoring, detection, and warning to use as a baseline from which to determine what would still be needed for a global warning network. (See "Legislation" section.) U.S. government policy analysts have suggested that technological challenges and possible national security issues could arise in building and sharing a truly "global" system. Technical concerns include international standardization for tsunami warning instrumentation on data collection and relay platforms. Terrorism concerns include access to and possible sabotage of international telecommunication networks. In addition, some intelligence experts have concerns that certain data collected could be considered sensitive and perhaps compromise U.S. or other nations' intelligence-gathering operations. At a House briefing, Assistant Director of NOAA for Satellite and Information Services, Gregg Withee, stated that some nations, including India, maintain proprietary rights to all of their real-time satellite data. Some of these data, he asserted, could be critical for detection and tracking of tsunamis in the Indian Ocean and for post-disaster damage assessment, leaving other countries having to pay for them.[7]

International Proposals

On January 6, 2005, the United Nations proposed an international effort to develop a tsunami early warning capacity for nations bounded by the Indian Ocean. That effort would be led by the U.N. Educational, Scientific, and Cultural Organization's (UNESCO) Intergovernmental Oceanographic Commission (IOC).

---

[7] Gregg Withee, Jan. 5, 2005 House briefing. Stefan Maus of NOAA's National Geophysical Data Center (NGDC) of NESDIS visited India Oct. 22, 2005, to Nov. 20, 2005, to enhance the exchange of geomagnetic data for space weather, main field, and crustal field modeling. See [http://www.ngdc.noaa.gov/products/news_archive_2005.html].

Australia, Japan, Thailand, and India have also announced their own initiatives to expand monitoring on Indian Ocean coastlines.

On February 15, 2005, in Brussels, Belgium, IOC members finalized plans for an international global ocean observing system (IGOOS). IGOOS, they noted, is one data network that could serve as the backbone on which a regional tsunami early warning system for the Indian Ocean could be built. A month later, experts from Indian Ocean countries that were affected by the December 26, 2004, tsunami and other countries convened a UN Interagency Oceanographic Commission (IOC) summit in Paris, France (March 3-8, 2005). The collective goal was to plan for an internationally coordinated effort to develop a tsunami early warning system for the Indian Ocean and to solicit member countries' possible financial pledges to that endeavor. The Director of the UN International Strategy for Disaster Reduction (ISDR) chaired that summit.[8]

NOAA's Director of the National Weather Service (NWS), Brig. Gen. David L. Johnson, USAF (Ret.), has emphasized that in addition to operating a capacity to monitor and detect possible tsunamis, a telecommunications infrastructure for issuing tsunami warnings (such as that presently in place in the Pacific Ocean), is critical for the Indian, western Atlantic, and far Pacific Oceans' populations. However, he noted that NOAA's responsibility for tsunami warnings terminate when emergency communications are relayed to international emergency management officials.[9] He added that the United States forecasts and warnings of severe weather are picked up and distributed by local emergency managers and the media after being issued by local and regional NWS weather forecast offices and are broadcast to individuals with NOAA Weather Radio receivers.[10] In terms of global adequacy, observers of international disasters have shown that there are varying capabilities for relaying public emergency warnings. In some regions those capabilities are inadequate or nonexistent.

U.S. Collaboration

Addressing international tsunami detection and warning capabilities, NOAA's Administrator, Admiral Lautenbacher, has promoted development of the international Global Earth Observing System of Systems (GEOSS), an initiative that has been supported by President Bush. Billed as "an excellent example of science serving society," GEOSS is to be built upon data collection platforms and would use the telecommunications capabilities of other observation systems and communication

---

[8] UN ISDR, "Meeting in Paris to Plan Tsunami Early-Warning System," Press Release IHA/1019, Mar 1, 2005.

[9] Testimony of Brig. Gen. Jack Kelly, Jr., former NWS Director, and present Deputy Administrator for NOAA on behalf of Vice Admiral Conrad Lautenbacher, Jr. (U.S. Navy, Ret.) Undersecretary of Commerce for Oceans and Atmosphere and NOAA Administrator, National Oceanic and Atmospheric Administration, Department of Commerce, in U.S. Congress, Senate Committee on Commerce, Science, and Transportation, *The Tsunami Preparedness Act of 2005*, hearing, 109th Cong., 1st sess., Feb. 2, 2005, S.Hrg. 109-93 (Washington: GPO, 2005).

[10] Id.

networks currently operating around the world.[11] One of these networks is the previously mentioned International Global Ocean Observing System (IGOOS). A second consists of thousands of Argo floats that monitor global climate in the equatorial Pacific. (See the "Tsunami Detection Operations" section.) Through implementation of GEOSS and, in particular, IGOOS, the United States would help IOC members to build a global tsunami detection and early warning capacity.[12]

On February 16, 2005, the United States Group on Earth Observation (US GEO) and international science ministers met in Brussels, Belgium and adopted a 10-year implementation plan for GEOSS. The European Union hosted the event with representatives of 60 other countries in attendance. Details about U.S. international funding commitments and a role in global tsunami warning efforts is being revealed as GEOSS implementation unfolds.[13] Most international science agencies and nongovernmental organizations representing Indian Ocean nations generally support GEOSS and President Bush's January 2005 proposal and July 2005 "action plan" for a U.S. tsunami warning system and have called it "a good start."

Tsunami Protection for the United States

Although some Members of Congress are on record as supporting international development of a "global" tsunami detection and warning system after the Indian Ocean disaster, Representative Pallone was the first to call for establishing a tsunami detection and warning network for the U.S. Atlantic coast, the Gulf of Mexico, and the Caribbean Sea.[14] Other lawmakers questioned whether the risk for a tsunami on the U.S. Atlantic coast would justify such expenditures. In briefings to Members of Congress, NOAA scientists emphasized potential dangers for the western Atlantic

---

[11] U.S. Dept. of Commerce, NOAA, Office of the Federal Coordinator for Meteorology, "World Weather Program: The Global Observing System: Its Impacts and Future," by BGEN John J. Kelly Jr., (USAF, Ret.), *The Federal Plan for Meteorological Services and Supporting Research: Fiscal Year 2006*, Report FCM P1-2005, Appendix B: 237-243 (Washington, DC: October 2005). Other examples of international communications networks are included.

[12] Gen. David Johnson, Jan. 5, 2005 House briefing. For more information on ocean observing systems, see U.S. Congress, House Resources Subcommittee on Fisheries, Conservation, and Wildlife, *Status of Ocean Observing Systems in the United States*, Oversight Hearing, serial no. 108-102, July 13, 2004 (Washington, DC: GPO, 2005).

[13] Op cit. 9. Written testimony of Hon. John Marburger III, Director of the Office of Science and Technology Policy prepared for Senate Commerce Tsunami Preparedness hearing, February 2, 2005.

[14] Statement of Representative Frank Pallone, *Congressional Record*, January 4, 2005: H40. "There has been a lot of discussion and I think there is a need to expand the tsunami early warning system that exists in the Pacific not only to the Indian Ocean but also possibly to the Atlantic Ocean and throughout the world."

Ocean because of the Puerto Rican Trench, which is the deepest point in the western Atlantic Ocean.[15]

As noted previously, massive landslides and sloughing have occurred on the face of North American continental shelf, generating deadly tsunamis. Strong underwater earthquakes have periodically occurred off the coast of Puerto Rico and, in some cases have generated tsunamis that resulted in loss of life and property damage.[16] One U.S. Atlantic coast state, New Hampshire, a state on the U.S. Atlantic Coast has had an emergency contingency plan for tsunamis and a clearinghouse for information about historical tsunami disasters for the past few years.[17] In 2005, two communities on the Atlantic seaboard received notoriety for having become the first NWS *TsunamiReady* communities in the Gulf of Mexico and on the Atlantic Coast.[18] Meanwhile, some Pacific coast states and Hawaii have had tsunami evacuation plans in place for almost 60 years.

Administration Proposal

On January 14, 2005, the White House Office of Science and Technology Policy (OSTP) announced the Bush Administration proposal for an improved tsunami warning and detection system for the United States.[19] That plan included the NWS of NOAA procuring and deploying a total of 32 dedicated tsunami warning and detection "DART" buoys by mid-2007, for the purpose of improving tsunami detection in the Pacific and Atlantic Oceans, Gulf of Mexico, and Caribbean Sea. (See **Figure 1**, below.)

---

[15] USGS, Woods Hole Science Center, "Caribbean Tsunami and Earthquake Hazards Studies Program," available at [http://woodshole.er.usgs.gov/projects/project_get.php?proj=29210EQ&style=html].

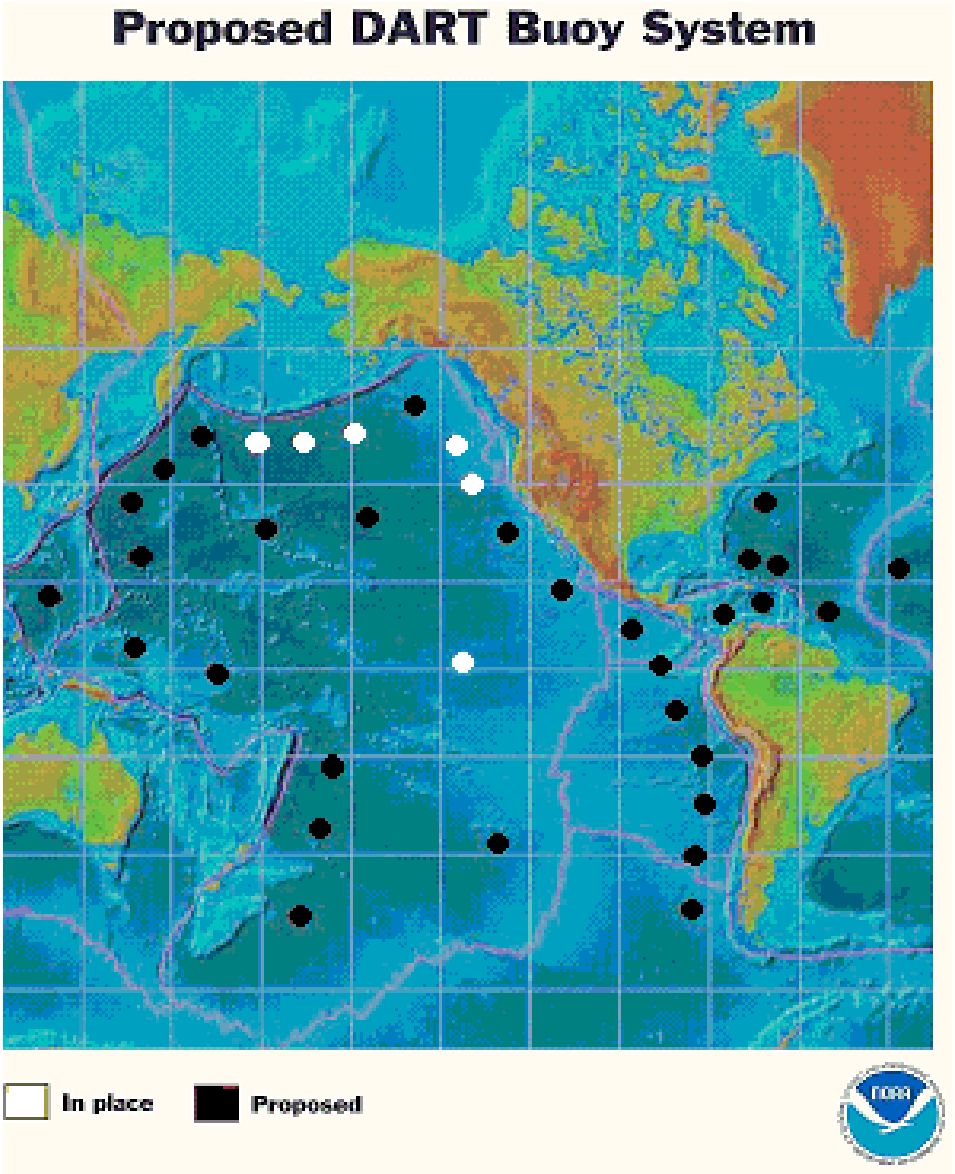
[16] See "The Puerto Rico Trench: Implications for Plate Tectonics: Earthquake and Tsunami Hazards," at [http://oceanexplorer.noaa.gov/explorations/03trench/trench/trench.html].

[17] State of New Hampshire, "Disaster Plan 409," Sect. II, Geological Hazards, Seismic Hazards, at [http://www.nhoem.state.nh.us/mitigation/state_of_new_hampshire.asp]. See also "Is your Community Ready for the Next Tsunami," National Weather Service Tsunami Ready program, at [http://tsunami.gov].

[18] NOAA, National Weather Service, "*TsunamiReady* Sites in Six States," available at [http://www.stormready.noaa.gov/tsunamiready/ts-communities.htm].

[19] U.S. Office of Science and Technology Policy, "U.S. Announces Plan for Improved Tsunami Detection and Warning System," press release, *OSTP News*, Jan. 14, 2005. See also Eli Kintisch, "South Asia Tsunami: U.S. Clamor Grows for Global Network of Sensors," *Science*, vol. 307, Jan. 14, 2005, p. 191.

Figure 1. U.S. Proposal for Tsunami Detection/Warning System



Source: National Oceanic and Atmospheric Administration, from "U.S. Announces Plans for an Improved Tsunami Warning and Detection System" (modified by CRS for contrast), at [http://www.noaanews.noaa.gov/stories2005/s2369.htm], visited January 18, 2005.

Funding for the U.S. Tsunami Warning Program. NOAA officials estimate that the cost of adding tsunami detection instruments on Atlantic Ocean platforms, such as weather buoys, or building dedicated DART platforms, could vary depending upon the scale of the project — for example, the number of instruments to be deployed and the out-year costs of operation and maintenance (O&M).[20] Other

[20] U.S. Congress, House Committee on Science, "Tsunamis: Is the U.S. Prepared?", hearing, (continued...)

expenditures supporting the program include funding for NOAA's U.S. tsunami-related research activities, tsunami mitigation programs, public outreach and education, the *TsunamiReady* program, and telecommunications upgrades for supporting technologies such as the USGS Global Seismic Network (GSN). (See "Related U.S. Programs" section.)

Table 1. National Oceanic and Atmospheric Administration (NOAA) Funding for U.S. Tsunami Programs

($million)

U.S. TSUNAMI WARNING PROGRAM[a]		NTHMP[b]	TWEAK[c]	DART Buoy Acq.[d]	Strengthen Tsunami Warnings[e]	Annual Total
FY2007	Approp.	—	—	—	—	**—**
	Req.	0.0	0.0	1.0	11.4	**$12.4**
FY2006	Approp.	2.3	2.0	6.0	3.8	**$14.1**
	Req.	2.3	0.0	6.0	3.5	**$11.8**
FY2005 Suppl.[f]		7.1	0.0	10.2	—	**$17.3**
FY2005	Approp.	4.2	2.0	0.0	—	**$6.2**
	Req.	0.0	0.0	0.0	—	**$0.0**
FY2004	Approp.	4.3	2.0	0.6	—	**$6.9**
	Req.	0.0	0.0	0.0	—	**$0.0**
FY2003	Approp.	4.3	—	—	—	**$4.3**
	Req.	0.0	—	—	—	**$0.0**
FY2002	Approp.	3.3	—	—	—	**$3.3**
	Req.	2.3	—	—	—	**$2.3**
FY2001	Approp.	3.3	—	—	—	**$3.3**
	Req.	0.0	—	—	—	**$0.0**

Source: Compiled by CRS from annual Commerce, Justice, State, Judiciary and Related Agency annual appropriations reports, and NOAA FY2007 Budget Summary.

---

[20] (...continued)
p.41, Jan. 26, 2005 [Serial No. 109-1], Prepared Statement of Rep. Sheila Jackson Lee. See [http://commdocs.house.gov/committees/science/hsy98395.000/hsy98395_0.htm]. "DART stations cost about $250,000 to purchase and around $125,000 per year to maintain. Stations are now located off the coasts of Alaska, the Pacific Northwest, and Chile, but we need to consider how this system can be expanded to other parts of the world. Reliability of the DART system needs to be understood as we consider its deployment worldwide."

Notes:

a. Funding for NOAA tsunami programs is not currently authorized by legislation. The last official NOAA authorization to fund NWS/NOAA Research programs occurred on October 29, 1992 in the 102nd Congress (P.L. 102-567).

b. The Tsunami Hazard Mitigation Program has been operated out of the Pacific Tsunami Warning Center, HI, and funded since FY2004 by the National Weather Service (NWS). A major portion of the funding is divided among each of five Pacific states (AK, HI, WA, OR, and CA). The NTHMP also operates the NOAA's *Tsunami Ready* program, which provides assistance for developing local warning capacity, emergency planning, and tsunami inundation mapping.

c. Prior to FY2004, the Tsunami Warning and Environmental (Observation Center) AK conducted experimental tsunami warning system programs. In FY2004, that program was transferred to NWS along with all other tsunami-related programs.

d. Includes funding proposed for deployment of DART buoys in P.L. 109-13 and FY2006 regular appropriations.

e. NWS systems acquisition funding is in NOAA's Procurement Account. This funding would upgrade NOAA tsunami warning communications network capabilities, and global telecommunications infrastructure. (A request of $8.1 million in P.L. 109-13 for USGS's Global Seismic Network (GSN) telecommunication upgrades and an increase of seismic monitoring personnel is not included.)

f. Emergency Supplemental Appropriations Act, 2005 (P.L. 109-13).

Table 1, shows funding for U.S. tsunami-related programs since FY2001. Prior to 2004, tsunami-related activities were funded by the NOAA Research ORF budget. Beginning in FY2004, annual funding requested for the NOAA NWS under Operations and Research budget included U.S. tsunami monitoring and detection operations, early warning, research, outreach and education, and mitigation. Regular appropriations for NOAA tsunami-related programs are found in Title II, Department of Commerce "National Oceanic and Atmospheric Administration" in the annual Science Space, Justice, and Commerce appropriations act. After the December 24, 2004 tsunami disaster in the Indian Ocean, the FY2005 emergency supplemental appropriations act (P.L. 109-13) provided funding for the NWS Procurement, Acquisition and Construction (PAC) account to procure additional DART buoys (three were already in service prior to the tsunami disaster) and other equipment needed for expansion of the U.S. tsunami warning network.

President Bush has committed almost $40 million for FY2006-FY2007 to implement his proposal. The Director of OSTP, John Marburger, has noted that the system would "ultimately include the Indian Ocean," in terms of tsunami warning benefits.[21] That is because the U.S. would contribute to international tsunami warning efforts through implementation of the Global Earth Observing System of Systems (GEOSS) that was conceived and is being developed by NOAA, and its implementation is administered by an interagency "US GEO" team.[22]

---

[21] Testimony of John H. Marburger, Director of Office of Science and Technology Policy, *Tsunami Preparedness*, hearing before the U.S. Senate Committee on Commerce, Science, and Transportation, Feb. 2, 2005. (Hereafter, Senate Commerce, Tsunami Preparedness hearing.)

[22] The United States Group on Earth Observations (US GEO), Interagency Working Group on Earth Observations is a standing subcommittee under the Committee on Environment and Natural Resources, the United States Group on Earth Observations (US GEO)." See [http://www.sdr.gov/Tsunami%20Risk%20Reduction%20for%20the%20US%20-%20A%20Framework%20for%20Action%202005-12-22.pdf].

P.L 109-13, Emergency Supplemental Appropriations for FY2005. The first round of funding for the President's proposal to upgrade and expand U.S. tsunami detection and warning capabilities was requested as part of emergency supplemental appropriations for FY2005 (P.L. 109-13).[23] The conference report on H.R. 1268 (H.Rept. 109-72, Div. A) — the Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and Tsunami Relief, 2005 — indicated that NOAA's National Tsunami Warning Program led by NOAA's NWS would receive $25.4 million. Conferees on H.R. 1268 had augmented the request for NWS Operations, Research, and Facilities (ORF) account by $7.1 million to provide for ongoing coastal inundation mapping and outreach and preparedness programs (tsunami education and training) for U.S. communities-at- risk. Also, a portion of that funding would be used for upgrading services of the Alaska tsunami warning center and for establishing an international regional warning center in Hawaii.[24] NWS was authorized to hire and provided funding for an additional 43 full time equivalents to be onsite at U.S. tsunami warning centers monitoring USGS earthquake alerts and tsunami detection instrumentation and issuing tsunami warnings 24/7.

Conferees also increased NOAA's Procurement, Acquisition, and Construction (PAC) account by $10.2 million. PAC funding would be used to acquire new DART buoys for the Pacific and Atlantic Oceans, the Gulf of Mexico, and the Caribbean Sea, which would add several new data points for observing ocean conditions at depth. (See "National Weather Service Tsunami Programs" section.) As for the GEOSS initiative, conferees encouraged the agency "to develop buoys with capabilities beyond the single purpose of tsunami reporting."[25]

Further, conferrees approved $8.1 million for the USGS National Earthquake Information Center (NEIC) in Golden, CO. The NEIC would upgrade the Global Seismic Network (GSN), increasing the number of instruments that can relay real-time earthquake data, in addition to staffing the center around the clock. Currently 80% of the 127 instruments in the network have telemetry capability. GSN seismic data are used by the NWS warning centers to determine the potential for tsunami generation (tsunami-genesis) after an underwater earthquake or other geological disturbance. The Alaska warning center models the possible intensity and track of large waves and, in turn, issues warnings to regional emergency managers. President Bush signed H.R. 1268 into law as P.L. 109-13, on May 11, 2005.

---

[23] U.S. Congress, House Committee on Appropriations, "Communication for the President of the United States Transmitting a Request for Supplemental Appropriations ... Including Tsunami Relief and Reconstruction," H.Doc. 109-9, Feb. 15, 2005 (Washington: GPO, 2005).

[24] Id.

[25] U.S. Congress, Senate Committee on Appropriations, *Departments of Commerce and Justice, Science, and Related Agencies Appropriations Bill, 2006* (S.Rept. 109-88 on H.R. 2682), p. 78, "Tsunami Preparedness, Warnings, and Forecasts," June 23, 2005.

In December of 2005, President Bush released *Tsunami Risk Reduction for the United States: A Framework for Action* (July 2005).[26] This plan of action outlines steps to be taken to reduce tsunami risk domestically and in U.S. territories in the far Pacific Ocean and Carribean Sea.[27] To assist in implementing this plan, for FY2007, President Bush has requested $20.4 million for the NWS. He also requested $3.95 million for USGS's Global Seismic Network (GSN), which is $35,000 more than FY2006 enacted funding. FY2007 funding will continue USGS's effort to convert all of its 127 seismic sensing platforms around the globe to be capable of telemetry.

Some social scientists have argued for "institutionalizing" a public education component in whatever legislation that might implement the President's initiative for U.S. protection from tsunamis.[28] The public education initiative they envision includes training local authorities to be the developer and deliverer of disaster education. It encourages (federal) interagency partnerships and a visible federal agency presence within the community. Further, it supports adaptation as an alternative approach to disaster management and promotes low-tech, high-impact solutions for local emergency management.[29] (See "Legislation" section.)

U.S. National Weather Service Tsunami Programs

Currently, NOAA's NWS manages an operational program for warning U.S. Pacific coastal areas of tsunamis. The National Tsunami Warning Program (NTWP) consists of two regional U.S. tsunami warning centers in the Pacific Ocean responsible for monitoring, detecting, and warning for possible tsunamis. An associated cooperative program under the NTWP studies ways to help reduce the rate of false tsunami alarms issued for the Pacific Ocean. The National Tsunami Hazards Mitigation Program develops potential coastal innundation maps. It is also responsible for NOAA's public outreach and education programs and operates the NOAA *TsunamiReady* program.

Tsunami Warning Centers. NWS operates a Pacific Tsunami Warning Center (PTWC) at Ewa Beach, HI, and a West Coast/Alaska Tsunami Warning Center (WC/AKTWC) at Palmer, AK. The PTWC monitors for tsunamis and issues warnings for the Hawaiian Islands, the U.S. Pacific territories, and other U.S. and international interests in the Pacific Basin. It was established in 1949 after a strong earthquake and massive landslides off the coast of southwest Alaska that caused a tsunami disaster in the Hawaiian Islands hours later. The WC/AKTWC was established in 1967, after a devastating earthquake of M_w9.2 in Anchorage, AK in

---

[26] Executive Office of the President, National Science and Technology Council, *Tsunami Risk Reduction For the United States: A Framework for Action*, A Joint Report of the Subcommittee on Disaster Reduction and the United States Group on Earth Observations, July 2005. (Released Dec. 2005.)

[27] Ibid., Ch. 4, "International Cooperation."

[28] Testimony of Eileen Shea, Project Coordinator, East West Center, Honolulu, HI), Senate Commerce Tsunami Preparedness hearing, Feb. 2, 2005, available at [http://commerce.senate.gov/hearings/testimony.cfm?id=1361&wit_id=3955].

[29] Id.

1964 caused localized tsunami damages.[30] This center is responsible for issuing tsunami warnings to state emergency officials in Alaska, British Columbia (Canada) Washington State, Oregon, and California. It will also be the warning center that supports developing tsunami warning operations in the western Atlantic Ocean and there will be a direct telecommunications link to the DART buoys located there.

National Tsunami Hazard Mitigation Program (NTHMP). In 1992, NOAA launched the NTHMP to address the agencies credibility for Pacific tsunami warnings. At that time, there was a 75% false alarm rate for tsunamis. Local officials were concerned about the significant social upheaval and economic disruption caused by false alarms. They were concerned about whether the public would heed tsunami warnings in the future. The error rate has improved significantly since then. Another major research effort of the NTHMP studies the potential for a sizable earthquake in the Pacific Northwest Cascadia Region that USGS scientists believe would generate devastating tsunamis that would damage several U.S. Pacific coastal regions.[31] The NTHMP has assisted five Pacific states, Alaska, California, Hawaii, Oregon, and Washington, and two Atlantic states, Florida and Virginia, in developing local tsunami preparedness plans through the NOAA's *TsunamiReady* program.[32] NTHMP also continues to develop tsunami disaster models and inundation maps for many coastal communities of its current member states.[33]

In addition, NOAA's NWS directs the UNESCO International Coordinating Group (ICG) for the International Tsunami Warning System in the Pacific (ITSU). ITSU was created in 1968 and has operated out of the PTWC until recent completion of its own Pacific center. In October 2005, the ICG/ITSU was renamed as the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (ICG/PTWS). The change was made to align its name with other tsunami warning and mitigation systems that are being newly established as governing bodies under the auspices of the UNESCO Intergovernmental Oceanographic Commission (IOC). ICG/PTWS currently serves 28 member nations concerned with tsunamis generated in the Pacific Ocean, and Australia, Thailand and parts of Indonesia, which are threatened by tsunamis in the Indian Ocean.[34]

Tsunami Detection Operations. NOAA will soon operate a network of ten dedicated tsunami detection and relay stations as part of the Deep-Ocean Assessment and Reporting of Tsunamis (DART) program.[35] (See **Figure 1** for locations and

---

[30] See NOAA, NWS, "How *TsunamiReady* Helps Communities and Counties at Risk available at [http://www.stormready.noaa.gov/tsunamiready/].

[31] Eric L. Geist, *Local Tsunami Hazards in the Pacific Northwest from Cascadia Subduction Zone Earthquakes*, at [http://pubs.usgs.gov/pp/pp1661b/pp1661-b.pdf].

[32] NOAA, National Weather Service, "*TsunamiReady* Sites in Six States." Op. Cit., 18.

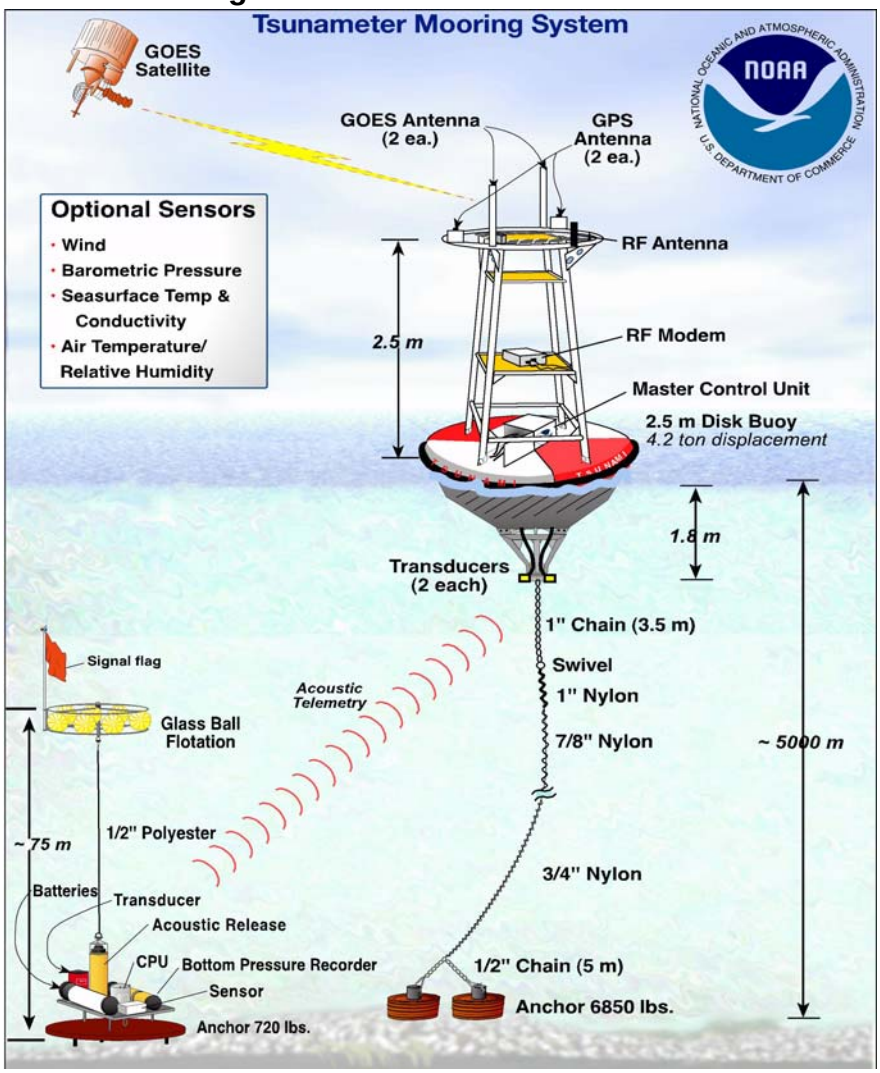
[33] Eddie Bernard of NOAA, Jan. 5, 2005 House briefing.

[34] See "International Tsunami Information Center: ITSU Master Plan," the International Coordination Group for the Tsunami Warming System in the Pacific (IGC/ITSU), UNESCO/IG, at [http://www.tsunamiwave.info/].

[35] Hugh B. Milburn et al., "Real-Time Tsunami Reporting from the Deep Ocean," NOAA (continued...)

Figure 2 for the components.) DART buoys are equipped to provide an early warning capability for tsunamis, but NOAA officials caution these are only effective if there are emergency managers to receive their communications and, in turn, are able to alert the public to take the necessary precautions or evacuate.

Figure 2. NOAA DART Platform



Source: National Oceanic and Atmospheric Administration, from "U.S. Announces Plans for an Improved Tsunami Warning and Detection System." See [http://www.noaanews.noaa.gov/stories2005/s2369.htm].

[35] (...continued)
Pacific Marine Environmental Laboratory (1996), at [http://www.ndbc.noaa.gov/Dart/milburn_1996.shtml]. A seventh DART buoy owned and operated by the Chilean government is deployed off Chile's coast in South America.

Seven DART buoys are expected to be operational in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico in April 2006.[36] Eventually, there will be 25 for the Pacific Ocean, including the three currently deployed in the Pacific Ocean and three off the Alaskan Peninsula.

There are currently hundreds of NWS weather buoys and NOAA National Ocean Service (NOS) tide-gages operating off *all* coasts of the United States and in the Great Lakes. These also would figure into the plans for a tsunami warning system for the United States. NWS weather buoys record various meteorological data, while marine data buoys measure speed of ocean currents, temperature, salinity, and pressure change. Sea surface height (or sea level) is measured by satellite-based GPS (global positioning system) and by the NOS tidal monitoring networks which are capable of detecting tidal surges. Generally, these buoys are equipped to relay emergency communications in support of commercial and recreational navigation.[37]

In addition to weather and navigational buoys, 1,000 of an envisioned array of 3,000 data buoys, known as Argo floats, are now used for short-term climate change observations. These operate in the equatorial Pacific Ocean to detect ocean conditions associated with El Niños and La Niñas, which are periodic climate variations that affect global weather. NOAA officials have advocated the use of Argo floats as platforms for situating tsunami detection instrumentation[38] and NOAA officials identify them as "the next step in global observations."[39]

Possible platforms for tsunami monitoring and detection in the Atlantic Ocean include a growing number of regional and local coastal and ocean observation networks operating or being developed along the coasts of Canada and the United States. As early as the 108th Congress, legislation called for the use of such technologies to serve as part of a tsunami detection and warning network.[40] In the 109th Congress, S. 361 and H.R. 1584 propose similar action. (See "Legislation" section.)

---

[36] NOAA FY07 Budget Briefing, National Press Club, Washington, DC, Feb. 9, 2006.

[37] Eddie Bernard, House briefing, Jan. 5, 2005.

[38] NOAA/Woods Hole Oceanographic Institute, *Observing the Ocean in Real-Time: Argo, a Global Array of Profiling Floats to Understand and Forecast Climate*, ed. Stan Wilson (1996). Funded in part by private academic institutions.

[39] Ibid.

[40] On Jan. 5, 2005, Rep. Curt Weldon circulated a "Dear Colleague" letter advocating the reintroduction of H.R. 5001 (108th Congress), the Ocean and Coastal Observation System Act, in the 109th Congress. This legislation promoted development of an "Integrated Ocean Observation System," to protect U.S. citizens in coastal communities from tsunamis. For further information on U.S. ocean observation systems, see U.S. House Resources Subcommittee on Fisheries, Conservation, and Oceans, *Status of Ocean Observing Systems in the United States*, oversight hearing, serial no. 108-102, July 13, 2004 (Washington, DC: GPO, 2005).

Related U.S. Programs

To assist in reducing costs of a U.S. Atlantic coast tsunami early warning system, engineers at NOAA have stated that it is technologically possible to modify weather and marine data buoys situated off the United States's coasts to serve as platforms for mounting some tsunami monitoring and detection instrumentation. Although these platforms would not measure ocean conditions at great depths like DART buoys, they would monitor for abrupt physical changes at the ocean's near-surface. The USGS is improving its global seismic monitoring stations by upgrading their capability for real-time data communications. It is also improving coverage of seismic alerts received by the National Earthquake Information Center (NEIC) in Golden, CO. Plans are to rely on international telecommunications networks, cell phones, and the internet as the means to issue tsunami warnings to local emergency managers and many rural populations.[41]

The U.S. Geological Survey (USGS). USGS contributes to the U.S. National Tsunami Warning Program. Its Global Seismic Network (GSN) is critical for early warning of tsunamis. The USGS operates 128 global seismic monitoring stations, including some in the Indian Ocean. The GSN is managed by the Incorporated Research Institutions for Seismology (IRIS), which is a consortium of academic institutions involved with earthquake monitoring, detection, and modeling.[42] Although the USGS does not specifically monitor for tsunami genesis, the GSN measures land-based and submarine earthquakes around the globe in real time. Depending on where they occur and their magnitude, the USGS makes determinations whether to alert NOAA of the possible onset of a tsunami. USGS officials have reported that only about 80% of the GSN has capability for real-time data communication.[43] P.L. 109-13 reflects the President's request and congressional appropriations of $8.1 million provided by emergency supplemental funding for FY2005. This funding is being used to upgrade the real-time telecommunications capabilities of the entire GSN, as well as expand the number of seismic monitoring stations around the globe.[44] In addition, a portion of that funding is being used to improve communications and increase staff at the National Earthquake Information Center (NEIC) in Golden, CO and the two NWS warning centers. Communication improvements will allow USGS and NOAA to exchange data and information for tsunami modeling more rapidly.

---

[41] Kenneth B. Allen, Director of the Partnership for Public Warning, "Letter to President Bush,"Jan. 3, 2005, at [http://www.partnershipforpublicwarning.org/ppw/]. See also, Joab Jackson, "Cisco, IBM Propose Internet-Based Disaster Alert System," *Government Computer News*, Feb. 11, 2005, at [http://www.gcn.com].

[42] Incorporated Research Institutions for Seismology (IRIS), "Global Seismic Network (GSN) at [http://www.iris.edu/about/GSN/].

[43] Dr. Charles Groat, Director of the USGS, presentation on the USGS FY2006 budget held at the Dept. of the Interior, Washington, D.C., Feb. 7, 2005. Congress appropriated $8.1 million in emergency supplemental appropriations for FY2005 in P.L. 109-13.

[44] Dr. Charles Groat, Director of the USGS, presentation on USGS FY2007 budget held at the Dept. of the Interior, Washington, D.C., Feb. 6, 2006.

USGS geological researchers collect and analyze data on crustal deformation and ocean floor displacement, which could be precursors to earthquakes that generate tsunamis. Also, USGS topographical mapping data is used in developing tsunami inundation maps for emergency managers to develop evacuation plans, as well as for local long-term government planning and private development. Although the USGS primarily monitors for seismic activity on land, officials have asserted that land-based operations can be as important for tsunami detection and alerts as ocean buoys.[45] For example, in coastal areas of the United States, and especially along the Pacific coast, earthquakes have generated landslides. Some of these have resulted in mass wasting of land that has entered the ocean abruptly and displaced large volumes of water. Landslides can also originate beneath the ocean on the continental shelf and generate tsunamis. A major concern for the Atlantic coast of the United States, some scientists believe, is the potential for a volcano in the Canary Islands off the Coast of west Africa to collapse.[46]

World Weather Watch. NOAA and other international weather agencies issue warnings of meteorological conditions that primarily affect commercial air traffic and navigation, but that also might put human lives in danger and cause significant economic disruption in large geographic regions. The U.N. World Weather Watch (WWW) is a cooperative program organized and administered by the U.N. World Meteorological Organization (WMO).[47]

NOAA plays a leadership role in the WWW, representing the United States in scientific research, weather data collection and management, and meteorological forecast and warning. The Department of State plays an important role in achieving and maintaining international agreements to sustain WWW operations globally. The WWW has an established international telecommunications network for receiving and distributing weather data and warnings, including those for the United States and its trust territories.[48] NOAA Satellite Services manages two of three global World

---

[45] These include the USGS Advanced National Seismic System (ANSS), the Global Seismic Network (GSN), National Strong-motion Program, and other U.S. regional networks and cooperators. See [http://earthquake.usgs.gov/research/index.php?areaID=12].

[46] Rossella Lorenzi, "Top World Tsunami Hotspots Detailed," *Discovery News (online)*, Jan. 11, 2005, at [http://dsc.discovery.com/news/briefs/20050110/tsunamidanger.html]. "According to Simon Day, Benfield Greig Hazard Research Center at University College London, U.K., geological evidence suggests that during a future eruption, Cumbre Vieja Volcano on the island of La Palma in the Canary Islands, off West Africa, could experience a catastrophic failure of the western flank."

[47] U.S. Dept. of Commerce, NOAA, Office of the Federal Coordinator for Meteorology, "World Weather Program," *The Federal Plan for Meteorological Services and Supporting Research: Fiscal Year 2005*, Report FCM P1-2004, Appendix B: 223-228 (Washington, DC: Oct. 2004). Examples of international communications networks are included.

[48] NOAA, National Environmental Satellite Data and Information Service (NESDIS), "About the World Data Center System." NESDIS operates two U.S. WWP data centers and performs analysis on and archives weather satellite data for international use. This resource has since provided valuable information about the Indian Ocean tsunami. See the NESDIS website at [http://www.ngdc.noaa.gov/wdc/wdcmain.html]. See also "NOAA Scientists

(continued...)

Weather program (WWP) data centers for weather data analysis and forecasting. These also serve as an international telecommunications gateway for relaying weather warnings around the globe.[49] NOAA officials have regarded telecommunications networks of such global reach as an important component for earth observations and for issuing tsunami warnings regionally and locally around the world.

National All Hazards Weather Radio (NAHWR). As for local emergency management capabilities in the United States, the Department of Homeland Security (DHS) and the National Weather Service have modified the NOAA Weather Radio network as a means communicating public warnings for all disasters, natural or otherwise. Over time, Congress has expanded the reach of NOAA Weather Radio (NWR) to make this emergency telecommunications infrastructure capable of providing adequate coverage of weather services and to improve local forecasting and warning of extreme weather for more severe weather-prone regions of the United States. NOAA since has (1) improved the technology of weather instrumentation to increase lead time of emergency warnings; (2) constructed transmission towers; (3) added repeaters to expand ranges of emergency notification; and (4) made available to the public for a modest cost individual NOAA Weather Radio receivers. NWR has particularly targeted rural areas, so as many U.S. citizens as possible can receive disaster warnings and emergency communications. DHS has led the initiative to expand NWR warnings to cover all disasters.[50] DHS funding for the National All Hazards Weather Radio Network (NAHWR) on behalf of NOAA has been about $5.5 million annually since FY2003.[51]

---

[48] (...continued)
Able to Measure Tsunami Height from Space," at [http://www.noaanews.noaa.gov/stories2005/s2365.htm].

[49] NESDIS's NGDC maintains the NOAA and International Oceanographic Committee (IOC) long-term archive for global tsunami event, inundation, and damage data. NOAA official stress that "The exchange and sharing of data on a worldwide basis is a critical part of developing descriptions and the understanding of our global environment." NOAA notes that "The GEO Workplan for 2006 identifies the WDCs as one of the archives for data collected over coastal regions subject to tsunami risk." See [http://www.ngdc.noaa.gov/products/news_archive_2005.html].

[50] See NOAA All Hazards Weather Radio (NWR) at [http://www.nws.noaa.gov/nwr/].

[51] Of note, the Senate approved $156 million for the "National Alert and Tsunami Warning Program Act, 2005," which is §3010 of S. 1932, the Senate amended version of the "Deficit Reduction Act of FY2005." (See H.Rept. 109-362, p. 204). That funding would "provide for an *all hazards* alert system to [issue] alerts in response to natural disasters, man-made accidents, and terror incidents." Plans are to fund the program with the proceeds from a Federal Communications Commission (FCC) spectrum auction. Proceedings of that sale is authorized to be provided to the National Telecommunications and Information Agency (NTIA). The amended measure containing the tsunami warning provisions passed Congress on Feb. 6, 2006 (H.Rept. 109-366). It was signed by the President on Feb. 8, 2006. The budget resolution has no force in law, however.

Conclusion

Decisions about whether and how to proceed with establishing an international tsunami early warning system for the Indian Ocean (and elsewhere) will likely be complicated for a number of reasons. One reason is the number of different potential international parties that would be involved in coordinating data collection and disseminating warnings. A second is the funding needed to establish physically regional tsunami warning systems. A third is that nations, including some in the Indian Ocean, might charge for access to critical satellite data that may help with post-disaster assessments and in warning potential victims. Some Members of Congress contend that the costs of acquiring those data may be well worth it, in terms of lives saved. However, others assert that licensing for accessing proprietary data and the costs to acquire and use the data could be prohibitive. They are of the opinion that access to global environmental data should be provided free of charge, especially when the United States and other nations have provided disaster relief and funding for tsunami detection and warning activities in the Indian Ocean.[52]

Many international science and engineering institutions foresee challenges in standardizing tsunami detection instrumentation and other related technology and in providing long-term operations and maintenance for tsunami warning systems on a global network. Other concerns relate to national security and a possible compromise of U.S. intelligence-gathering operations if international telecommunications networks are used for alerts. Some U.S. lawmakers question the actual risk of a tsunami hitting the U.S. Atlantic coast.[53] They believe the probability is low and assert that risk should be considered when guiding development of and investment in a cooperative early tsunami warning system for the U.S. eastern seaboard. It appears that many international scientific and engineering experts view the Bush Administration's plan for expanding the U.S. tsunami early warning network as a viable one. Further, the plan is backed by some Members of Congress who have introduced legislation to prepare the way for a more effective, expanded detection and warning system for coastlines of the United States and trust territories. (See "Legislation" section.)

The President's January 2005 proposal for upgrading U.S. tsunami early warning capabilities proposed nearly $30 million for FY2005 and FY2006, the bulk of which was requested in H.R. 1268, the FY2005 Emergency Supplemental Appropriations Act (P.L. 109-13). The 109th Congress approved a total of $25.4 million for tsunami warnings, including a Senate amendment for an additional $2.7 million in funding for international "in country" sociological needs for public education and adaptation strategies to complement technological needs. The President has requested almost $12.5 million in FY2007 funding to complete the U.S. system. If Congress were to approve the President's request for FY2007, the U.S. government will have committed almost $40 million to improve capabilities for early tsunami warnings in all U.S. coastal areas and in territorial waters. A number of

---

[52] Op. cit. 7.

[53] USGS, Earthquake Hazards Program, "Off W Coast of Northern Sumatra, Can It Happen in the United States?" at [http://earthquake.usgs.gov/eqinthenews/2004/usslav/canit.html].

international science agencies and countries who currently rely on the United States's tsunami warning program for detection and warning are encouraged about U.S. efforts to expand and upgrade its tsunami warning systems.

U.S. lawmakers and statesmen alike have argued for greater deliberation before the United States commits resources to an international effort for developing a global tsunami warning network. They are of the opinion that the United States must first define its role and responsibilities in such a long-term endeavor. International planning and development for global tsunami warning network through the U.N. Intergovernmental Oceanographic Commission (IOC) has proceeded along a similar time frames as U.S. domestic efforts, although IOC members await U.S. deployment of the Global Earth Observation System of System (GEOSS), which, fundamentally, will be the United States' long-term contribution to global tsunami early warning protection. Henceforth, U.S. and international challenges would likely arise from sustaining a long-term cooperative international effort, not only for global tsunami detection and warning, but also for building, operating, and maintaining an ocean observation infrastructure of global scope. NOAA officials and others at international science and engineering agencies assert that without GEOSS's full deployment, a truly "global" tsunami warning system would be compromised.

Legislation

One bill was introduced as early as in the 108th Congress seeking to expand tsunami early warnings networks globally.[54] However, the balance of legislation has been introduced in the 109th Congress, after the Indian Ocean tsunami disaster. Most of these bills emphasize expediting expanded coverage for the United States and its trust territories. Similar to the Bush Administration's January 2005 proposal and the July 2005 action plan, congressional legislation calls for domestic needs to be met before international commitments are made. Also, some of the bills introduced call for strong research, public education, and social adaptation components. The more globally oriented legislation calls for the United States to participate in negotiations of nations' roles and responsibilities for a global tsunami early warning network and that negotiations be conducted through established international diplomatic channels.

S. 34 (Lieberman)/H.R. 499 (Shays). S. 34, the Global Tsunami Detection and Warning System Act was introduced on January 24, 2005 and referred to the Senate Committee on Commerce, Science, and Transportation. It would address "U.S. tsunami early warning capabilities and deficiencies." Also, the bill would encourage cooperative efforts with established international agencies to develop regional tsunami warning and emergency management capabilities for coastal communities around the globe. In addition, the bill would encourage an inventory of existing international capabilities. This legislation is primarily focused on the institutional needs of developing a global warning network, and what might be an appropriate U.S. contribution.

---

[54] Op cit. 40. Representative Curt Weldon sponsored an original bill, H.R. 5001, in the 108th Congress. H.R. 1584 is a reintroduction of that measure.

S. 34 would authorize $30 million for NOAA in FY2005 to expand the existing Pacific network and add coverage for the Atlantic and Gulf of Mexico/Caribbean Sea. Additionally, $7.5 million would be authorized for each of FY2006 through FY2012 to operate and maintain the (U.S.) system. It would direct the Secretary of Commerce to work with the Secretary of State and the Department of the Interior (through USGS) to convene an international conference seeking agreement on a U.S. contribution to a global tsunami warning network, including funding pledges. H.R. 499, a related bill, was introduced on February 1, 2005, and was referred to the House Committees on International Relations and Resources. This bill would provide for the development of a global tsunami detection and warning system and for the United States to assist in improving communications of tsunami warnings to all nations potentially affected. H.R. 499 was referred to the Subcommittees on Fisheries and Oceans and Energy and Minerals on February 9, 2005. No further legislative action has occurred.

S. 50 (Inouye). The Tsunami Preparedness Act of 2005 was introduced on January 24, 2005 and referred to the Senate Committee on Commerce, Science, and Transportation. The bill directly supports the Bush Administration's proposals for an expanded U.S. tsunami early warning system, and similarly proposes that the United States assist other nations in an international endeavor to build a global detection and warning capacity. However, S. 50 goes further than the Administration proposal by requiring dissemination of U.S. tsunami information and research findings internationally, and would facilitate technology transfer for global tsunami hazard mitigation efforts. To that end, S. 50 would establish a U.S. multi-agency task force including NOAA, the Federal Emergency Management Agency (FEMA), USGS, and the National Science Foundation (NSF). NOAA would be directed to lead global tsunami warning efforts through involvement with establishing an international earth observation system [GEOSS]. Section 8, of S. 50 would authorize $35 million for "each of fiscal years 2006 though 2012, to carry out the Act."

On February 2, 2005, the Senate Commerce Subcommittee on Disaster Preparedness held hearings on S. 50. At that hearing Senator Inouye noted that "the new subcommittee could be effective in educating populations at risk," referring to tsunami disasters. The Senator also stated that S.50 considers sociological needs in addition to detection and warning, which would require NSF's contribution. Further, NOAA would be authorized to receive reimbursement of cash or services "in-kind" from international agencies it assists in developing the global warning network. On March 10, 2005, the Commerce, Science, and Transportation Committee marked up S. 50. S.Amdt.1101 to S. 50, the Tsunami Preparedness Act, sponsored on July 1, 2005 by Senator Stevens, chairman, would authorize specific funding for the Administrator of NOAA to strengthen its tsunami detection, forecast, warning, and mitigation program. S. 50 (amended) would also authorize establishment of an International Tsunami Warning Center for monitoring tsunamis and issuing warnings for member nations in the far Pacific, and for disseminating tsunami-related information among ITSU members states. The committee amendment was adopted in the nature of a substitute bill. During mark up of S. 50, Senator Stevens stated that NOAA would have to notify Congress if a (DART) buoy were to stop functioning so that arrangement for a replacement could be made and deployed expeditiously. The committee amendment also authorizes $5 million annually for an "integrated coastal vulnerability and adaption program." S. 50 (amended) was reported favorably to the

full Senate on March 10, 2005. The written report of the committee (S.Rept. 109-59) was issued on April 19, 2005. No further legislative action has occurred.

S. 361 (Snowe)/H.R. 1489 (Gilchrest) H.R. 1584 (Weldon, Curt). The Ocean and Coastal Observation Systems Act of 2005 was introduced on February 10, 2005 and referred to the Senate Committee on Science, Commerce, and Transportation. This bill would develop a U.S. capacity "to monitor a range of ocean conditions and quickly assess ocean-based threats, including tsunamis...."[55] Through NOAA, S. 361 proposes broader public access to and facilitation of timely public warnings of hazardous ocean conditions. It authorizes "such sums as may be necessary" for each of fiscal years 2006 through 2010, of which at least half of the amount would be used to deploy regional ocean and coastal observing systems. Funding for that effort would be made available until expended. S. 361 was marked-up on March 10, 2005, and was ordered to be reported favorably to the Senate, without objection. On April 19, 2005, the Committee on Commerce, Science, and Transportation reported S. 361 (S.Rept. 109-60) without amendment. On July 11, 2005 S. 361(amended) was referred to the House Committees on Science and Resources and then, on July 20, 2005 to the House Resources Subcommittee on Fisheries and Oceans. No further legislative action has occurred.

The Coastal Ocean Observation System Integration and Implementation Act of 2005, H.R. 1489, was introduced on April 6, 2005 and referred to the House Committees on Science and Resources. One of the stated purposes of the bill is "To more effectively predict and mitigate impacts of natural hazards such as tsunamis, hurricanes, coastal erosion, and fluctuating water levels in the Great Lakes, and conserve healthy and restore degraded coastal ecosystems." Hearings were held by the House Resources Subcommittee on Fisheries and Oceans on April 19, 2005. No further legislation has occurred.

Introduced on April 12, 2005, H.R. 1584, the Ocean and Coastal Observation System Act of 2005, a related bill, would develop and maintain an integrated system of coastal and ocean observations for the Nation's coasts, oceans, and Great Lakes, "to improve warnings of tsunamis and other natural hazards, to enhance homeland security, to support maritime operations, and for other purposes." The bill was referred to the House Committees on Resources and Science. It was subsequently referred to the House Science Subcommittee on Technology and Standards on May 26, 2005.[56] There has been no further action on this legislation.

H.R. 396 (Menendez)/S. 1753 (DeMint). The Early Warning and Rapid Notification Act of 2005 was introduced on January 26, 2005 and referred to the House Committee on International Relations. This bill would focus on the sociological and institutional needs for developing tsunami warning systems in foreign countries. The legislation emphasizes four components of a proposed program to be established through the U.S. Agency for International Development (US AID) consisting of (1) expansion upon prior knowledge of risks faced by communities; (2) technological monitoring of hazards; (3) delivery of understandable

---

[55] Statement introducing S. 361, *Congressional Record*, Feb. 14, 2005, pp. S1293-S1294.

[56] Op cit. 40.

warnings to those at risk; and (4) knowledge and preparedness of how to act when threatened by disasters. Although this bill addresses *all* disasters, the Indian Ocean tsunami is cited as one of the primary reasons for its introduction. H.R. 396 would seek to improve international lines of communication for delivery of disaster warnings by identifying impediments in U.S. and foreign government policies. It identifies the U.N. International Early Warning Program as the appropriate institution to undertake that task. In addition, it would authorize $10 million annually for FY2006 through FY2010 to (1) develop an effective global public warning capability; (2) establish the necessary communications infrastructure; (3) provide technical expertise and training; and (4) launch public education campaigns to minimize the loss of life and property. In addition, H.R. 396 calls for employing emerging technologies, such as wireless communications for U.S. territories' emergency warning systems, and also in lesser economically advantaged tsunami-prone international locations. There has been no further legislative action.

S. 1753, the Warning, Alert, and Response Network Act, is in many respect a companion bill with H.R. 396. It was introduced on September 22, 2005 and referred to the Senate Commerce, Science, and Transportation. S. 1753 would create a national alert system that builds upon current alerting capabilities and provides alerts to the public across a variety of media technologies to protect public safety. It would provide for the development and administration of a unified alerting system that will allow federal, state, tribal and local officials to provide alerts to their communities across a variety of communication technologies. The bill would aim to ensure that an *individual* will receive an alert of a pending threat regardless of their location or the communication technologies in use. As amended S. 1753 would authorize NOAA to establish, operate, and maintain a dependable national tsunami warning system providing maximum tsunami detection capability for the nation. It calls for using a model based on the U.S. tsunami warning system established in the Pacific, and would provide for its repair (operations and maintenance), expansion, and modernization by 2007. The system would include four components: (1) an expanded and upgraded detection and warning system; (2) a federal-state tsunami hazard mitigation program; (3) a tsunami research program; and (4) a modernization and upgrade program. In addition, the bill would direct NOAA to provide any necessary technical or other assistance to international efforts to establish regional systems in other parts of the world, including the Indian Ocean. The bill would authorize $35 million for each of fiscal years 2006-2012 to carry out these activities. Unlike H.R. H.R. 396, however, it does authorize funding for activities described in S. 1753. S. 1753 was ordered to be reported on November 18, 2005 to the Senate, and a written report (S.Rept. 109-was issued on Dcember 8, 2005. No further action has occurred on this legislation.

H.R. 465 (Faleomavaega)/H.R. 882 (Boehlert). On February 1, 2005, H.R. 465 was introduced "To Provide for the Establishment of a Tsunami Mitigation Program for all United States Insular Areas." It was referred to the House Committee on Resources. The bill would establish a tsunami hazard mitigation program within NOAA for all U.S. insular areas. Also, it would require NOAA to perform an assessment of tsunami hazards, monitoring and warning capabilities, and public education functions for American Samoa, Guam, the U.S. Virgin Islands, and the Commonwealths of Puerto Rico and the Mariana Islands. No funding authority was proposed in the legislation. On February 10, 2005, H.R. 465 was referred to the

House Resources Subcommittee on Fisheries and Oceans. H.R. 882, a related bill introduced February 17, 2005, was referred to the House Science Subcommittee on Environmental Technology and Standards on March 3, 2005. No further legislative action has occurred. (See **H.R. 1674**, below.)

H.R. 890 (Pallone)/S. 452 (Corzine). H.R. 890, the Tsunami Warning and Relief Act of 2005 was introduced February 17, 2005, and was referred to the House Science Committee. Title I, Tsunami Warning Systems establishes a global tsunami disaster reduction program in NOAA's NWS to upgrade U.S. and other international regions' protection from tsunamis by encouraging cooperation through the building of global observations systems. The bill would expand the U.S. *TsunamiReady* program to assist other tsunami-prone communities in planning for a tsunami disaster. It would direct NOAA and USGS to integrate seismic monitoring into the detection process using the Global Seismic Network (GSN). It would also require annual progress reports from NOAA. H.R. 890 would authorize $38 million for FY2006, and $32 million for FY2007. On March 3, 2005, H.R. 890 was referred to the House Science Subcommittee on Environmental Technology and Standards. There has been no further legislative action. Introduced on February 17, 2005, S. 452, a related bill, was referred to the Senate Committee on Commerce, Science, and Transportation. It would provide for establishing national and global tsunami warning systems. No further legislative action has occurred.

H.R. 1674 (Boehlert). The United States Tsunami Warning Education Act. This bill would direct the National Weather Service to strengthen tsunami detection, forecasts and warnings, and increase support for related disaster mitigation activities. It would upgrade and expand the U.S. warning network for the Pacific, including U.S. territories, the Atlantic Ocean, the Gulf of Mexico, and Caribbean Sea. Introduced on April 18, 2004, H.R. 1674 was referred to the House Committee on Science. The bill was marked up by the Subcommittee on Environment, Technology, and Standards on April, 20, 2005. This legislation also encourages cooperation between NOAA and the USGS and the National Science Foundation, in establishing an international (tsunami) research program.

In addition, H.R. 1674 would (1) improve coordination for tsunami and other coastal hazards warnings at federal, state, and international government levels; educate for public preparedness; and (3) aid in establishing a multinational regional tsunami warning network for countries bounded on the Indian Ocean. Further the bill would encourage the mutual sharing of related data among participating countries of a "Global Tsunami and Warning Mitigation Network." The legislation provides for developing educational and outreach activities for U.S. populations-at-risk. It would authorize $30 million for each of fiscal years 2006-2008 to carry out this act, and would allocate 70% of that spending authority to upgrade operations and management of the U.S. network; 20% for mitigation programs; and 10% for an international tsunami research program. In many respects, this legislation is similar could be considered a companion bill to S. 50 (Inouye). H.R. 1674 was marked up by the House Science Subcommittee on Environment, Technology, and Standards on April, 20, 2005. Full committee markup was held for H.R. 1674 on May 4, 2005. The amended measure was ordered to be reported (There is no written report). No further legislative action has occurred.

It appears that S. 50 and H.R. 1674 are the most likely legislative vehicles for Congress to act on with respect to possible authorization of a long-term commitment for developing and maintaining a U.S. and global tsunami early warning system. Thus far no new stand-alone legislation has been introduced.