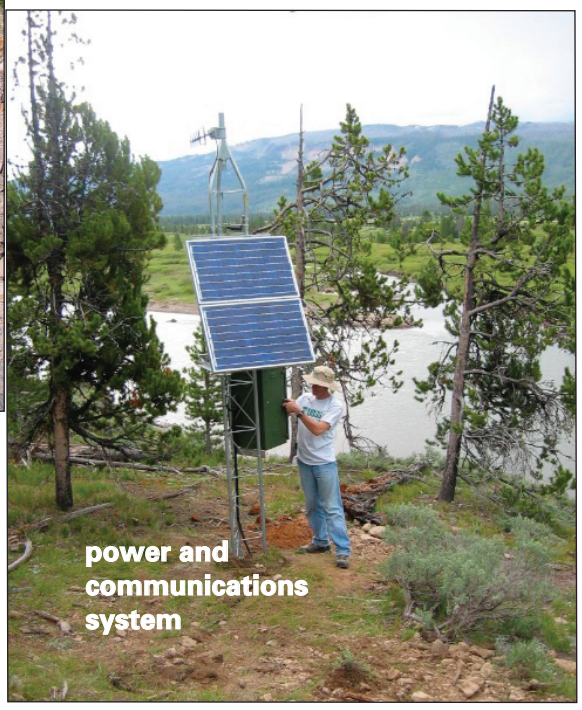
# Improving Earthquake and Tsunami Warnings for the Caribbean Sea, the Gulf of Mexico, and the Atlantic Coast

The magnitude-9 Sumatra–Andaman Islands earthquake of December 26, 2004, increased awareness in the United States of the destructive hazard posed by earthquakes and tsunamis. The U.S. Government, working with international partners, is responding with a real-time system that will significantly improve global earthquake and tsunami monitoring. This fact sheet describes a project to improve earthquake and tsunami monitoring along a major portion of our vulnerable coastal regions, the Caribbean Sea, the Gulf of Mexico, and the Atlantic Ocean. The project is a result of collaboration between the U.S. Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA).


A typical USGS earthquake monitoring station consists of a broadband seismometer, a multichannel digitizer, and telecommunications equipment to transmit ground-shaking data instantaneously to the 24/7 National Earthquake Information Center in Golden, Colo.



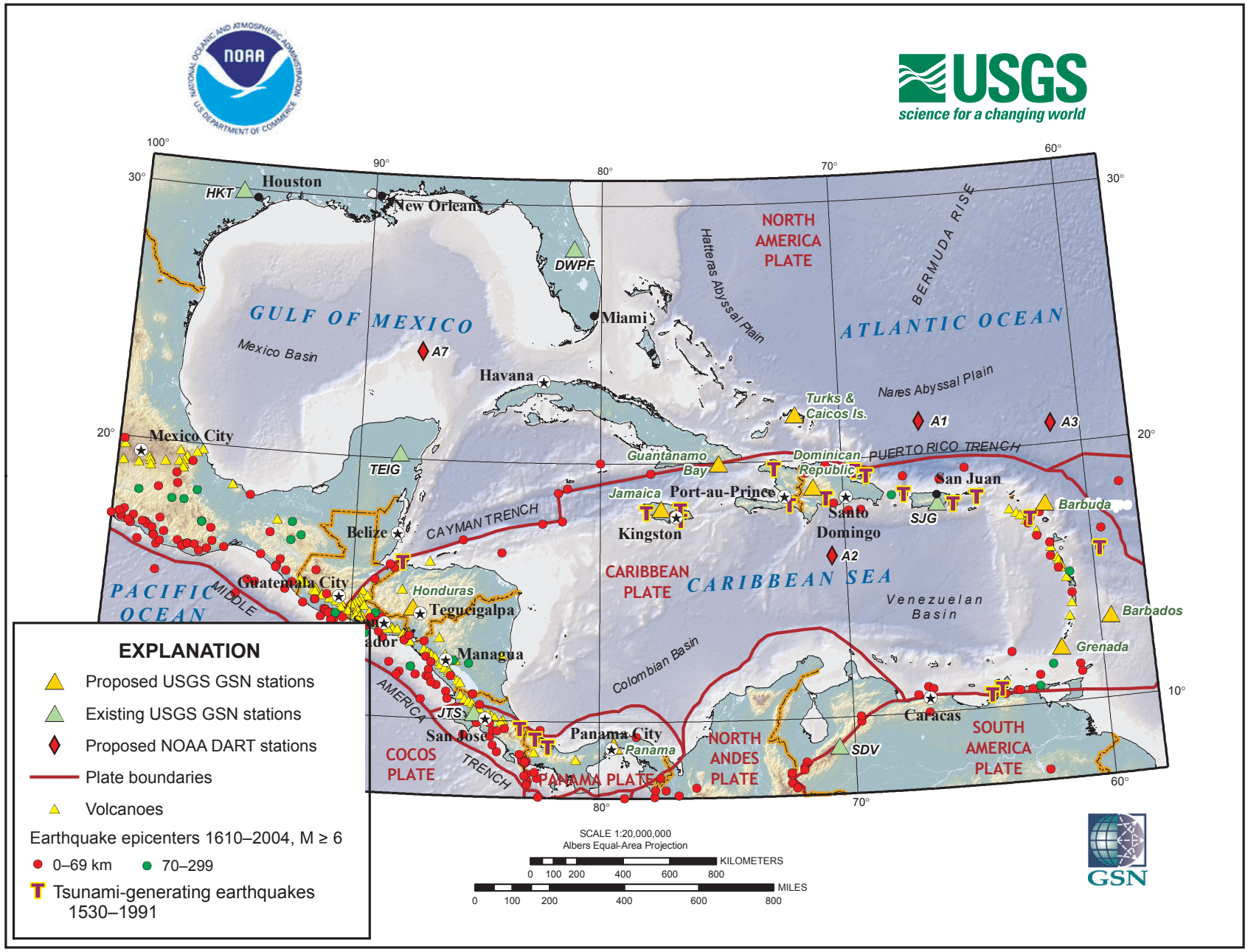

## Earthquake and Tsunami Hazard Assessment and Research

Seismically active areas of the Caribbean Sea region pose a tsunami risk for Caribbean islands, coastal areas along the Gulf of Mexico, and the Atlantic seaboard of North America. Nearly 100 tsunamis have been reported for the Caribbean region in the past 500 years, including 14 tsunamis reported in Puerto Rico and the U.S. Virgin Islands. In this time, 30 tsunamis caused significant damage and as many as 9,600 recorded fatalities. During the past 150 years, nearly 2,000 deaths were attributed to tsunamis. Over the same period, the loss of life in the Caribbean was five times higher than along the combined coasts of Hawaii, Alaska, California, Oregon, and Washington. In 1946, a magnitude 8.0 earthquake just north of Hispaniola generated a tsunami that killed a reported 1,600 people in the region.

With several hundred million people now living in coastal areas surrounding the Caribbean, and with major earthquakes occurring on average every 50 years, it is not a question of whether a destructive tsunami will occur but when. A need therefore exists for a Caribbean tsunami early-warning system that serves the entire region. An additional need exists for increased public education and outreach on the hazards posed by tsunamis and how to respond to warnings. Such education is especially important in the Caribbean where tsunamis have devastated coasts within minutes of a local earthquake.

## Monitoring System for Warning Guidance and Mitigation

As part of the President's initiative for an improved tsunami warning and detection system, NOAA and the USGS are expanding earthquake and tsunami




Improved earthquake and tsunami monitoring in the Caribbean. The map shows the seismicity and tectonic setting of the region as well as planned USGS and NOAA monitoring stations. The planned seismic stations will be affiliated with the Global Seismographic Network (GSN), which is funded jointly by the National Science Foundation and the USGS. NOAA's National Data Buoy Center operates DART (Deep-ocean Assessment and Reporting of Tsunamis) stations.

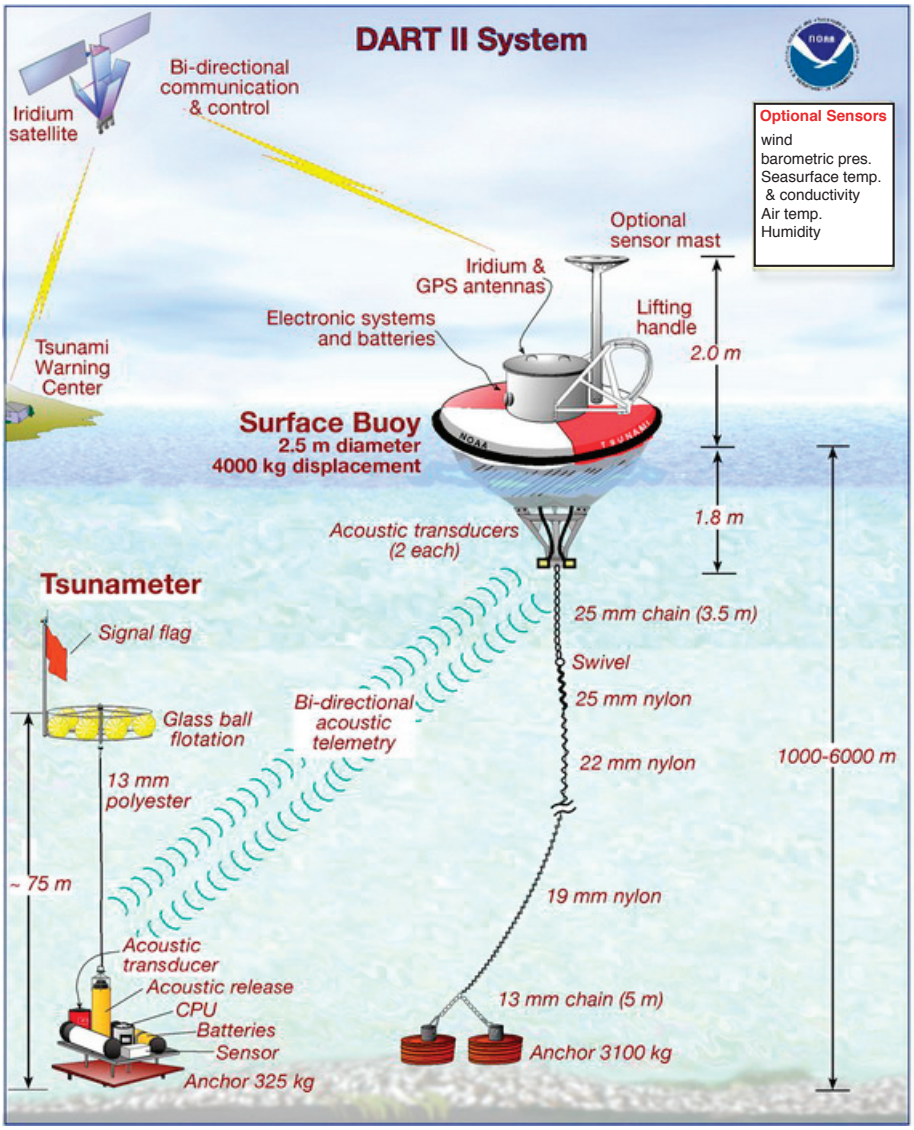
monitoring in the Caribbean and Atlantic coastal regions. This effort will be conducted in partnership with eight Caribbean host nations and will directly address the needs spelled out by the Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and Tsunami Relief, 2005 (http://www.whitehouse.gov/news/releases/2005/05/20050511-5.html). Funds will be targeted at improved earthquake detection and notification capability, deployment of a system for real-time detection of tsunami waves, faster tsunami warning capability, focused studies to address tsunami inundation and earthquake hazard modeling, and improved education and training.

## The Role of NOAA: Tsunami Detection and Warning

As part of the President's initiative to improve domestic tsunami warnings, NOAA will deploy 39 Deep-ocean Assessment and Reporting of Tsunamis (DART II) buoy stations in the Pacific (32), Atlantic (5), and Caribbean (2) regions to detect and verify tsunami waves. Together, the earthquake- and tsunami-monitoring instrumentation will provide the United States with nearly 100 percent detection capability for a U.S. coastal tsunami. Notification of tsunami-generating earthquakes will originate from USGS National Earthquake Information Center (NEIC) in a matter of minutes after rupture initiation, allowing the NOAA tsunami warning center to analyze the quake for tsunamigenic potential and alert vulnerable coastal areas well ahead of tsunami waves. The integrated system is expected to be in place by mid-2007.

## The Role of the USGS: Earthquake Detection and Warning

Warning of a potentially dangerous tsunami begins with rapid earthquake detection and notification. To improve these capabilities in the Caribbean region, the USGS will work with host countries to install or upgrade 12 seismic monitoring sites distributed around the various earthquake source zones. The new stations will be affiliated with the Global Seismographic Network (GSN), a collaborative effort of the USGS, the National Science Foundation (NSF), and the Incorporated Research Institutions for Seismology (IRIS). Long-term operation will be conducted by USGS in cooperation with partners from the




NOAA developed Deep-ocean Assessment and Reporting of Tsunamis (DART II) buoy stations for early detection, measurement, and real-time reporting of tsunamis in the open ocean. Two Caribbean and five Atlantic DART II buoy stations will be deployed in regions with a history of tsunami generation.

host countries. Equipment at each station will conform to standards in place for the National U.S. "backbone" array and will consist of the following:

- ground-motion sensors to detect distant tsunami-generating earthquakes and to measure the effects of strong shaking from local earthquakes,
- high-resolution, digital data-acquisition system,
- real-time satellite telemetry system that will transmit ground-motion data to automated processing systems at the USGS National Earthquake Information Center (NEIC) and the NOAA tsunami warning centers, and
- robust and redundant power systems to maximize uptime in the event of local disasters due to earthquakes, tsunamis, and hurricanes.

The planned seismic stations in the Caribbean will allow more accurate, timely, and responsive monitoring in the region by lowering the earthquake-magnitude detection threshold, reducing hypocenter error, and decreasing NEIC earthquake notification time.

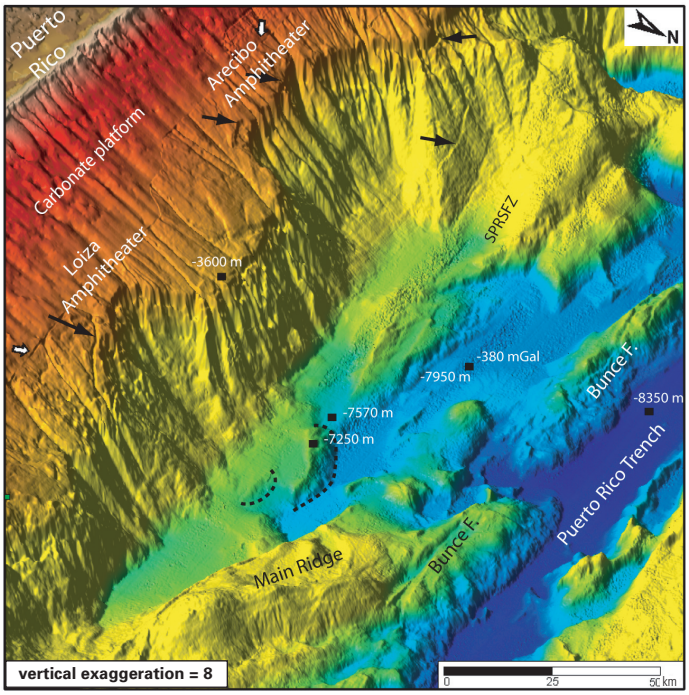
## Part of a Larger Picture of Hazard Mitigation Within the USGS

The tsunami hazards for coastlines of the Gulf of Mexico, Atlantic Ocean, and Caribbean islands are unique in that practically all the known causes of tsunamis are present, including earthquakes, submarine landslides, and island volcanoes. For example, large submarine landslides pose significant tsunami hazards along with earthquakes.

Researchers think that past landslides resulted from ongoing plate-tectonic movement that tilted the seafloor 4° down to the north. The tilt caused massive slope failures that appear to be continuing, as evidenced by large fissures in the seafloor. The new monitoring system will focus on earthquakes and tsunamis and complement existing USGS and NOAA scientific investigations in the region, including earthquake hazard assessment, tectonics and active fault studies, tsunami hazard and inundation modeling, and submarine landslide hazard studies.

## International Cooperation Required

Close international cooperation among all the Caribbean, South American, and Latin American nations threatened by earthquakes and tsunamis will be essential to assure success. The primary organization for seismic monitoring in the Caribbean region is the Middle America Seismograph Consortium (MIDAS). The USGS has a long-term partnership with MIDAS and its members and will continue to work through this organization to coordinate efforts in the region. Members of MIDAS include the U.S. territory Puerto Rico, Turks and Caicos Islands, Dominican Republic, Jamaica, Tobago, Trinidad, Barbados, Antigua/Barbuda, Honduras, and Panama.




A NOAA image of the ocean-floor bathymetry north of Puerto Rico. Two ancient submarine landslides are visible as head scarps (labeled Loiza and Arecibo Amphitheaters). Seafloor fissures are indicated by black arrows, and dashed lines outline debris flows from past failures (map by Uri Ten Brink of the USGS).

The National Oceanic and Atmospheric Administration (NOAA), an agency of the U.S. Commerce Department, is dedicated to enhancing economic security and national safety through the prediction of and research on weather- and climate-related events and providing environmental stewardship of our Nation's coastal and marine resources. Through the emerging Global Earth Observation System of Systems (GEOSS), NOAA is working with its Federal partners and nearly 60 countries to develop a global monitoring network that is as integrated as the planet it observes.

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