



Seismic Waves

How the National Earthquake Hazards Reduction Program Is Advancing Earthquake Safety

Seismic Safety Secures a Share of Stimulus Spending

Goals of NEHRP and Recovery Act Intersect

The American Recovery and Reinvestment Act of 2009 (ARRA) was enacted, in part, to spur technological advances and infrastructure improvements that will provide long-term economic benefits for the Nation.¹ Several agencies participating in the National Earthquake Hazards Reduction Program (NEHRP) received ARRA funding to achieve those goals through earthquake-related research and infrastructure.

Three NEHRP agencies—the National Institute of Standards and Technology (NIST), the National Science Foundation (NSF), and the U.S. Geological Survey (USGS)—have enabled and targeted ARRA support for earthquake risk reduction, each in its own way. While USGS funding was specifically directed toward infrastructure improvements, NIST and NSF have also expanded funding opportunities for basic and applied research.

Strengthening Monitoring Systems

In late 2009 and early 2010, USGS allocated \$29.5 million of ARRA funding toward modernizing existing urban, regional, national, and global seismic and geodetic networks operated by the agency and its partners. Scientists use this infrastructure to monitor and report on earthquake activity and measure changes in the Earth's surface caused by crustal deformation.²

Existing seismic station components are up to 40 years old, preventing the networks from taking full advantage of technological advancements that have significantly improved the equipment available for detecting, measuring, processing, and communicating seismic activity. By upgrading to newer technology and further integrating seismic and geodetic networks, this ARRA-funded work will increase the speed, accuracy, reliability, and efficiency of monitoring operations. At the same time, these investments provide short- and long-term economic benefits to the Nation by supporting U.S. equipment manufacturers, installers, and operators, and by making available enhanced monitoring data that can enable further advances in our understanding of earthquakes and in seismic loss-reduction strategies and technologies.

Thirteen universities, the UNAVCO university consortium, and the Montana Bureau of Mines and Geology were

awarded ARRA funds to plan and conduct monitoring network upgrades in the United States. These organizations partner with USGS to operate and maintain seismic and geodetic networks in high-hazard regions of California, Alaska, the Pacific Northwest, the Intermountain West, and the Central and Eastern States. USGS furnished state-of-the-art equipment, purchased with ARRA funds, to these partners for installation. This work, which is scheduled for completion by September 2011, will upgrade more than 800 monitoring stations within the Advanced National Seismic System (ANSS) and regional geodetic networks. When completed, these investments will bring ANSS a quarter of the way toward achieving its modernization and expansion goals, which represent a strategic priority in NEHRP's strategic plan.



Field Instrumentation Specialist Jacob Crummey of Caltech installing new batteries as part of the final stages of upgrading the Dos Picos County Park seismic station in Rosemont, CA, with modern seismic equipment provided through economic stimulus funding. Credit: David Johnson, Caltech.

USGS has also devoted some of the network modernization funds to improve the robustness of operations at the National Earthquake Information Center (NEIC) in Colorado. The NEIC serves as a global hub for compiling and analyzing earthquake monitoring data and for developing and disseminating notifications and other information products derived from these data.

A key source of data from outside the United States is the Global Seismographic Network (GSN), which is maintained by USGS and the NSF-supported university consortium, Incorporated Research Institutions for

¹ See www.recovery.gov/About/Pages/The_Act.aspx for a description of and link to the Recovery Act.

² Outside of NEHRP, USGS also allocated \$15 million for improvements to volcano monitoring networks.

Seismology (IRIS). USGS allocated a portion of its ARRA funding to an ongoing effort to upgrade GSN monitoring equipment. NSF has also devoted \$5 million of ARRA funds to this effort and together, these allocations will allow the completion of the current GSN modernization effort over the next few years.

Competing with Other Critical National Priorities

In January 2010, NIST awarded three ARRA-funded grants for research related to earthquakes. These were among 27 awards made under NIST's Measurement Science and Engineering Research Grants Program, a one-time funding opportunity made possible by ARRA, which received more than 1,300 competing research proposals.

The program targeted six research areas of critical national importance: energy; environment and climate change; information technology and cybersecurity; biosciences and health care; manufacturing; and physical infrastructure. The three earthquake projects were among five funded proposals pertaining to physical infrastructure. The projects will be completed within 3 years at a total cost of about \$2.9 million.

Using these ARRA funds, researchers at the University of California, San Diego are developing design methods, experimental data, and analytical tools that can be used to improve the seismic performance of, and building-code requirements for, shear walls in reinforced masonry buildings. Structural systems that can meet the goals of performance-based earthquake engineering (negligible damage in small earthquakes, acceptable damage in moderate earthquakes, and a low probability of collapse in large earthquakes) are being devised at the Virginia Polytechnic Institute and State University. Along with these systems, the project team will produce corresponding structural design procedures as well as evaluation tools and techniques that engineers can use to demonstrate that designs based on the systems will meet performance goals. In the third project, University of Delaware researchers are creating innovative risk-optimization tools that stakeholders can use to collaboratively design regional natural disaster risk management systems. The researchers will

demonstrate how these tools can be used through case studies of earthquake risk in Los Angeles and hurricane risk in North Carolina.

Funding Additional Highly Rated Proposals

Many more earthquake-related research projects have been supported with ARRA funds awarded by NSF. Rather than issuing special research solicitations underwritten by ARRA, NSF used most of its allocation from the Recovery Act to fund additional proposals submitted under the agency's existing solicitations. These are projects that, despite being rated highly by reviewers, NSF would otherwise have had to turn away for lack of funds.

During 2009 and 2010, NSF's Engineering and Geosciences Directorates awarded 43 ARRA-funded grants totaling \$14.5 million to 33 U.S. universities for research directly related to the earthquake risk reduction goals of NEHRP. Researchers in a number of these projects are utilizing the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) to carry out their work. NEES, supported by NSF, is a shared national resource comprising a unique network of 14 university-based experimental facilities and a Web-based, hub-type cyberinfrastructure (nees.org). NEES gives researchers, educators, and students access to shared data, interactive simulation software, and collaborative tools. One of the NEES facilities, the Shake Table Laboratory at the University of Nevada, Reno, is being expanded into the largest such facility in the United States with a \$12.2 million construction grant recently awarded by NIST.³

In addition to directly supporting specific projects through ARRA-funded grants, NSF leveraged additional research by providing \$800,000 in ARRA funding to the Southern California Earthquake Center (SCEC). Supported by both NSF and USGS, SCEC is a community of scientists from more than 60 universities and research institutions focused on developing a comprehensive, physics-based understanding of earthquakes in Southern California and elsewhere. The center organizes and funds research and communicates risk-reduction information through educational, outreach, and knowledge-transfer activities.

³ See NIST news release at www.nist.gov/public_affairs/releases/20100929_cgp_awards.cfm. Although this award was made through the NIST Construction Grant Program, which has distributed nearly \$180 million of ARRA funding for new research facilities, ARRA funds were not used for this project.

For more information, visit www.nehrp.gov or send an email to info@nehrp.gov.



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