WESTERN STATES SEISMIC POLICY COUNCIL
POLICY RECOMMENDATION 11-3

Earthquake Monitoring Networks

Policy Recommendation 11-3

WSSPC advocates the continuation and expansion of earthquake monitoring networks as envisioned and supported by the Advanced National Seismic System (ANSS). ANSS emphasizes strong-motion instrumentation of urban ground-motion monitoring sites and selected engineered structures as well as increased broadband seismograph instrumentation. The resulting data provide better understanding of future ground shaking potential, rapid information for emergency response, and insights for the design of more earthquake-resistant new and retrofitted construction.

WSSPC calls upon all parties committed to earthquake loss reduction to advocate greater support of the U.S. Geological Survey's efforts to expand ANSS monitoring and to standardize data collection, processing, and storage. To further these efforts, WSSPC encourages the USGS to strengthen partnerships with emergency managers, engineers, and corporate response and business interruption planners, as well as State and local agencies.

Background

Earthquake monitoring networks are vital both to respond to earthquakes and to characterize earthquake hazards. The earthquake parameters produced by modern seismic networks, when combined with historic earthquake catalogs and the paleoseismic record, are essential input for developing the Nation's probabilistic seismic hazard maps and analyses. Automated processing of earthquake information by seismic networks in the United States provides near-real time information on earthquake locations, magnitudes, and patterns of moderate and damaging ground shaking. In the last decade, seismologists have expanded the capabilities of the seismic network system in some areas to routinely produce ShakeMaps, fault orientations and slip distributions, and aftershock probabilities. In California, ShakeMap has become a valuable tool to assist emergency responders in identifying the possible extent of earthquake damage. Strong-motion data (now increasingly available in real-time) are essential to evaluate the engineering relationship of structural damage to severity of ground shaking.

During the 1960s, the U.S. Geological Survey (USGS) began to operate, support and coordinate local seismic networks that were sensitive enough to detect microearthquakes, including aftershocks of larger earthquakes. Data from these early seismograph networks were used to delineate the spatial relationships between earthquake hypocenters and active faults. Earthquake networks provide fundamental earthquake data in the form of catalogs specifying hypocenter location, time of occurrence, and magnitude. These data find uses in diverse applications ranging from earthquake hazard analysis to disaster response. Seismic networks throughout the U.S. have provided fundamental data for the U.S. Geological Survey's National Seismic Hazard Mapping Project, which is generating ever-advancing state-of-the-art earthquake hazard maps for the U.S. The availability of earthquake monitoring network data has led to new and innovative research that has advanced the field of seismology through an improved understanding of the physics of earthquake occurrence.

Despite the importance of its products, earthquake monitoring in the United States faces many problems and challenges, the most notable of which are:

- Outdated, inadequate instrumentation
- Separation of functions between strong- and weak-motion monitoring systems
- Lack of sufficient and uniform geographic coverage in areas at risk
- Lack of uniform operational standards
- Well-established independent networks with non-standardized and even incompatible equipment, operations, products, and funding sources.

Many of the currently deployed instruments record only high frequency (1-25 Hz), vertical motions over a very limited dynamic range. Known as "short-period" seismographs, these analog instruments are extremely sensitive, recording even tiny microearthquakes. However, moderate and larger magnitude earthquakes drive short-period seismograph signals off-scale. The full amplitudes of shaking cannot be recorded and the resulting waveforms are highly distorted.

For the western states, modern monitoring of earthquakes is crucial. The largest proportion of the Nation's seismic risk is in the western states. However, large and damaging earthquakes are not limited to California. Two of the largest earthquakes in the lower 48 states during the past four decades have occurred in the Northern Rocky Mountain region (magnitude 7.3 1959 Hebgen Lake, MT; and magnitude 6.9 1983 Borah Peak, ID). Yet, the Northern Rocky Mountain region remains the largest seismically active region of the lower 48 states without sufficient modern instrumentation.

The recent advent of digital instrumentation has revolutionized seismology. High-fidelity earthquake data transmitted in real-time via terrestrial and satellite communication links and analyzed with modern techniques rapidly provide data and results essential for all aspects of seismology. Modern dataloggers coupled with broadband and strong-motion sensors have the capability to record the full spectrum of earthquake-related ground motions—everything from the high frequencies of nearby earthquakes to the low-frequency, rolling motion of distant earthquakes. Most importantly, digital instruments have dynamic range sufficient to detect tiny earthquakes and yet able to remain on-scale for a major, nearby earthquake. Additionally, all three axes of ground motion (up-down, north-south, and east-west) are recorded (as opposed to only the vertical direction of ground motion recorded by many current network seismographs). High-quality recordings by even a few broadband seismographs from earthquakes with magnitudes as small as 3.5 allow computations that uniquely characterize the type of faulting, amount of energy released, and the stress field responsible for the quake. Likewise, high-quality strong-motion recordings in the urban environment are necessary to understand how seismic shaking can cause damage to buildings and other structures. All this information is now immediately posted to the Internet, and datacenters provide ready access to the information for rapid response and recovery as well as long-term research.

The vision of the next generation of national earthquake monitoring, the Advanced National Seismic System (ANSS), was issued in 1999 by the U.S. Geological Survey, which has now begun its implementation. Its design has been developed in consultation with earthquake specialists in academia and the States together with the engineering community. The mission of the Advanced National Seismic System is to provide accurate and timely data and information on earthquakes and their effects on buildings and structures, employing modern monitoring methods and technologies.

Since the ANSS was established by Congress in 2000, the USGS has fostered the organization of seven regional networks developed through incorporation of local efforts into regional systems. The seven networks are in California, the Pacific Northwest, Alaska, Hawaii, the Intermountain region, the Central U.S. (including the Southeast), and the Northeast. With USGS support, the newly established ANSS regional networks have installed almost 800 new and upgraded monitoring stations in 24 states since its inception. The largest numbers of new stations are in Alaska, California, Nevada, Utah and Washington, and most have been installed in urban areas where seismic risk is high.

Automated processing of earthquake information by seismic networks provides near-real-time information on the Internet about earthquake location, magnitude, fault orientation, slip distribution, and aftershock probabilities. Together with other parties, the USGS has developed ShakeMap, an analytical methodology that creates maps of the severity of ground shaking developed from ground-motion data recorded by the newly installed ANSS instrumentation and other modern stations.

ShakeMaps are posted to the Internet within minutes following earthquakes and also are distributed through technologies like CISN Display and ShakeCast. The initial maps are automatically revised as new seismic data become available. In areas of California with a relatively dense distribution of strong-motion seismometers, ShakeMap can help emergency managers immediately identify areas that have been exposed to strong shaking before damage reports are available. ShakeMap is being used in conjunction with earthquake loss modeling to make preliminary estimates of earthquake damage costs.

The planned ANSS instrumentation of engineered structures to monitor their responses to earthquake ground motion is just beginning. Because of limited funding, only a small number of buildings have been instrumented so far. This type of monitoring is very important to the establishment of better building code requirements and design practices to achieve improved earthquake resistance in both new construction and retrofitted structures. Following damaging earthquakes, real-time monitoring of the response of lifelines and buildings will also be valuable in emergency response.

Facilitation and Communication

WSSPC recommends expansion of the regional free-field real-time earthquake monitoring in the western states and throughout the Nation. WSSPC also endorses the expansion of monitoring of engineered structures in order to use insights from investigation of their earthquake performances in the creation of better design procedures and construction standards. To accomplish such expansion, WSSPC encourages the USGS to form partnerships to further these efforts with the emergency managers, engineers, and corporate response and business interruption planners, as well as State and local agencies. In addition, recognizing the synergistic aspects of the National Science Foundation's EarthScope Program, which is deploying temporary seismic and GPS instruments, WSSPC encourages the USGS to take full advantage of EarthScope instruments in fulfilling the mission of ANSS. WSSPC commends those states that are partnering with ANSS to fund modernizing and increasing the numbers of seismic monitoring stations.

The ANSS funding to date is a small fraction of the planned and requested capitalization needed to build out ANSS, although there has been some incremental growth. There are more than 6,000 stations needed to meet the ANSS requirements.

Assessment

The success of this policy can be assessed by the increase in the number of engineered structures with strong motion instruments, the level of funding available for maintaining and enhancing networks, and the evidence of partnerships implementing seismic networks among the USGS, state and local agencies, and the private sector.

History

WSSPC Policy Recommendation 08-3 was first adopted in 1997 as WSSPC Policy Recommendation 97-4. It was reviewed, revised, and re-adopted as WSSPC Policy Recommendation 02-5 by unanimous vote of the WSSPC membership at the Annual Business Meeting September 18, 2002. It was reviewed, revised, and re-adopted as WSSPC Policy Recommendation 05-3 by unanimous vote of the WSSPC membership at the WSSPC Annual Business Meeting September 12, 2005. It was reviewed, revised, and re-adopted as WSSPC Policy Recommendation 08-3 by unanimous vote of the WSSPC membership at the WSSPC Annual Business Meeting April 22, 2008. Policy Recommendation 08-3 was reviewed, revised and re-adopted as WSSPC Policy Recommendation 11-3 by unanimous vote of the WSSPC membership at the WSSPC Annual Business Meeting April 4, 2011.