nehrp
SeismicWaves
How the National Earthquake Hazards Reduction Program Is Advancing Earthquake Safety
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Advances in Rapid Earthquake Assessment and Alerting Systems

Over the past decade, the U.S. Geological Survey (USGS) has made dramatic strides in translating seismic data into timely and actionable earthquake assessment and notification tools. This work is strengthening and affirming the role of seismic monitoring in reducing the death, suffering, damage, and disruption that can accrue in the aftermath of earthquakes.

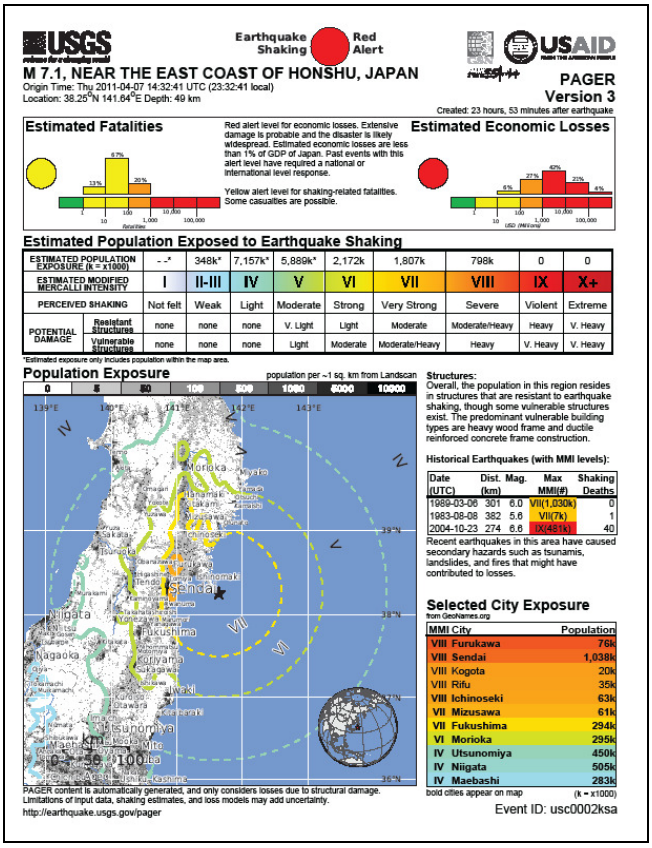
Earthquake assessment and notification tools are an important USGS contribution to NEHRP. They are being developed through the USGS National Earthquake Information Center (NEIC). An integral component of the USGS Advanced National Seismic System (ANSS), the NEIC reports on earthquakes worldwide using data generated by ANSS and the Global Seismographic Network. All NEIC tools and information are freely accessible through the USGS earthquake pages, one of the Federal Government's most popular websites.

Assessing Impacts for Response

Late last year, USGS implemented a new version of the Prompt Assessment of Global Earthquakes for Response (PAGER) system. For significant earthquakes occurring anywhere in the world, PAGER now generates rapid estimates of the human and economic impacts of the event. These automated alerts, which are usually available within 30 minutes of an event, enable recipients to quickly and reliably assess the probable scope of the earthquake's effects and make better-informed judgments about what level of response is appropriate.

Human impacts are represented by estimates of fatalities and economic impacts by damage estimates. Currently, these estimates reflect only impacts attributable to ground shaking and do not include losses associated with tsunamis, landslides, fires, or other secondary causes. The loss estimates are color-coded to quickly convey the scale of the impacts and, based on experience with past earthquakes, of a proportionate response. Green indicates little or no impact requiring little or no response, yellow a regional impact and response, orange a national impact and response, and red an international response.

As in its previous version, PAGER still provides a map and two tables showing the cities and numbers of residents exposed to different shaking intensities, and describing the levels of damage typically associated with



PAGER alert issued by USGS for a magnitude 7.1 earthquake that occurred near the coast of Japan on April 7, 2011.

these intensities among resistant and vulnerable structures. Another section summarizes available information about vulnerable buildings and impacts of past earthquakes in the affected region. These elements complement PAGER's information about the level of response needed by helping responders know where (i.e., in what portions of the affected region and in what types of structures) to concentrate their efforts.

The NEIC automatically transmits PAGER alerts to relevant emergency-response authorities, public- and private-sector aid agencies, media outlets, and other critical users. At the same time, more detailed versions of the alerts are made available on the USGS website.

Developments in Earthquake Mapping

PAGER is one of several information tools that take advantage of USGS ShakeMap technology, which displays how the intensity of ground shaking and the levels of

other seismic parameters vary across the geographic area affected by an earthquake. Along with PAGER, ShakeMap helps inform the media and public about where stronger shaking was experienced and provides critical input to the Federal Emergency Management Agency's HAZUS-MH loss-estimation software and to scientists and engineers working to understand earthquakes and mitigate earthquake losses.

In urban areas with sufficiently dense seismic sensor networks, ShakeMaps directly reflect instrumental data. Having such dense networks in all at-risk urban areas is a long-term goal of ANSS, but even without such dense monitoring, model-based ShakeMaps can be produced automatically for moderate-to-large earthquakes occurring worldwide.[1] These maps and associated data are normally posted on the USGS website within minutes, and can be sent automatically to individuals and organizations through use of the USGS ShakeCast product.

The ShakeCast system is primarily intended for use by utilities, transportation agencies, school districts, businesses, and other large organizations that maintain networks of geographically dispersed facilities or infrastructure. ShakeCast enables these critical users to quickly determine the levels of earthquake shaking experienced at their facilities, compare these intensities to facility-specific vulnerability data and assess the likelihood of damage, and automatically notify (via pagers, cell phones, or e-mail) the managers or inspectors responsible for potentially damaged facilities. A smaller, "Lite" version of ShakeCast is also available to scientists and others interested in automatically downloading ShakeMap data or maps relating to particular, user-defined regions.

Earthquake Notification—A Two-Way Street

More than 265,000 subscribers from the United States and other countries are automatically notified of earthquakes through the USGS Earthquake Notification Service (ENS). These notifications provide basic, preliminary data (e.g., magnitude, time of occurrence, location) about significant earthquakes occurring worldwide. Generally sent within 30 minutes for U.S. earthquakes and fewer than 60 minutes after global events to subscribers' e-mail, pager, or cell phone addresses, ENS notifications serve as an initial heads-up.

The notifications include hyperlinks to the USGS website, where users can access the PAGER and ShakeMap information needed to efficiently assess and prioritize response requirements. ENS allows subscribers to customize their notifications by limiting them to events that occur in specified regions, that exceed specified magnitudes, or that occur during specified hours of the day.

USGS is using the Internet to collect as well as disseminate earthquake information. The Did You Feel It? (DYFI) system enables Internet users in quake-affected areas worldwide to report on shaking and damage experienced at their locations. They do so by filling out a simple multiple-choice questionnaire accessed on the DYFI site. Questionnaire results are aggregated in "community Internet intensity maps" displayed on the site. Over ½ million individual DYFI reports are provided to USGS by users around the country and the globe each year.

DYFI intensity data can be gathered quickly and have proven to be "a surprisingly good measure of earthquake ground motion" because they "make up in quantity what they may lack in scientific quality."[2] They are among the additional data sources that have enabled USGS to generate ShakeMap products (and from them, PAGER alerts) for earthquakes that occur in areas that are less heavily monitored.

In the aftermath of damaging earthquakes, decisions must be made about whether, how, and where to respond. Made at all levels of government and in the private sector, these decisions can significantly affect the ultimate human and economic impacts of seismic events. Through its recent and ongoing development of innovative earthquake notification and information systems, USGS is helping to ensure that these decisions are more informed, better focused, and cost-effective.

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[1] For earthquakes with magnitudes greater than 5.5 worldwide and greater than 3.5–4.0 in the United States. There is less uncertainty in the maps produced for areas densely monitored by ANSS, which include major parts of AK, CA, HI, NV, OR, UT, and WA.

[2] Gail M. Atkinson and David J. Wald, "'Did You Feel It?' Intensity Data: A Surprisingly Good Measure of Earthquake Ground Motion," *Seismological Research Letters* 78, no. 3 (May/June 2007): 362.