

The formulae $\frac{\partial \rho U_i}{\partial t} + \frac{\partial}{\partial x_j}(\rho U_j U_i) = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j}(\mu \frac{\partial U_i}{\partial x_j}) + g_i(\rho - \rho_0)$ for building $\frac{\partial}{\partial x_j}(\rho U_j U_i) = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j}(\mu \frac{\partial U_i}{\partial x_j} - \rho u_i u_j) + g_i(\rho - \rho_0)$ state of the art $\frac{\partial}{\partial x_j}(\rho U_j U_i) = \frac{\partial}{\partial x_j}(\rho u_j u_i)$ biomedical research facilities.

United States Geological Survey (USGS) ShakeMaps and ShakeCast for Post-Earthquake Facility Evaluation at the National Institutes of Health (NIH)

Earthquakes pose a significant risk to infrastructure, and timely evaluation of critical facilities at the National Institutes of Health (NIH) following such events is essential to ensure personnel safety and effectively prioritize facility recovery and repair efforts. The United States Geological Survey (USGS), a scientific agency within the U.S. government that conducts research and provides data on natural resources, natural hazards, and the landscape of the United States, has developed two tools — ShakeMaps and ShakeCast. These tools both play an integral role in post-earthquake situational awareness and response assessments. These technologies facilitate rapid evaluations of seismic impacts, enabling NIH engineers and upper management to make well-informed decisions.

ShakeMap

ShakeMaps are detailed, color-coded visualizations of ground shaking generated immediately after an earthquake. These maps leverage data from NIH and USGS regional seismic monitoring stations, reported intensities, geological analysis, and mathematical modeling to estimate the intensity and distribution of ground shaking across affected areas. Key metrics provided by ShakeMaps, such as peak ground acceleration (PGA), describe the severity of shaking and its potential impacts on structures to help structural engineers and first responders better respond to an event.

ShakeCast

ShakeCast is a software application that leverages ShakeMap shaking estimates to provide automated assessments of earthquake impacts on specific facilities and critical assets. Facility-specific structural-design information, including seismic design parameters and vulnerability data, are entered into the ShakeCast system. Following an earthquake, ShakeCast compares ShakeMap data with these facility details to evaluate potential damage levels, which can help to prioritize inspection needs.

ShakeMap Intensity Map

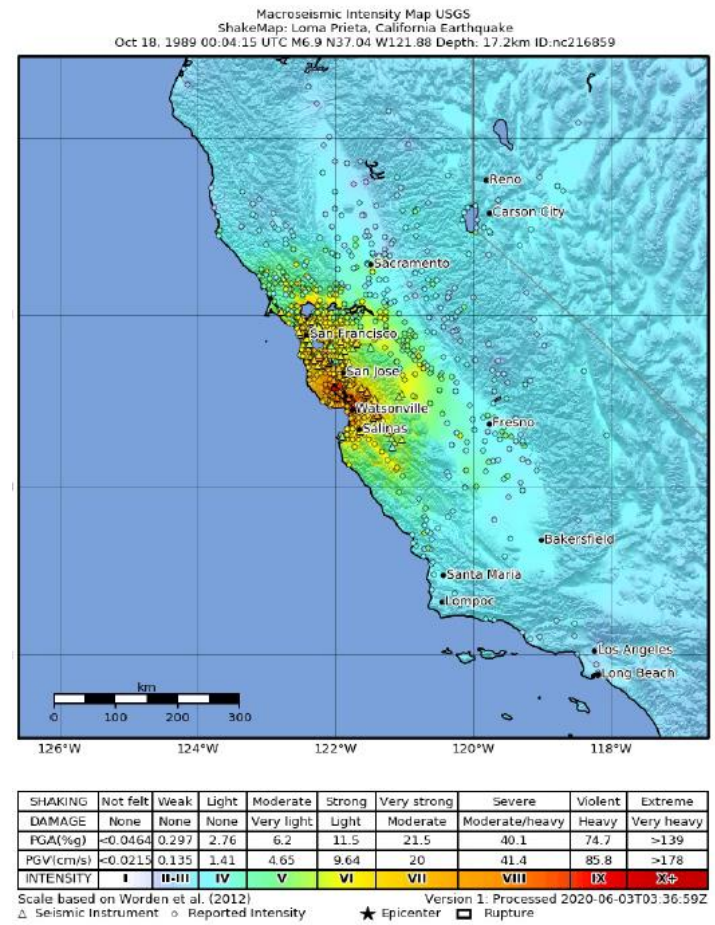


Figure 1: ShakeMap Intensity Map

ShakeCast delivers results within minutes of an event or earthquake, generating reports that categorize facilities by their likelihood of potential damage and inspection priority. These reports are color-coded, allowing users to quickly identify high-risk structures. For critical infrastructure on campus, such as the hospital and the Central Utility Plant, ShakeCast helps to streamline post-earthquake evaluations by prioritizing resources on the most vulnerable assets. Importantly, ShakeCast also has the potential to save resources when ShakeMap reported shaking levels are determined to be below those of concern— avoiding unnecessary inspections, or the shutdown of critical facilities.

Magnitude 5.8 - 14km SSE of Louisa, Virginia Version 2
 Origin Time: 2011-08-23 11:51:04UTC Process Time: 2024-09-19 14:00:19UTC
 Latitude: 37.9097 Longitude: -77.9363 Depth: 6.0 km

These results are from an automated system and users should consider the preliminary nature of this information when making decisions relating to public safety. ShakeCast results are often updated as additional or more accurate earthquake information is reported or derived.

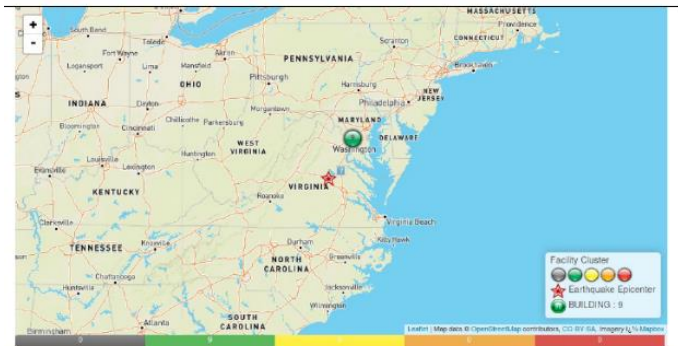


Figure 2: ShakeCast Report

ShakeCast is widely used across the Department of Homeland Security’s 16 critical infrastructure sectors. It is also employed by international agencies, such as the International Atomic Energy Agency, to assess potential earthquake damage at critical sites. It has proven effective in identifying damaged infrastructure, such as during the South Napa Earthquake, where it flagged several bridges, later confirmed as damaged. Efforts are underway to expand its capabilities nationally with support from the California Department of Transportation (Caltrans) and the Federal Highway Administration (FHWA).

Post-Earthquake Facility Evaluation

ShakeMaps combined with ShakeCast are particularly effective for post-earthquake facility evaluations due to their speed and specificity. Facility managers can use ShakeMaps to gain a general understanding of the earthquake’s impact and utilize the ShakeCast system for detailed, facility-level insights. This dual approach minimizes downtime, ensures site safety, and prioritizes repairs. Furthermore, ShakeMaps are used to calibrate ShakeCast, a supplementary tool for conducting facility-specific structural evaluations based on the ShakeMap shaking estimates at each location.

Both tools reduce the need for immediate exhaustive on-site inspections in low-risk areas, saving valuable time and resources. Additionally, they enhance preparedness by enabling NIH facility managers and engineers to pre-configure vulnerability data, ensuring rapid and accurate evaluations when an earthquake occurs.

Conclusion

By utilizing these newly acquired tools, NIH can better understand the geographic extent of an earthquake’s impact to the NIH campus by identifying areas most likely to experience severe damage.

These USGS tools empower NIH to enhance its emergency preparedness and response capabilities by pinpointing facilities that may require immediate attention, ultimately protecting critical infrastructure and ensuring the safety of personnel and operations.

References

1. Following any earthquake, go to: <https://earthquake.usgs.gov>
2. More on ShakeMap: <https://earthquake.usgs.gov/data/shakemap/>
3. More about ShakeCast: <https://code.usgs.gov/ghsc/esi/shakecast/shakecast/-/wikis/home>
4. ShakeCast Background: <https://www.usgs.gov/news/featured-story/usgs-shakecast-system>