

# “Epicenters” of resilience

The 25th anniversary of the magnitude (*M*) 6.9 Loma Prieta earthquake that struck the San Francisco Bay Area on 17 October 1989 is a fitting time to examine what progress has been made in increasing community resilience to minimize seismic risk. The regions affected by the 2010 *M* 7.0 earthquake that struck Port-au-Prince, Haiti, and the *M* 8.8 event near Concepción, Chile, a few weeks later illustrate the extremes in earthquake resilience. In the zone of most intense shaking, 1 of every 10 Haitians was killed, compared to 1 of every 2500 Chileans, reflecting huge differences in construction quality and community resilience. The Loma Prieta event left 63 people dead, largely the result of the collapse of a bridge, an overpass, and homes built on unconsolidated fill. But beyond the loss of life, the Bay Area was affected by more than \$10 billion in disruption of economic activity and damaged infrastructure. One challenge in implementing community resilience is to use science and engineering to find solutions that not only save lives but also get communities back to business as quickly as possible after a seismic event.

The Loma Prieta event catalyzed partnerships of scientists, engineers, elected and building inspection officials, and emergency managers, as well as building and infrastructure owners, members of the business community, and tenant groups, to make the region safer and speed recovery. Over the past 25 years, the Bay Area has become an “epicenter” of resilience, in which the community has made substantial investments that are driven and supported by science-informed public policy.

Translation of science, accurate and clear risk communication, and actionable risk reduction measures with specific performance goals formed the cornerstones of campaigns to generate the political will to achieve public acceptance and enable substantial investments to improve resilience. One key to the success of these campaigns was a San Francisco–based planning and urban research nonprofit organization that included citizens

and members of the business community as well as public policy, science, and engineering experts. This group led a dialogue to clearly define the attributes and performance measures of a resilient city subject to earthquakes. Enlightened leadership, both public and corporate, was also key to the success. After Loma Prieta, the area’s major utility and transportation providers designed programs to lower vulnerability and speed recovery after a quake, and invested more than \$25 billion in upgrades to their critical infrastructure, funded almost exclusively by local ratepayers and taxpayers. At the same time, over \$30 billion has been invested by business and taxpayers in extensive retrofitting of commercial and public buildings and residential structures. Mandatory seismic safety inspections and retrofit ordinances also have been passed in several communities. Over 100 local governments now work together to strengthen community resilience, using measures such as financial incentives to upgrade buildings and public service systems, postdisaster governance plans, and inter-jurisdictional alliances.

The citizens of Haiti, situated directly adjacent to a major fault, were unaware of their risk and built homes that would collapse in an earthquake. Chile recognized its seismic risk, developed strong building codes, and enforced them. The Bay Area’s robust high-tech economy gives it the capacity and public will, more than most, to invest more than \$50 billion in resilience.

However, there are valuable general lessons from the response to the Loma Prieta quake that can inform resilience building elsewhere. No-cost or low-cost measures such as broad engagement by the scientific and non-science communities working together to communicate risk and set recovery priorities and performance objectives; providing the public with actionable risk reduction measures; and forming regional governmental and community alliances to implement science-informed policy are relevant to communities at risk everywhere. These are measures with a payoff that one cannot put a price on.

– Mary Lou Zoback



**“One challenge...is to use science and engineering to...get communities back to business... after a seismic event.”**



*Mary Lou Zoback is a consulting professor in the Department of Geophysics, Stanford University, Stanford, CA. E-mail: marylouz@stanford.edu*

# Science

## "Epicenters" of resilience

Mary Lou Zoback

*Science* **346** (6207), 283.  
DOI: 10.1126/science.1261788

### ARTICLE TOOLS

<http://science.sciencemag.org/content/346/6207/283>

### RELATED CONTENT

<http://science.sciencemag.org/content/sci/346/6210/710.2.full>

### PERMISSIONS

<http://www.sciencemag.org/help/reprints-and-permissions>

Use of this article is subject to the [Terms of Service](#)

---

*Science* (print ISSN 0036-8075; online ISSN 1095-9203) is published by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005. 2017 © The Authors, some rights reserved; exclusive licensee American Association for the Advancement of Science. No claim to original U.S. Government Works. The title *Science* is a registered trademark of AAAS.