

Earthquakes in Review: A Foundation for Understanding Risk



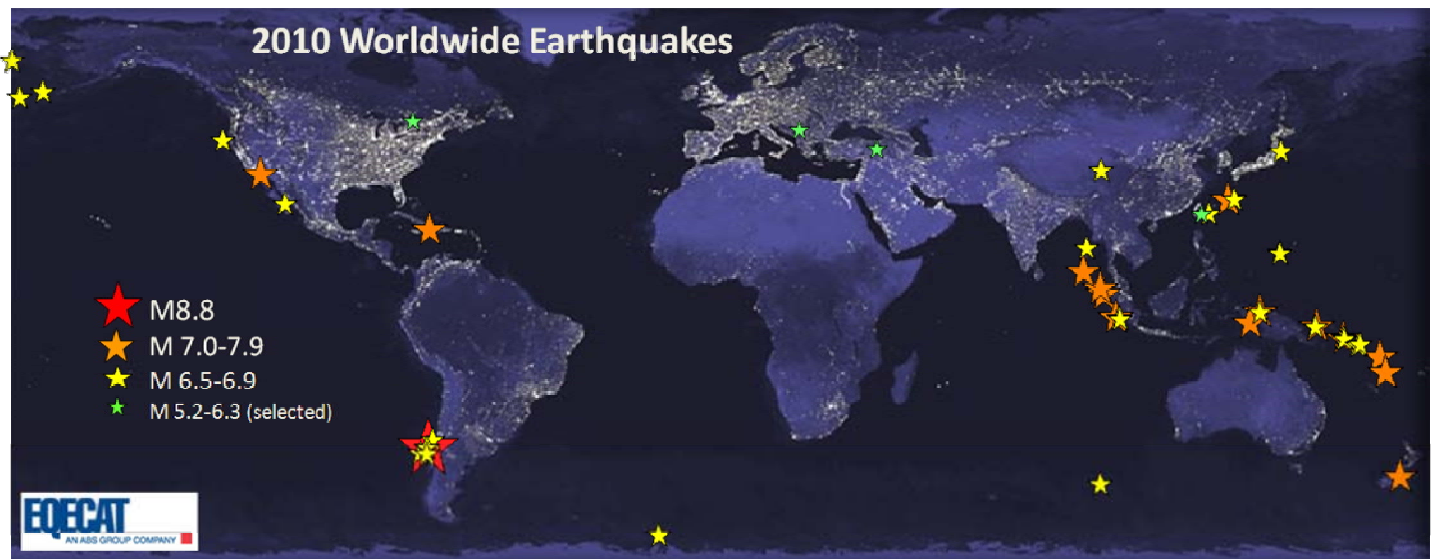
(Photos courtesy of EERI)

EQECAT Special Report on the Events of 2010

By Kate Stillwell, EQECAT, Inc.

While the number of earthquakes in 2010 wasn't exceptional, a large number of significant earthquakes occurred near population centers, translating into above-average loss of life and physical property.

Worldwide, earthquakes in 2010 caused more than 225,000 deaths, insured losses exceeding USD \$10 billion, and approximately USD \$40 billion in economic losses. The M8.8 quake in Chile was the most costly earthquake since the 1994 M6.7 Northridge, California earthquake which caused economic losses of USD \$40 billion¹. The M7.1 quake in Haiti claimed the most lives since the 1976 M7.5 earthquake in Tangshan, China.



The 2010 earthquakes clearly illustrate the impact of catastrophic earthquakes on both developed and developing countries, and shed light on the need to mitigate earthquake risk through both physical and financial measures. As we approach the one year anniversaries of the Haiti and Chilean disasters, this report offers a perspective on how these events will impact catastrophe modeling, how the US and Japan might have fared with similar earthquakes, and critical steps needed for earthquake loss reduction.

¹ EERI, 1994 dollars

Most Significant 2010 Earthquakes at a Glance

	Haiti Jan 12, 2010	Chile Feb. 27, 2010	Baja Calif., Mexico April 4, 2010	New Zealand Sept. 3, 2010
Magnitude	7.1	8.8	7.2	7.1
Duration of Shaking	10 to 20 sec	90 sec +	~30 sec	~40 sec
Nearest Major City	Port-au-Prince, 15 km, 2m people	Concepcion, 35 km, 200k people	Mexicali / Calexico, 50 km, 1m people	Christchurch, 40 km, 350k people
Fatalities	222,000	600	4	0
Population affected	2.5 million	7 million	1 million	350,000
Fatalities "per capita" affected	1 per 10	1 per 10,000	1 per 250,000	0
Building Codes	Largely unenforced	Stringent; largely enforced	Present; moderate enforcement	Stringent and enforced
Economic Losses	USD \$8 billion	USD \$30 billion	USD \$1 billion	USD \$4 billion ²
Losses / national GDP	100% to 200%	10% to 15%	<0.1%	3%
Insured Losses	< USD \$0.3 billion	USD \$8 billion	USD \$0.3 billion	USD \$3 billion ³
Key Lessons	<ul style="list-style-type: none"> • Construction standards save lives • Construction sequence affects seismic resistance for masonry infill structure types 	<ul style="list-style-type: none"> • Uninsured damage affects insured losses • Duration of shaking affects damage • Tsunami effects can be significant • Damage to new condos is politically divisive 	<ul style="list-style-type: none"> • Earthquake awareness in southern California has grown • Scientific follow-up studies show strain is building up north of the event, in southern California. 	<ul style="list-style-type: none"> • Geologic effects (liquefaction) can be significant and disruptive • Widespread insurance cover minimizes costs borne individually and spurs recovery

² According to a New Zealand government estimate on Dec. 20, 2010

³ Preliminary estimate

How do recent events inform models?

Since earthquakes in populated areas are relatively infrequent, there is a scarcity of event-related data. Every earthquake has the potential of informing models by providing a source of new data. Data on strong ground motion can improve the modeling of the footprint of shaking for a given earthquake. Data on building damage and losses, including data from buildings with no damage or losses, can inform vulnerability functions. The scientific and modeling communities are already collaborating to share shaking and damage data from the Chile and New Zealand events.

Even so, data gaps will always exist. Consistent with our heritage as an engineering company and our commitment to scientific defensibility, EQECAT accounts for data gaps by characterizing uncertainty throughout the modeling process, so that our clients can use results to set rational expectations about risk.

Every earthquake can improve models by providing a wealth of data: on ground shaking, damage, losses, and uncertainty.

Destruction in Port-au-Prince validated the extreme vulnerability modeled for developing economies like Haiti.

(Photo courtesy of EERI)



Earthquake-induced perils can be as significant as the shaking itself, and events improve how models capture these secondary effects. Tsunamis, associated with earthquakes typically exceeding M8, can cause devastation multiple times more than that of the initial shock. Likewise, fire following earthquake, a large, uncontrollable conflagration in a densely-built area, can produce losses much higher than the shake loss.

Considering the Chile earthquake, how well might the US or Japan have fared?

This year's 2010's Maule, Chile earthquake is the best preview we have of potential performance in many locations in the US and other developed nations. The Pacific Northwest has a particularly similar seismotectonic setting and level of preparation. Historically, the Cascadia subduction zone that underlies much of Oregon, Washington, and British Columbia (Canada) has been known to generate earthquakes up to M9, producing tsunamis that reach as far as Japan. The last of these so-called "megathrust" earthquakes in the Pacific Northwest occurred in 1700, and given an estimated return period in the range of 300 to 500 years, the next one could occur in the foreseeable future.

In California, scientists at the Southern California Earthquake Center cite ever-increasing probabilities of a large rupture of the southern San Andreas fault, and have produced simulations of a M8 earthquake that would cause reverberations lasting up to six minutes in the Los Angeles basin and economic losses exceeding USD \$600 billion.

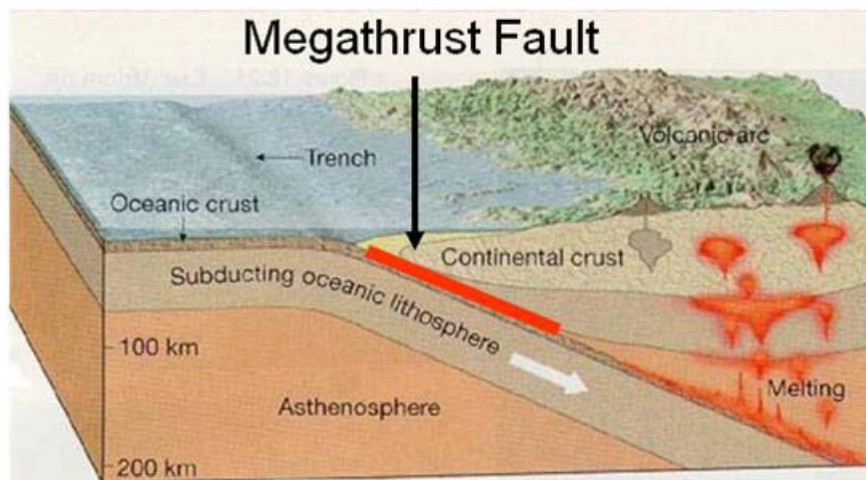
According to a 2005 report from the Japanese government (Central Disaster Management Council), a hypothetical M7.3 earthquake hitting Tokyo could cause economic losses approaching USD \$1 trillion.

Measuring Earthquake Risk in the Pacific Northwest

The long duration of shaking associated with megathrust earthquakes can particularly amplify swaying and potential damage in high-rise buildings.

Just because buildings are code-compliant does not mean they will meet social expectations for post-quake usability and repair costs, and this lesson has come through loud and clear from Chile.

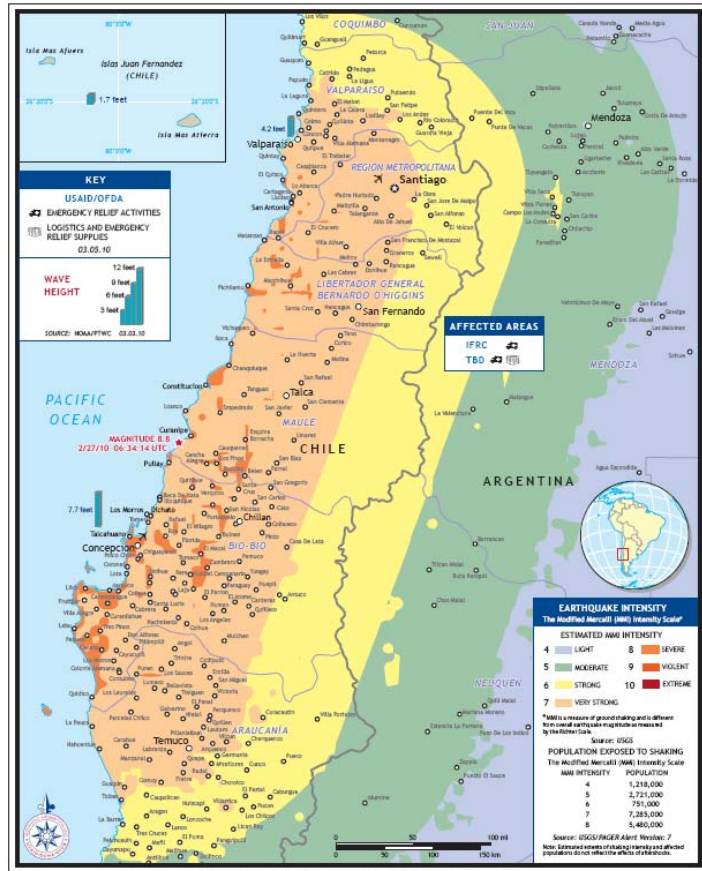
Uninhabitable residential towers carry large social and economic costs. A 2005 report from EERI estimates that losses from a shallow M6.7 earthquake in Seattle would approach USD \$40 billion. A M9 megathrust event would release 5,000 to 7,000 times more energy than a M6.7.



Subduction-zone earthquakes are caused by slip between one plate as it slides under another. This is the mechanism at work in Chile, many parts of Japan, and the Pacific Northwest.

The area of strong shaking in Chile was as large as the state of California. Shaking from a Cascadia megathrust earthquake could be just as widespread, spanning from northern California to central British Columbia.

(Map courtesy USAID)



Are developed economies doing enough?



In much of the developed world there is still room for more advance preparation – both physical and financial. New Zealand and Chile both demonstrated the effect of infrastructure impairment on damage to privately-owned property; broken sewer pipes or collapsed bridges can render even undamaged buildings uninhabitable, and cause a ripple effect of business delays reaching far beyond the area of shaking.

New Zealand geologic effects
 (Photo courtesy of Holmes Group)

Financial preparation for earthquakes is surprisingly modest in much of the developed world. Only 12 percent of Californians insure their homes for earthquakes, leaving them open to economic ruin. Take-up of earthquake insurance in Japan is likewise low, at estimated rates of less than 10 percent.

While not an earthquake, of course, Hurricane Katrina showed us in stark reality the consequence of insufficient post-disaster funding: stalled economic recovery of the region as a whole. Preventing economic downturn from following a natural disaster will require continued investment in public infrastructure as well as creative ways to improve insurance penetration and provide credible financial backstops.

Preliminary estimates from New Zealand show that the 2010 earthquake is likely to spur rather than hamper overall economic development, and this is largely attributable to the broad earthquake cover provided through the Earthquake Commission, which relies both on private and public financing.

Infrastructure Investments and Room for Improvement

California and Japan have high public awareness of earthquakes, but gaps still remain in critical infrastructure. For example, in 2008, a seismic upgrade was completed for the most vulnerable point of the main water pipeline serving San Francisco, where it crosses the active Hayward fault. But if a M6.7 Northern-California earthquake were to liquefy levees in the San Joaquin River Delta, water supply to southern California could be cut by up to 40% for as long as a year.



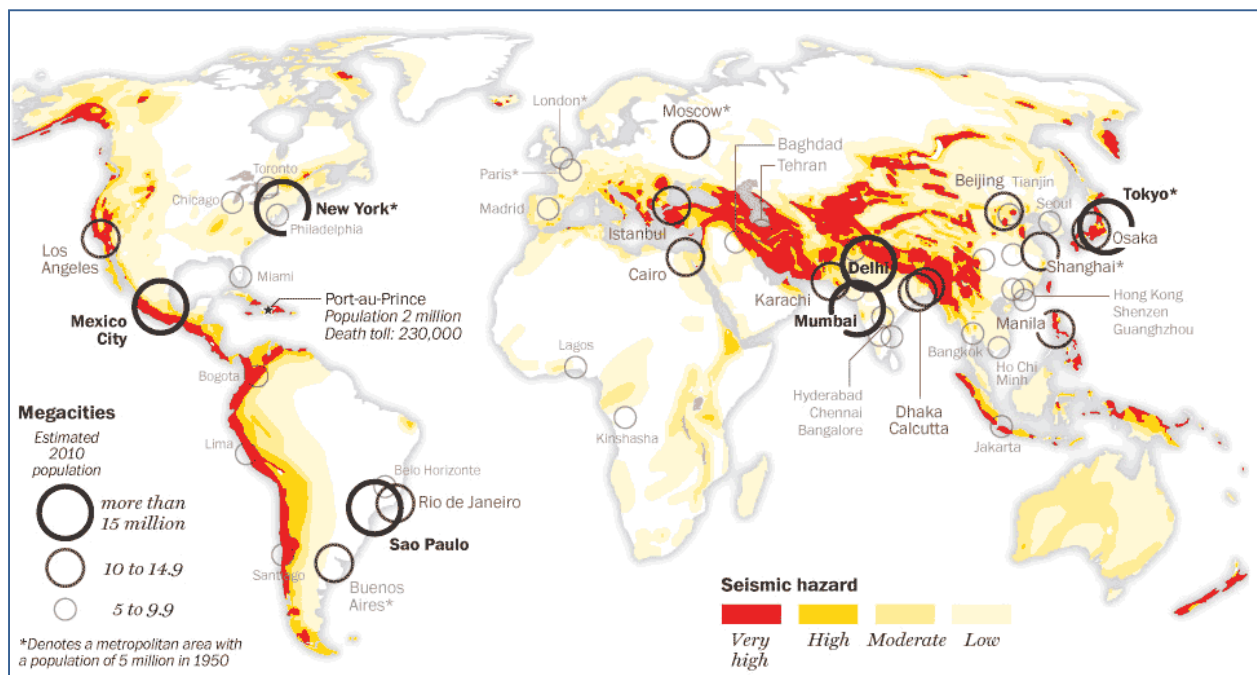
Uninsured damage, which will comprise a majority of the damage in a large California quake, affects insured losses due to widespread disruption.

(Photo courtesy of Holmes Group)

What other regions are vulnerable to disaster?

The biggest significance of the events has been to raise awareness—among both the public and the insurance industry—of the potential devastation that earthquakes can cause. Any location where high seismic hazard occurs near a densely populated area is prone to earthquake disaster.

This includes many of the capital cities in Central and South America, cities along the Himalayan front such as Dhaka and Kathmandu, cities along the Pacific trenches including Manila and Jakarta, and many cities across central Asia and along the ancient “silk road,” from Istanbul to Tehran to Kabul, and, to a lesser extent, even Beijing.



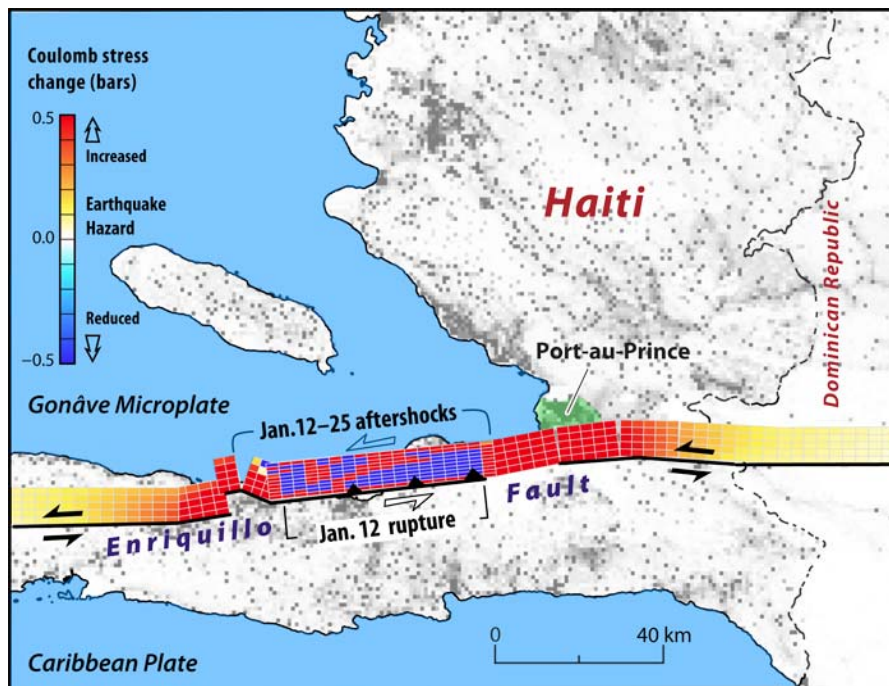
Source: *Global Seismic Hazard Assessment Program, United Nations Population Division*

Not only are these regions less financially resilient than the US and Japan, but there is less overall awareness of seismic risk and less earthquake preparation. Reducing risk will require not only public awareness campaigns but also coordinated, long-term commitment from the insurance industry – working in collaboration with public entities – to create instruments that provide immediate liquidity for recovery.

The Caribbean Catastrophe Risk Insurance Facility, which paid out USD \$8 million to the Haitian government within a week of the earthquake there, is a small first step toward broader industry participation in minimizing the long-term economic consequences of disaster.

Microinsurance is a living example of “doing well by doing good,” and its growth promises to continue in the property market.

A recent report from Swiss Re⁴ lays detailed groundwork for insurance solutions that build economic resilience even in the poorest nations. The emergence of microinsurance is a living example of “doing well by doing good,” and its growth promises to continue expanding into the property insurance market.



The 2010 earthquake in Haiti increased stress on adjacent portions of the fault, multiplying the chances of another large earthquake even closer to Port-au-Prince, within the next decades.

Image modified from Lin, Stein, Sevilgen, and Toda (2010).

⁴ Swiss Re, 2010, “Weathering climate change: insurance solutions for more resilient communities,” available at http://media.swissre.com/documents/pub_climate_adaption_en.pdf

How can we lay the foundation for earthquake risk reduction?

Minimizing physical and economic ruin from future earthquakes requires more than words, it takes coordinated investment across multiple dimensions and disciplines: awareness-building, investment in physical mitigation when it is cost-effective, and innovation in financial instruments to spur recovery. Chile and Haiti have sounded a reminder for the part each of us can play in the multi-faceted solution to reducing earthquake risk.



***Kate Stillwell** is a leader in groundbreaking, earthquake risk reduction efforts. She played a key role in the 2010 update of the EQECAT USQuake™ model, which includes the innovations of soil-based attenuation (SBA) and 3-dimensional vulnerability to reduce uncertainty, and provide the insurance/reinsurance industry with the necessary tools to set rational expectations about earthquake risk.*

EQECAT, Inc. — Corporate Headquarters

475 14th Street, Suite 550
Oakland, CA 94612-1938
USA

Phone: (510) 817-3100
information@eqecat.com
www.eqecat.com

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