

**Public Release of Estimated Impact-based Earthquake Alerts
by the U.S. Geological Survey**

David Wald¹, Kishor Jaiswal¹, Kristin Marano¹, K., Mike Hearne¹, Steve Mathias¹, David Applegate¹

Douglas Bausch²

1 U.S. Geological Survey

2 Federal Emergency Management Agency

wald@usgs.gov

The U.S. Geological Survey (USGS) has begun publicly releasing earthquake alerts for significant earthquakes around the globe based on estimates of potential casualties and economic losses. These estimates should significantly enhance the utility of the USGS Prompt Assessment of Global Earthquakes for Response (PAGER) system that has been providing estimated ShakeMaps and computing population exposures to specific shaking intensities since 2007. Quantifying earthquake impacts and communicating loss estimates (and their uncertainties) to the public has been the culmination of several important new and evolving components of the system.

First, the operational PAGER system now relies on empirically based loss models that account for estimated shaking hazard, population exposure, and employ country-specific fatality and economic loss functions derived using analyses of losses due to recent and past earthquakes. Second, human and economic loss information is now portrayed as a supplement to existing intensity/exposure content on both PAGER summary alert (available via cell phone/email) messages and web pages. Loss calculations also include estimates of the economic impact with respect to the country's gross domestic product. Third, in order to facilitate rapid and appropriate earthquake responses based on our probable loss estimates we implemented a four-level Earthquake Impact Scale (EIS). Instead of simply issuing median estimates for losses—which can be easily misunderstood and misused—this scale provides ranges of losses from which potential responders can gauge expected overall impact from strong shaking. EIS is based on two complementary criteria: the estimated cost of damage, which is most suitable for U.S. domestic events; and estimated ranges of fatalities, which are generally more appropriate for global events, particularly in earthquake-vulnerable countries. Alert levels are characterized by alerts of green (little or no impact), yellow (regional impact and response), orange (national-scale impact and response), and red (international response). Corresponding fatality thresholds for yellow, orange, and red alert levels are 1, 100, and 1000, respectively. For damage impact, yellow, orange, and red thresholds are triggered when estimated US dollar losses reach 1 million, 100 million, and 1 billion+ levels, respectively.

Finally, alerting protocols have been improved to explicitly support EIS-based alerts. Critical users can receive PAGER alerts i) based on the EIS-based alert level, in addition to or as an alternative to magnitude and population/intensity exposure-based alerts, and ii) optionally, based on user-selected regions of the world.

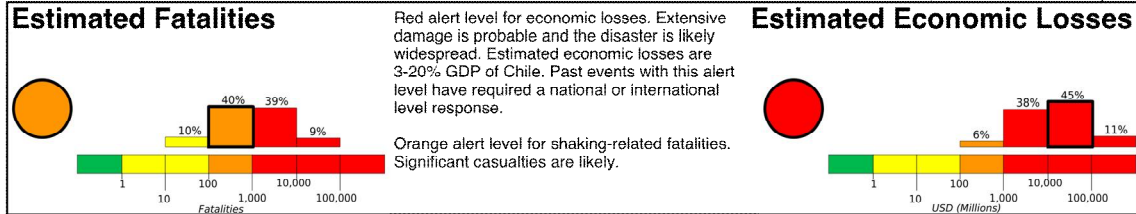
M 8.8, OFFSHORE MAULE, CHILE

Origin Time: Sat 2010-02-27 06:34:14 UTC (02:34:14 local)

Location: 35.85°S 72.72°W Depth: 35 km

PAGER
Version 3

Created: 3 hours, 10 minutes after earthquake



Estimated Population Exposed to Earthquake Shaking

ESTIMATED POPULATION EXPOSURE (k = x1000)	--*	--*	487k*	2,147k*	3,657k	6,405k	3,083k	0	0	
ESTIMATED MODIFIED MERCALLI INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+	
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very Strong	Severe	Violent	Extreme	
POTENTIAL DAMAGE	Resistant Structures	none	none	none	V. Light	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy
	Vulnerable Structures	none	none	none	Light	Moderate	Moderate/Heavy	Heavy	V. Heavy	V. Heavy

*Estimated exposure only includes population within the map area.

Population Exposure



Structures:

Overall, the population in this region resides in structures that are resistant to earthquake shaking, though some vulnerable structures exist. The predominant vulnerable building types are low-rise reinforced/confined masonry and adobe block construction.

Historical Earthquakes (with MMI levels):

Date	Dist. (km)	Mag.	Max MMI(#)	Shaking Deaths
1985-03-03	308	7.9	VIII(301k)	0
1985-03-03	352	7.0	IX(174k)	0
1985-03-03	313	7.9	VII(5,433k)	177

Recent earthquakes in this area have caused secondary hazards such as tsunamis, landslides, and liquefaction that might have contributed to losses.

Selected City Exposure

from GeoNames.org

MMI City	Population
VIII Arauco	25k
VIII Lota	50k
VIII Concepcion	215k
VIII Constitucion	38k
VII Bulnes	13k
VII Cabrero	18k
VI Temuco	238k
VI Valparaiso	282k
VI Santiago	4,837k
IV Mendoza	877k
III Neuquen	242k

bold cities appear on map

(k = x1000)

PAGER content is automatically generated, and does not consider secondary hazards in loss calculations. Limitations of input data, shaking estimates, and loss models may add uncertainty.

<http://earthquake.usgs.gov/pager>

FOR TSUNAMI INFORMATION, SEE: tsunami.noaa.gov

Event ID: us2010ftan

Example red alert PAGER summary figure showing population density and contoured intensity level (lower left), total population exposed per color-coded intensity level (middle), selected cities with population and intensity level (lower right), vulnerable structures and relevant historical earthquakes (middle right) and the color-coded impact scale indicated the alert level (top). The alert level is based on the median loss estimates; the uncertainty in the alert level can be gauged by the histogram.