



Estimating ground shaking intensity for real-time loss estimation



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The concept of QLARM Earthquake Loss Assessment for Response and Mitigation

The QLARM computer program and its standard world dataset will be available for use by expert users. Its purpose is to calculate mean damage to the built environment and human losses in case of earthquakes anywhere in the world in real time and scenario mode.

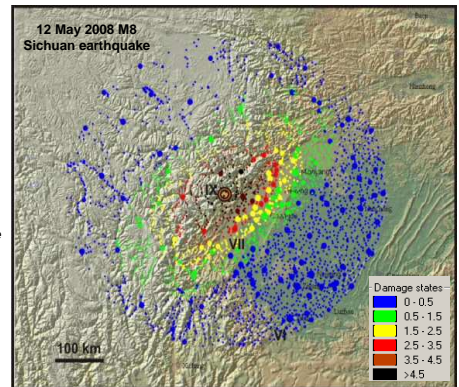
The world data sets we are currently updating include :

- (1) Regional earthquake source properties.
- (2) Attenuation of seismic waves.
- (3) Local soil conditions.
- (4) Population.
- (5) Building stock.
- (6) Critical facilities (hospitals, schools, airports, etc.)

Since 2003, 390 loss reports after major earthquakes worldwide have been posted with an average delay of 28 minutes.

Map provided by the WAPMERR alert after the earthquake.
The size of the dots is proportional to population.

	Revised Real Time Report Delay : 4h39mn	Situation Report updated July 16
Fatalities	20,000 – 90,000	88,678
Injured	40,000 – 200,000	374,176



Loss estimates we compute contain a map showing the average degree of damage in settlements near the epicenter, the total number of fatalities, the total number of injured, and a detailed list of the casualties and damage rates in these settlements (see the example for the Sichuan 2008 earthquake).

QLARM Intensity Calculation

The various options for estimating shaking intensity that will be available with QLARM are:

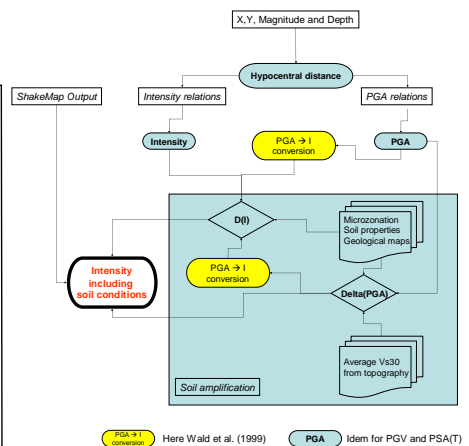
- 1) direct intensity relationships (e.g. Shebalin (1975)),
- 2) two-stage approach of first predicting PGA/PGV and then converting to intensity and
- 3) using ShakeMap output files generated by the USGS Global ShakeMap system as shown in the flow chart.

The attenuation database will contain:

- (1) Well-known attenuation relationships that the user may select.
- (2) Regional attenuation relationships that have been reviewed by our team.

The local soil condition database will include :

- (1) Average Vs30 value for each settlements based on topographic slope data and its related soil amplification factors.
- (2) Soil amplification factors derived from microzonation maps, geotechnical and geological data. In this case, a city is divided in different sectors in accordance with population and building stock data.



Calibration of QLARM

General attenuation relationships are :

SheC1_C2_C3 Shebalin, N.V. (1975). Estimating seismic intensity, in: Nazarov, A.G., Shebalin, N.V. (Eds.), Seismic Scale and Methods for Estimating Seismic Intensity [in Russian]. Nauka, Moscow, 87-109. ($I = C1 M - C2 \log(\sqrt{(r^2+h^2)}) + C3$)

Y97 Youngs, R. R., S.-J. Chiu, W. J. Silva, and J. R. Humphrey (1997). Strong ground-motion relationships for subduction zones. Seism. Res. Letters, 68, No. 1, 58-73.

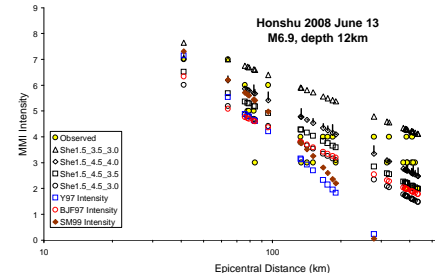
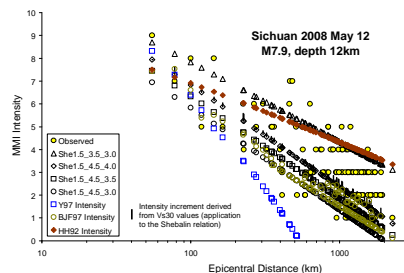
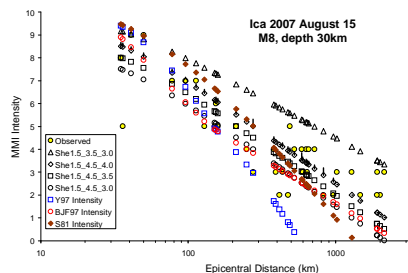
BJF97 Boore, D. M., W. B. Joyner, and T. E. Fumal (1997). Equations for estimating horizontal response spectral and peak acceleration from western North American earthquakes: A summary of recent work. Seism. Res. Letters, 68, 128-153.

Regional attenuation relationships are :

S81 Saragoni, R., M. Crempian, and Araya (1981). Características de los movimientos fuertes en Chile. Publ. SES 1-2/81 (164).

HH92 Huo, J. and Y. Hu (1992). Study on attenuation laws of ground motion parameters. Earthquake Engineering and Engineering Vibration, 12, 1-11.

SM99 Si, H. and S. Midorikawa (1999). Attenuation Relations for Peak Ground Acceleration and Velocity Considering Effects of Fault Type and Site Condition. Journal of Struct. Construct. Eng. (Transactions of AIJ), No. 523, 63-70 (in Japanese).



We evaluate the performance of the direct and two-stage intensity estimation methods by comparing estimated and observed intensities for three reported earthquakes.

Observed intensities are provided by the Community Internet Intensity Map (CIIM) of the USGS. Site amplification is accounted for by using topographically-derived Vs30 averaged value for each reported city. General attenuation relationships are compared with locally-derived ground motion prediction equations.

Discussions and Perspectives

The direct intensity relationship of Shebalin (1975) matches the observation in the three cases by adapting the parameters of the regression to the regional context.

The general relationships (BJF97 and Y97) fit the observations at epicentral distances shorter than 100km and underestimate the lower observed intensities.

The regional attenuation relationships used for the three earthquakes are not robust enough to predict the observed intensities.

We propose to select general and regional relationships by testing the robustness of the ground shaking model with a set of earthquakes for which observations at short distances (less than 50 km) are available. The existing relations to convert ground shaking into intensity will also be investigated to be compatible with the EMS98 vulnerability models used by QLARM.