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A new method for the production of social fragility functions and the result of its use in worldwide fatality loss estimation for earthquakes

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A review of over 200 fatality models over the past 50 years for earthquake loss estimation from various authors has identified key parameters that influence fatality estimation in each of these models. These are often very specific and cannot be readily adapted globally.
In the doctoral dissertation of the author, a new method is used for regression of fatalities to intensity using loss functions based not only on fatalities, but also using population models and other socioeconomic parameters created through time for every country worldwide for the period 1900-2013. A calibration of functions was undertaken from 1900-2008, and each individual quake analysed from 2009-2013 in real-time, in conjunction with www.earthquake-report.com.
Using the CATDAT Damaging Earthquakes Database containing socioeconomic loss information for 7208 damaging earthquake events from 1900-2013 including disaggregation of secondary effects, fatality estimates for over 2035 events have been re-examined from 1900-2013. In addition, 99 of these events have detailed data for the individual cities and towns or have been reconstructed to create a death rate as a percentage of population.
Many historical isoseismal maps and macroseismic intensity datapoint surveys collected globally, have been digitised and modelled covering around 1353 of these 2035 fatal events, to include an estimate of population, occupancy and socioeconomic climate at the time of the event at each intensity bracket. In addition, 1651 events without fatalities but causing damage have also been examined in this way.
The production of socioeconomic and engineering indices such as HDI and building vulnerability has been undertaken on a country-level and state/province-level leading to a dataset allowing regressions not only using a static view of risk, but also allowing for the change in the socioeconomic climate between the earthquake events to be undertaken. This means that a year 1920 event in a country, will not simply be regressed against a year 2000 event, but normalised.
A global human development index (HDI) (life expectancy, education and income) was developed and collected for the first time from 1900-2013 globally on a country and province level allowing for a very useful parameter in the regression. In addition, the occupancy rate from the time of day that the event occurred, as well as population density and individual earthquake attributes like the existence of a foreshock were also examined for the 3004 events in the regression analysis.
Where an event has not occurred in a country previously, a regionalisation strategy based on building typologies, seismic code index, building practice, climate, earthquake history and socioeconomic climate is proposed.
The result is a set of “social fragility functions” calculating fatalities for use in any country worldwide using the parameters of macroseismic intensity, population, HDI, time of day and occupancy, that provide a robust accurate method, which has not only been calibrated to country level data but to town and city data through time. The estimates will continue to be used in conjunction with Earthquake Report, a non-profit worldwide earthquake reporting website and has shown very promising results from 2010-2013 for rapid estimates of fatalities globally.