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A stochastic risk assessment for Eastern Europe and Central Asian countries for earthquakes

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This systematic assessment of earthquake risk for 33 countries in the ECA region was motivated by the interest of the World Bank and the Global Facility for Disaster Reduction and Recovery (GFDRR) in supporting Disaster Risk Management (DRM) efforts. They envisaged an exposure-based analysis that looked at the potential economic and/or social exposure of the populations of various countries to earthquake risk.

Using a stochastic earthquake hazard model and historical catalogues, a unified earthquake catalogue was created for the 33 countries. A combined fault and background source model was created using data from many authors. The maximum magnitude and seismotectonic source zone discretization was undertaken using logic tree approaches. Site effects were taken into account on the basis of local topography and tectonic regime. Two approaches were used to calculate local ground motion – intensity prediction equations for MMI and a combination of GMPEs for stable and active settings.

A 1km grid was used for analysis with aggregations of exposure quantified in terms of GDP and capital stock using disaggregated provincial analysis from CATDAT, as well as population data from Deltares. Vulnerability functions were calculated using socio-economic empirical functions derived by Daniell (2014) for the countries taking into account historical losses, seismic resistant code implementation and building typologies in each country.

PML curves were created for each province in the 33 nations, through 3 methods; the 1st using direct historical values via the CATDAT Damaging Earthquakes Database; the 2nd using normalization procedures in order to provide a quick estimate of the historical record quantified in today's terms filling in gaps; and the 3rd being a traditional stochastic modelling approach over a period of 10,000 years taking all uncertainties into account.
SSP projections of growth from the OECD were used to quantify the risk in 2010, 2030 and 2080 in order to examine future loss potential. Four loss metrics were quantified as PML curves – (1) Population affected in damaged areas (I>6), (2) GDP affected in damaged areas (I>6), (3) Deaths, (4) Economic Losses.

The approach taken has large uncertainties, as with any stochastic earthquake risk analysis, and more detailed and refined analysis can be undertaken in any one of the countries, but the approach showed a ballpark figure for planning and development as well as a view as to expected losses where existing detailed models do not exist.