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Seismic hazard and risks estimates for Himalayas and surrounding regions based on the Unified Scaling Law for Earthquakes

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The parameters A, B, and C of the Unified Scaling Law for Earthquakes (USLE) in Himalayas and surrounding regions have been studied on the basis of a variable space and time scale approach. The basic law of seismicity, the Gutenberg-Richter recurrence relation, is suggested in a modified form involving a spatial term: log N(M,L) = A – B•(M-6) + C•log L, where N(M,L) is the expected annual number of mainshocks of a certain magnitude M within an area of linear size L. The observed temporal variability of the A, B, C coefficients indicates significant changes of seismic activity at the time scales of a few decades. For Himalayan region, the value of A ranges between -1.95 to -0.66, which determines the average rate of earthquakes that accordingly differs by a factor of 20 or more. The value of B mainly ranges between 0.5 to 1.7, while the fractal dimension of the local seismic prone setting, C, changes from under 1 to 1.4 and larger. We have used the deterministic approach to estimate the corresponding peak ground acceleration (PGA) from the estimated A, B and C based magnitude and the maximum observed magnitude during 1900-2012 to prepare the seismic hazard map of Himalayas with spatially distributed PGA. Further an attempt is made to generate the earthquake risk maps of the region based on the population density exposed to the seismic hazard.

Any kind of risk estimates R(g) at location g results from a convolution of the natural hazard H(g) with the exposed object under consideration O(g) along with its vulnerability V(O(g)). Note that g could be a point, or a line, or some area on or under the Earth surface and that distribution of hazards, as well as objects of concern and their vulnerability, could be time-dependent. There exist many different risk estimates even if the same object of risk and the same hazard are involved. Specifically, it may result from the different laws of convolution, as well as from different kinds of vulnerability of an object of risk under specific environments and conditions. Both conceptual issues must be resolved in a multidisciplinary problem oriented research performed by specialists in the fields of hazard, objects of risk, and object vulnerability. Here, to illustrate this general concept, we perform the following oversimplified four convolutions of seismic hazard assessment map H(g) in a cell g with the population density distribution P: (i) H(g)•gP, where gP is the integral of the population density over the cell g; (ii) H(g)•gP•P ; (iii) H(g)•gP•P•P; and (iv) H(g)•gP•P•P•P. We have to emphasize that the estimations addressing more realistic and practical kinds of seismic risk, not presented here, should involve experts in distribution of objects of risk of different vulnerability, i.e. specialists in earthquake engineering, social sciences and economics.