ESC2016-327-2, 2016
35th General Assembly of the European Seismological Commission

Partition of strain rates in Southwestern Canada for new regional earthquake hazard models

Simone Barani (1), Yan Jiang (2), Thomas S. James (2), and John F. Cassidy (2)

(1) Università degli Studi di Genova, DISTAV, Genova, Italy (barani@dipteris.unige.it), (2) Natural Resources Canada, Pacific Geoscience Centre, 9860 West Saanich Road, Sidney, B.C

The earthquake source model, which describes the spatial and temporal distribution of earthquakes in a region (or on a fault), is of central importance in probabilistic seismic hazard analysis (PSHA). Its definition involves specifying an earthquake recurrence relation, indicating the frequency with which various magnitude levels are exceeded over a given period of time. The choice of a recurrence relation is not an easy task as different relations may be representative of the earthquake distribution in the area. In addition, various forms of data (seismologic, geological, geophysical) and/or alternative methods can be employed to estimate the values of the parameters of a recurrence relation. For instance, earthquake recurrence parameters (e.g., b-value of the log-linear Gutenberg and Richter relation, earthquake occurrence rate above a minimum threshold magnitude) are generally evaluated on the basis of historical seismicity while maximum magnitude values can be determined from geologic data, geophysical data, or simply by increasing the maximum observed magnitude by an amount based on professional judgment. Therefore, a seismicity model should be analyzed to ensure that it is consistent with all available data. To this end, it may be useful to express earthquake size in terms of seismic moment. Thus, it is possible to compare seismic moment rates (or strain rates) with independent estimates derived from geology or geodetic measurements.

While the potential of geodetic data in PSHA is nowadays well known, their actual application is limited due to complexity in separating the aseismic contribution from the seismic one. In fact, it is observed that the ratio of the seismic moment release rate to the moment rate estimated from geodetic measurements is often lower than unity in many regions of the world. Hence, some strategies should be adopted to remove the aseismic contribution from geodetic rates, thus to implement them into a PSHA model. Neglecting doing so might imply an overestimation of the "true" (yet unknown) hazard. In this study, we compare strain rates from three main regions in Southwestern Canada and the US: Puget Sound, Vancouver Island, and the South zone of the Foreland Belt. The scope is the definition of a new hazard model that integrates geodetic data. To this end, strain rates computed from smoothed historical seismicity are compared with strain rates from GPS data. While the first two areas are regions where seismic and geodetic strain rates are found to agree, geodetic strain rate is three times faster than seismic strain rate in the third region. By comparing Glacier Isostatic Adjustment (GIA) models with different viscosity profiles, we make a quantitative estimate of strain rates caused by GIA versus seismic events. Geodetic strain rates can be accommodated by a lateral heterogeneous GIA model in this region. Such a contribution should be separated from the total geodetic deformation, not to overestimate the rate of earthquake occurrence used in future hazard assessments.