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Comparison of Methodologies to Compute the Probabilistic Seismic Hazard Involving Faults and Associated Uncertainties

Authors : Aude Gounelle, Gloria Senfaute, Ludivine Saint-Mard, Thomas Chartier

Abstract : The long-term deformation rates of faults are not fully captured by Probabilistic Seismic Hazard Assessment (PSHA). PSHA that use catalogues to develop area or smoothed-seismicity sources is limited by the data available to constraint future earthquakes activity rates. The integration of faults in PSHA can at least partially address the long-term deformation. However, careful treatment of fault sources is required, particularly, in low strain rate regions, where estimated seismic hazard levels are highly sensitive to assumptions concerning fault geometry, segmentation and slip rate. When integrating faults in PSHA various constraints on earthquake rates from geologic and seismologic data have to be satisfied. For low strain rate regions where such data is scarce it would be especially challenging. Faults in PSHA requires conversion of the geologic and seismologic data into fault geometries, slip rates and then into earthquake activity rates. Several approaches exist for translating slip rates into earthquake activity rates. In the most frequently used approach, the background earthquakes are handled using a truncated approach, in which earthquakes with a magnitude lower or equal to a threshold magnitude (Mw) occur in the background zone, with a rate defined by the rate in the earthquake catalogue. Although magnitudes higher than the threshold are located on the fault with a rate defined using the average slip rate of the fault. As high-lighted by several research, seismic events with magnitudes stronger than the selected magnitude threshold may potentially occur in the background and not only at the fault, especially in regions of slow tectonic deformation. It also has been known that several sections of a fault or several faults could rupture during a single fault-to-fault rupture. It is then essential to apply a consistent modelling procedure to allow for a large set of possible fault-to-fault ruptures to occur aleatory in the hazard model while reflecting the individual slip rate of each section of the fault. In 2019, a tool named SHERIFS (Seismic Hazard and Earthquake Rates in Fault Systems) was published. The tool is using a methodology to calculate the earthquake rates in a fault system where the slip-rate budget of each fault is conversed into rupture rates for all possible single faults and faultto-fault ruptures. The objective of this paper is to compare the SHERIFS method with one other frequently used model to analyse the impact on the seismic hazard and through sensibility studies better understand the influence of key parameters and assumptions. For this application, a simplified but realistic case study was selected, which is in an area of moderate to hight seismicity (South Est of France) and where the fault is supposed to have a low strain.

Keywords : deformation rates, faults, probabilistic seismic hazard, PSHA
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