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Procedure for fault-based PSHA in complex tectonic regimes (e.g. Western Anatolia): Implications of activity rate characterization

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Both extensional and compressional tectonic regimes display rather complex fault geometries including multiple sets of inclined active faults and pose a challenge for accurate representation of seismogenic sources for fault-based probabilistic seismic hazard assessment (PSHA). In the absence of individual fault slip rates and presence of only sparse seismic and geodetic data, calculation and distribution of activity rate in these regimes also includes a considerable amount of uncertainty. In this study, a detailed PSHA with sensitivity analyses of activity rate has been carried out at the northern margin of Western Anatolian Extensional Province. First, fault segments and systems are defined using connections between available active fault traces and first order geological complexities. The down-dip extent and dip of faults are determined using available earthquake depths and focal mechanism solutions respectively. Next, three alternative approaches (slip rate, seismic rate, moment rate) are employed to determine the activity rates for each sub-region. Later, calculated activity rates are partitioned among fault systems using two different approaches based on the fault morphology and the length of fault trace. Finally, proposed seismic source characterizations are incorporated into the hazard integral and peak ground acceleration (PGA) maps for 475-year return period are provided for each alternative. According to our results, slip based activity rates translate into high hazard estimates and more uniform distribution of PGA values, while seismicity and moment rate based hazard maps are more sensitive to the occurrence of large magnitude earthquakes in the region. Also, the effect of the approach utilized to partition activity rate is only noticeable at areas where strong asymmetric fault activity is inferred from morphology. As a result, a fault-based PSHA procedure that provides weighted, maximum and minimum PGA value maps incorporating activity rates from all the methods is established to evaluate and minimize the bias on hazard estimates of complex tectonic regimes in the current practice.