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Deterministic versus probabilistic seismic hazard assessment for the Shillong Plateau

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The Shillong Plateau is an earthquake-prone region in the northeastern India. Based on regional seismotectonic studies, we present the results of seismic hazard assessment, both deterministic (DSHA) and probabilistic (PSHA), and map peak horizontal accelerations (PHA) for three largely populated districts within the Shillong Plateau - the East Khasi hills, the Ri-Bhoi, and the West Garo hills. The hazard analysis methodology is based on the analysis of 72 earthquake sources (active faults) located within 500 km seismotectonic region around the plateau. Using an average sample log-likelihood approach, suitable ground motion prediction equations (GMPEs) are identified. As a variation in hypocentral distances can affect the ranks (or weights) of selected GMPEs, DSHA is performed separately for the three selected districts. DSHA shows that the northern part of the East Khasi hills, eastern part of Ri-Bhoi district and the West Garo hills districts exhibit the highest PHA value. DSHA indicates that the Barapani, Oldham, and Dauki faults influence significantly the seismic hazard of the studied region. In the case of PSHA, the annual frequency of exceedance of ground motions for three populated cities (Shillong city, Nongpoh, and Tura), located within above three districts respectively, are determined. Individual hazard curves indicate that the Barapani fault possesses the highest frequency of seismic hazard for Shillong city and Nongpoh. At Tura, both Eocene hinge zone and Dauki faults are responsible for the highest frequency of seismic hazard. The results of the PSHA are compared with those obtained using the DSHA approach indicating a difference between the two approaches for the West Garo hills district. It is shown that this difference is associated with the Oldham fault located near the district. The fault can produce a great earthquake, although with a lower probability of occurrence compared to a few other faults capable of producing smaller events with higher probability of occurrence. Hence, in the PSHA, the effect of the Oldham fault is less pronounced in terms of the design life of a structure, than in the case of the DSHA.