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Probability of distributed surface rupturing occurrence and displacement regression for dip-slip earthquakes

Fiia Nurminen[1], Francesco Visini[2], Stéphane Baize[3], Paolo Boncio[1], Bruno Pace[1], Oona Scotti[3], and Alessandro Valentini[1]

[1]University of Chieti, DiSPuTer, Chieti, Italy (fiia.nurminen@unich.it)
[2]INGV—Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Pisa, Pisa, Italy
[3]IRSN—Institut de Radioprotection et de Su□reté Nucléaire, Fontenay-aux-Roses, France

Probabilistic fault displacement hazard analysis (PFDHA) estimates the probability of occurrence and the expected exceedance of on-fault (principal fault rupturing; PF) and off-fault (dist ributed rupturing; DR) surface displacement during an earthquake. Here we concent rate on off-fault rupturing on dip-slip earthquakes, and present an original probability model for the occurrence of DR and for the expected exceedance of displacement dist ribution based on an approach named “slicing” (an alternative to the “gridding” approach commonly used). The method is developed based on the compilation and reappraisal of surface ruptures from 32 historical crustal dip-slip earthquakes, with magnitudes ranging from M_w 4.9 to 7.9. A ranking scheme is applied to distinguish PF (rank 1) from simple DR (rank 2) and t riggered faulting (rank 3). Thus modellers can use prediction equations based on or excluding ruptures st rongly related to local st ructural setting depending on the site of concern. In the case of a st ructural setting at a site where large-scale bending (rank 21, 22) and pre-existing faults (rank 1.5, 3) is considered irrelevant, modelling can be performed considering only the unpredictable DR (rank 2). To minimize bias due to the incomplete nature of the database, we int roduce the “slicing” approach, which considers that the probability of having a surface rupture within slices parallel to the PF is homogeneous along the st rike of each slice. “Slicing” probabilities, computed as a function of magnitude of the earthquake and distance from the PF, are then combined with Monte Carlo simulations that model the dependence of the probability of occurrence of rupture and exceedance of displacement with the dimensions and position of the site of interest with respect to the PF. Finally, both probabilities are combined with existing predictive equations of exceedance of displacement on the PF to calculate fault-displacement hazard curves for sites of interest.