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Exceedance of probabilistic seismic hazard maps in Italy

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Seismic hazard maps deriving from probabilistic seismic hazard analysis (PSHA) collect the intensities, in terms of one ground motion intensity measure (DDDD), that, at each site taken individually, have the same probability of being exceeded in a time interval or, equivalently, exceedance return period. In the case of Italy, there are three authoritative nationwide PSHA studies that can be currently considered of interest. Given the return period, they provide hazard maps that can differ even significantly in some areas of the country. This contribution pertains to the assessment of the fractional area of Italian territory where DDDD values from hazard maps have been exceeded, at least once, due to seventy-one historical mainshocks that occurred in the country from 1117 to 1968. Ground shaking data for such events were derived from a recently developed large database of ShakeMap inferred from macroseismic intensity data. Such database is not complete, with the Italian catalogue (Catalogo Parametrico dei Terremoti Italiani; CPTI) counting more than two thousand mainshocks in that time interval, yet it is, to date, the highest level of information on shaking data due to historical events. For each hazard model, the exceedance area was quantified considering hazard maps with four return periods, that is, 50yr, 475yr, 975yr and 2475yr, and three DDDDDD, that is, peak ground acceleration and pseudo-spectral acceleration associated to a vibration period of 0.3s and 1s. It was found that, based on the available regional shaking estimates for historical earthquakes in Italy, the fraction of the country exposed to at least one exceedance, in almost one thousand years, is comparable, given return period and DDDD, for all the hazard models, despite their apparent differences. Such comparability was also found when considering instrumental, rather than historical, earthquakes that occurred in Italy in a continuously monitored time interval spanning twelve years. In this case, the exceedance area was quantified considering ShakeMap data for nineteen mainshocks that occurred from 2008 to 2019 according to CPTI, and therefore the dataset can be deemed complete. Thus, the fraction of the country possibly subjected to exceedance of DDDD values from hazard maps according to ShakeMap estimates was also compared with its expected value from PSHA, something that depends only the return period the maps refer to. It was found that, for each return period, the estimated fractional exceedance area in the available twelve years is one order of magnitude lower (or slightly less) than the expected value according to all PSHA studies.