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Consecutive earthquake triggering in the 2012 Northern Italy seismic sequence: new insight on seismic hazard estimation in Italy

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The 2012, Emilia (Italy) earthquake sequence was composed by seven mainshocks of magnitude M>5, rupturing adjacent fault segments for a total length of about 50 km. We show that the mainshock sequence represents an exceptionally clear case of consecutive triggering, due to static Coulomb stress changes. Such an evidence of consecutive triggering can be observed, although in a less clear way, in almost all the Italian earthquake sequences observed by modern seismic instrumentation, starting from the Ml=6.9 1980 Irpinia earthquake. In all these sequences, the total lenght of the fractured fault zone is always approximately the same, i.e. about 50 km. In one case, namely the Irpinia 1980 earthquake, three consecutive subevents on two parallel anthitetic faults were consecutively triggered at intervals of about 20 seconds. The longest sequence was the 1997-1998 Umbria Marche, with a sequence of shocks of magnitude larger than 5 lasting about one year. These observations suggest that seismic hazard determination must take into account the possibility that sevral mainshocks are triggered consecutively, i.e. each one triggered by Coulomb stress transfer just after the previous one. In this case, structures are solicited by consecutive wave trains, increasing their acceleration amplitude due to resonance. We show this effect is very effective, increasing substantially the seismic risk in Italy, with respect to actual calculations based on historical catalogues biased by poor sampling of strong earthquakes.