# Likely near-simultaneous earthquakes complicate seismic hazard planning for Italy

September 1 2014

Before the shaking from one earthquake ends, shaking from another might begin, amplifying the effect of ground motion. Such sequences of closely timed, nearly overlapping, consecutive earthquakes account for devastating seismic events in Italy's history and should be taken into account when building new structures, according to research published in the September issue of the journal *Seismological Research Letters* (*SRL*).

"It's very important to consider this scenario of earthquakes, occurring possibly seconds apart, one immediately after another," said co-author Anna Tramelli, a seismologist with the Istituto Nazionale di Geofisica e Vulcanologia in Naples, Italy. "Two consecutive mainshocks of magnitude 5.8 could have the effect of a magnitude 6 earthquake in terms of energy release. But the effect on a structure could be even larger than what's anticipated from a magnitude 6 earthquake due to the longer duration of shaking that would negatively impact the resilience of a structure."

Historically, multiple triggered mainshocks, with time delays of seconds to days, have caused deadly earthquakes along the Italian Apennine belt, a series of central mountain ranges extending the length of Italy. The 1997-98 Umbria-March seismic sequence numbered six mainshocks of moderate magnitude, ranging M 5.2 – 6.0. The 1980 Irpinia earthquakes included a sequence of three events, occurring at intervals within 20 seconds of each other. The 2012 Emilia sequence started with an M 5.9 event, with the second largest mainshock (M 5.8) occurring nine days later, and included more than 2000 aftershocks.

In this study, Tramelli and her colleagues used the recorded waveforms from the 2012 Emilia seismic sequence to simulate a seismic sequence that triggered end-to-end earthquakes along adjacent fault patches, observing the affect of continuous ruptures on the resulting ground motion and, consequently, its impact on critical structures, such as dams, power plants, hospitals and bridges.

"We demonstrated that consecutively triggered earthquakes can enhance the amount of energy produced by the ruptures, exceeding the design specifications expected for buildings in moderate seismic hazard zones," said Tramelli, whose analysis suggests that the shaking from multiple magnitude 5.0 earthquakes would be significantly greater than from an individual magnitude 5.0 event.

And back-to-back earthquakes are more than theoretical, say the authors, who note that this worst-case scenario has happened at least once in Italy's recent history. Previous studies identified three sub-events at intervals of 20 seconds in the seismic signals recorded during the 1980 Irpinia earthquake sequence, whose shared ground motion caused more than 3000 deaths and significant damage to structures.

A "broader and modern approach" to seismic risk mitigation in Italy, suggest the authors, would incorporate the scenario of multiple triggered quakes, along with the present understanding of active fault locations, mechanisms and interaction.

**More information:** "The 2012 Emilia (Italy) quasi-consecutive triggered mainshocks: implications for seismic hazard," will appear in the September issue of *SRL*, which is published by the Seismological Society of America. DOI: 10.1785/0220140022