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Short-term earthquake risk assessment considering time-dependent b-values

Laura Gulia, Thessa Tormann, and Stefan Wiemer
Swiss Seismological Service, ETH, Zurich, Switzerland (gulia@ethz.ch)

Observations from laboratory experiments measuring acoustic emissions during loading cycles in pressurized rock samples have repeatedly suggested that small events in the precursory phase of an impending large event change in their relative size distribution. In particular, they highlight a systematic b-value decrease during the stress increase period before the main event. A number of large natural events, but not all of them, have been shown to have a precursory decrease in the b-value at very different time scales, from months to a few days before the subsequent mainshock.

At present short term-forecast models such as STEP and ETAS consider the generic probability that an event can trigger subsequent seismicity in the near field; the rate increasing during the foreshock sequences can offer a probability gain for a significant earthquake to happen. While the probability gain of a stationary Poissonian background is substantial, selected case studies have shown through cost-benefit analysis that the absolute probability remains too low to warrant actions. This was shown for example by van Stiphout et al. (2010, GRL), for the 2009 a Mw 6.3 earthquake that hit the city of L'Aquila (Central Italy) after three months of foreshock activity. We here analyze the probability gain of a novel generation of short term forecast models which considers both the change in the seismicity rates and the temporal changes in the b-value. Changes in earthquake probability are then translated also into time-dependent hazard and risk. Preliminary results suggest that the precursory b-value decrease in the L'Aquila case results in an additional probability increase of a M6.3 event of about a factor of 30-50, which then surpasses the cost-benefit threshold for short-term evacuation in selected cases.