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On the adaptive daily forecasting of seismic aftershock hazard

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Post-earthquake ground motion hazard assessment is a fundamental initial step towards time-dependent seismic risk assessment for buildings in a post main-shock environment. Therefore, operative forecasting of seismic aftershock hazard forms a viable support basis for decision-making regarding search and rescue, inspection, repair, and re-occupation in a post main-shock environment. Arguably, an adaptive procedure for integrating the aftershock occurrence rate together with suitable ground motion prediction relations is key to Probabilistic Seismic Aftershock Hazard Assessment (PSAHA). In the short-term, the seismic hazard may vary significantly (Jordan et al., 2011), particularly after the occurrence of a high magnitude earthquake. Hence, PSAHA requires a reliable model that is able to track the time evolution of the earthquake occurrence rates together with suitable ground motion prediction relations.
This work focuses on providing adaptive daily forecasts of the mean daily rate of exceeding various spectral acceleration values (the aftershock hazard). Two well-established earthquake occurrence models suitable for daily seismicity forecasts associated with the evolution of an aftershock sequence, namely, the modified Omori's aftershock model and the Epidemic Type Aftershock Sequence (ETAS) are adopted. The parameters of the modified Omori model are updated on a daily basis using Bayesian updating and based on the data provided by the ongoing aftershock sequence based on the methodology originally proposed by Jalayer et al. (2011). The Bayesian updating is used also to provide sequence-based parameter estimates for a given ground motion prediction model, i.e. the aftershock events in an ongoing sequence are exploited in order to update in an adaptive manner the parameters of an existing ground motion prediction model. As a numerical example, the mean daily rates of exceeding specific spectral acceleration values are estimated adaptively for the L'Aquila 2009 aftershock catalog. The parameters of the modified Omori model are estimated in an adaptive manner using the Bayesian updating based on the aftershock events that had already taken place at each day elapsed and using the Italian generic sequence (Lolli and Gasperini 2003) as prior information. For the ETAS model, the real-time daily forecast of the spatio-temporal evolution of the L'Aquila sequence provided for the Italian Civil Protection for managing the emergency (Marzocchi and Lombardi, 2009) is utilized. Moreover, the parameters of the ground motion prediction relation proposed by Sabetta and Pugliese (1996) are updated adaptively and on a daily basis using Bayesian updating based on the ongoing aftershock sequence. Finally, the forecasted daily rates of exceeding (first-mode) spectral acceleration values are compared with observed rates of exceedance calculated based on the wave-forms that have actually taken place.

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