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Time-dependent seismic hazard using synthetic catalogs for the broader Aegean area: Quantifying the effect of uncertainty of time-dependent mainshock predictions on seismic hazard

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We examine the effect of time-dependent seismicity on seismic hazard using a revised synthetic catalogue approach. The synthetic catalogues are generated using a crude Monte-Carlo approach, having specific characteristics regarding their spatiotemporal and magnitude distribution. Seismic hazard estimates are computed by direct computation of expected ground motions for each site of interest, using the complete dataset of each involved catalogue.
The approach is initially validated using comparisons with conventional seismic hazard algorithms for time-independent seismic hazard assessment. For this reason synthetic catalogues using a Poisson time distribution are used, adopting the spatial and magnitude seismicity distribution of a revised zonation model for the broader Aegean area. The results verify the applicability of the proposed approach, as well as its potential for improved estimates for complex seismotectonic settings (subduction zones, etc.). Furthermore, we demonstrate the possibility to stabilize the noise introduced into the hazard estimates from the random catalogue variability by introducing modified hazard estimates from the application of Gumbel's 1st-type extreme value distribution. As a second step catalogues with specific spatiotemporal characteristics are examined, where we assume that mainshocks above a certain cut-off magnitude (e.g. M>6.0) can be predicted, even with large space-time-magnitude uncertainties and significant false-alarm probabilities, while lower magnitude events are following a time-independent pattern. The proposed approach allows to quantitatively estimate the independent and combined effect of both prediction uncertainties and false-alarms on seismic hazard. The obtained results for the broader Aegean area suggest that even for relatively large prediction uncertainties and false alarm probabilities for mainshocks, a significant portion of the "real" seismic hazard is recovered, allowing the approximate identification of areas that will be mostly affected by the expected mainshocks, at least for the examined mainshock scenarios. This observation suggests that the consideration of even approximate mainshock prediction estimates may be practically useful for time-dependent hazard assessment