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Fault-based PSHA of an active tectonic region characterized by low deformation rates: the case of the Lower Rhine Graben

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The Lower Rhine Graben (LRG) is one of the few regions in intraplate NW Europe where seismic activity can be linked to active faults, yet probabilistic seismic hazard assessments of this region have hitherto been based on area-source models, in which the LRG is modeled as a single or a small number of seismotectonic zones with uniform seismicity. While fault-based PSHA has become common practice in more active regions of the world (e.g., California, Japan, New Zealand, Italy), knowledge of active faults has been lagging behind in other regions, due to incomplete tectonic inventory, low level of seismicity, lack of systematic fault parameterization, or a combination thereof. The past few years, efforts are increasingly being directed to the inclusion of fault sources in PSHA in these regions as well, in order to predict hazard on a more physically sound basis. In Europe, the EC project SHARE ("Seismic Hazard Harmonization in Europe", http://www.share-eu.org/) represented an important step forward in this regard. In the frame of this project, we previously compiled the first parameterized fault model for the LRG that can be applied in PSHA. We defined 15 fault sources based on major stepovers, bifurcations, gaps, and important changes in strike, dip direction or slip rate. Based on the available data, we were able to place reasonable bounds on the parameters required for time-independent PSHA: length, width, strike, dip, rake, slip rate, and maximum magnitude. With long-term slip rates remaining below 0.1 mm/yr, the LRG can be classified as a low-deformation-rate structure. Information on recurrence interval and elapsed time since the last major earthquake is lacking for most faults, impeding time-dependent PSHA.

We consider different models to construct the magnitude-frequency distribution (MFD) of each fault: a slip-rate constrained form of the classical truncated Gutenberg-Richter MFD (Anderson & Luco, 1983) versus a characteristic MFD following Youngs & Coppersmith (1985). The summed Anderson & Luco fault MFDs show a remarkably good agreement with the MFD obtained from the historical and instrumental catalog for the entire LRG, whereas the summed Youngs & Coppersmith MFD clearly underpredicts low to moderate magnitudes, but yields higher occurrence rates for $M > 6.3$ than would be obtained by simple extrapolation of the catalog MFD. The moment rate implied by the Youngs & Coppersmith MFDs is about three times higher, but is still within the range allowed by current GPS uncertainties. Using the open-source hazard engine OpenQuake (http://openquake.org/), we compute hazard maps for return periods of 475, 2475, and 10,000 yr, and for spectral periods of 0 s (PGA) and 1 s. We explore the impact of various parameter choices, such as MFD model, GMPE distance metric, and inclusion of a background zone to account for lower magnitudes, and we also compare the results with hazard maps based on area-source models.

References:

Anderson, J. G., and J. E. Luco (1983), Consequences of slip rate constraints on earthquake occurrence relations, Bull. Seismol. Soc. Am., 73(2), 471–496.

Youngs, R. R., and K. J. Coppersmith (1985), Implications of fault slip rates and earthquake recurrence models to probabilistic seismic hazard estimates, Bull. Seismol. Soc. Am., 75(4), 939–964.