A database of seismic sources for the Roer Valley Rift system

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The Roer Valley Rift system (RVRS) straddling the border zone of Belgium, the Netherlands, and Germany, is one of the most active tectonic structures in NW Europe. It is characterized by NW-SE oriented normal faults, and rather continuous seismic activity. Many faults have been mapped in the RVRS, but so far no model was made of fault hierarchy and fault segmentation. In the framework of the EC-project SHARE, we have devised a seismic-source model for the RVRS, consisting of composite (i.e., unsegmented) seismic sources. We distinguish 15 seismic sources based on major stepovers, bifurcations, intersections, gaps, and important changes in strike, dip direction or slip rate. In our concept, each composite seismic source may encompass one or more segments, but it is unlikely that a segment would extend across more than one source. The sources are further subdivided into one or more informal fault sections, each with an associated surface trace. For each source, we describe the limits and the composing fault sections, and present the geological arguments for them. We have compiled all relevant data concerning the seismic-source parameters required for the database, putting lower and upper bounds on strike, dip, rake, slip rate, and seismogenic depth, and an upper bound on earthquake magnitude (Mmax). Combination of literature and seismological data indicates that fault dips in the RVRS likely range between 50 and 65°. Minimum and maximum strike have been determined for each source based on the one-sigma variation of their mapped surface traces. We determined the variation in rake by stress-tensor inversion of focal mechanisms, and resolving the shear stress on planes with the aforementioned ranges in strike and dip. The primary data for slip rates are vertical displacements recorded by fluvial terraces intersecting faults in the RVRS. We compiled an extensive set of vertical deformation rates, allowing us to assign minimum and maximum rates to each source. These vertical deformation rates range mostly between 0.01 and 0.07 mm/yr. The Peelrand and Erft/Swist faults appear to be the most active faults. Earthquake hypocenters indicate a maximum depth of ~25 km. The minimum depth is set at 0 km, as all faults display offset of late Quaternary deposits, and paleoseismic studies have shown the occurrence of surface-rupturing earthquakes in the past. Both paleoseismic studies and source-length considerations suggest a Mmax of about 7. We hope this database will provide a solid basis for modeling seismic hazard in the RVRS.