Quantifying fault activity over different time scales in the Lower Rhine Graben, towards a new fault database for seismic hazard assessment.

Résumé

The Lower Rhine Graben (LRG) is an area of slow intra-plate extension (_˜0.1 +/- 0.03mm/yr) in north-western Europe. While the major active faults are well known, the activity of this complex system as a whole remains poorly understood, mostly because such slow deformation produces weak tectonic signal, easily overprinted by other processes. Thus, previous fault models omit structures presenting limited surface deformation and remain elusive about fault geometry and branching. Here, we present, a revised and homogeneous fault map, based on morphological observations of fault scarps and offset alluvial terraces realized on a high-resolution Lidar-based DEM, complemented by external information from paleoseismological and geophysical surveys. The eastern side of the graben exhibits clear scarps and sharp boundaries, while the western side presents smoother cumulative scarps, suggesting contrasting fault behavior across the graben. We compiled our active faults model in a database, including several levels of fault mapping (traces, fault sections, faults), with indications about the certainty of the faults identification and location. Another limitation for seismic hazard assessment in the area is the relative scarcity of fault-displacement data. In the southern LRG, a well-developed terrace allows to estimate the activity of most faults over the Quaternary, but such an extended marker is missing in the northern area. To complement these observations, we use several 3D-geological models to retrieve the vertical offsets at several locations along each fault, and obtain the spatial slip distribution at different timescales. We observe that, along individual faults, the slip profile evolves laterally and in time, showing some fault linkage, while at the scale of the graben borders the total slip is relatively homogenous. Moreover, although the surface-expression differs between the two sides of the graben, the total slip rates are fairly equivalent on both sides, suggesting a symmetrical extension, at least for the northern area.

Mots-Clés: fault network, offset measurement, scarp morphology