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Dealing with completeness, structural hierarchy, and seismic coupling issues: three major challenges for #Fault2SHA

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The vast majority of active faulting studies are performed at the scale of individual, presumably seismogenic faults or fault strands. Most SHA approaches and models, however, require homogeneus information on potential earthquake sources over the entire tectonic domain encompassing the site(s) of interest. Although it is out of question that accurate SHA must rely on robust investigations of individual potential earthquake sources, it is only by gathering this information in regionally extensive databases that one can address some of the most outstanding issues in the use of #Fault2SHA. We will briefly recall three issues that are particularly relevant in the investigation of seismogenic faulting in southern Europe.

A fundamental challenge is the completeness of the geologic record of active faulting. In most tectonic environments many potential seismogenic faults are blind or hidden, or deform the lower crust without leaving a discernible signal at the surface, or occur offshore, or slip so slowly that nontectonic erosional-depositional processes easily outpace their surface effects. Investigating only well-expressed faults is scientifically rewarding but also potentially misleading as it draws attention on the least insidious faults, leading to a potential underestimation of the regional earthquake potential.

A further issue concerns the hierarchy of fault systems. Most active faults do not comprise seismogenic sources *per se* but are part of larger systems, and slip only in conjunction with the master fault of each system. In the most insidious cases, only secondary faults are expressed at the surface while the master fault lies hidden beneath them. This may result in an overestimation of the true number of seismogenic sources that occur in each region and in a biased identification of the characteristics of the main player in each system.

Recent investigations of geologic and geodetic vs earthquake release budgets have shown that the "seismic coupling", which quantifies the fraction of tectonic fault slip that is turned into earthquake moment release, may be significantly smaller than 100%, particularly in contractional tectonic settings. Also this especially elusive circumstance may result in an overestimation of the true earthquake potential of specific areas.

All these circumstances are the source of fundamental epistemic uncertainties that are extremely difficult to be dealt with standard approaches, which normally focus on the variability of the parameters of major faults whose seismogenic nature is well established.

In summary, the current generation of earthquake geologists should definitely make a turn toward #Fault2SHA and contribute their data for improving current seismic hazard models. To achieve this goal, however, they should first (a) step back from the surface fault(s) and adopt a broader tectonic, geomorphic and three-dimensional perspective that encompasses at least the entire fault system being investigated; (b) make a more extensive use of subsurface evidence, focusing on the nature and geometry of depositional bodies rather than simply on brittle faulting; and (c) broaden their own perspective of the seismic cycle, comparing the (often incomplete) geological and geomorphic evidence with the (similarly incomplete) seismicity and geodetic records.