Italy’s Database of Individual Seismogenic Sources (DISS), 20 years on: lessons learned from the construction of a SHA-oriented fault database

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The prototype version of the DISS was launched and published in July 2000. Twenty years later we present an appraisal of how the database started off, how it evolved, and how it served the seismological and engineering communities.

During the early years of its development we learned that the three fundamental requirements of any SHA-oriented fault database are:

1) the capacity to represent seismogenic sources in 3D, thus providing a standardized quantitative basis for subsequent SHA calculations and stressing the hierarchy relationships among all existing active faults;

2) the completeness, i.e. the ability to portray the vast majority of seismogenic sources existing in the region of relevance and to progressively address the emerging lack of knowledge;

3) the reliability of the geometrical parameters of each seismogenic source and of the relevant slip and strain rates, and the ability to assess the associated uncertainties.

Given these requirements, we found it hard to build a database around existing studies of individual large faults, which are often carried out for non-SHA purposes; as such they do not necessarily involve a 3D delineation and a hierarchization of the master fault. Furthermore, most published studies concern surface-breaking faults occurring onshore; they are most relevant to surface faulting hazard, but in shaking-oriented SHA they are less crucial than deeper, hidden faults.

We initially developed the concept of “Individual Seismogenic Source” (ISS), a simplified but geometrically coherent representation of the presumed causative fault of the largest earthquakes of the investigated region. An ISS is based on original observations, seismological/geophysical evidence, and literature data. Since large portions of the Italian territory are characterized by blind or hidden faulting, we developed strategies based on the analysis of geomorphic evidence for cumulative tectonic strain, on the reappraisal of commercial seismic lines and subsurface data,
and on geological and geodetic evidence.

In 2005 we introduced the “Composite Seismogenic Sources” (CSSs): generalized, unsegmented sources designed to increase the database geographic coverage and completeness, based on the same type of information used for the ISSs and on regional-scale synopses of ongoing tectonic strain. Their identification was progressively extended to offshore areas, often scarcely considered in traditional fault mapping. In 2015 we also introduced the 3D definition of the subduction slabs and associated interfaces for the whole Mediterranean region.

The ISSs are routinely used in engineering applications aimed at investigating the shaking scenario associated with known earthquakes or well-identified quiescent fault segments. In contrast, the CSSs are not assumed to be capable of a specific-size earthquake; as such, they can be used in any standard PSHA procedure after estimating their activity rate and frequency magnitude distribution, based on tectonic slip rates integrated with the record of past earthquakes and GPS-determined strains, or derived from regional-scale geodynamic models.

DISS also served as a template for developing EDSF, the European Database of Seismogenic Faults. Over the years, DISS and EDSF have become the basic geological input for PSHA and PTHA, both at Italian scale (MPS04, MPS19, MPTS19) and European scale (ESHM13, ESHM20, NEAMTHM18).