THE GREEK DATABASE OF SEISMOGENIC SOURCES (GREDASS): STATE-OF-THE-ART

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The Aegean Region is among the most tectonically active areas of the Mediterranean Sea with the highest seismicity both in terms of frequency of events and magnitudes. There is a huge amount of national and international literature on the above topic providing rich, though jeopardized, information on the many aspects of the seismogenic structures and specific earthquakes. Following a former experience in the frame of the European FAUST Project (1998-2000), we think it is now time for a throughout critical revision of all the available data in order to create a homogeneous and possibly complete database. The major goals of this new reasearch project (GreDaSS: Greek Database of Seismogenic Sources) are (i) the systematic collection of all available information concerning active faults, capable faults and broader seismogenic volumes within the broader Aegean Region; (ii) the quantification of the principal seismotectonic parameters of the different sources as well as their degree of uncertainty; (iii) to supply an integrated view of potentially damaging seismogenic sources for a better assessment of the seismic hazard of Greece. The informatic framework of the database follows closely that used for the Italian Database of Individual Seismogenic Sources (DISS), which represents the result of almost twenty years experience of its Working Group (e.g. Valensise and Pantosti, 2001). We present here the state-of-the-art of GreDaSS relative to Northern Greece (Fig. 1) where according to DISS (Basili et al., 2008) we have distinguished two main categories of Seismogenic Sources based on their attributes, the nature and reliability of data used to define them:

- “Individual Seismogenic Sources” (ISS) are obtained from geological and geophysical data and are characterized by a full set of geometric (strike, dip, length, width and depth), kinematic (rake) and seismological-palaeoseismological parameters (average displacement per event, magnitude, slip rate, return period) and by a rating of the associated uncertainties. ISSs are assumed to exhibit “characteristic” behaviour with respect to rupture length/width and expected mean and max-

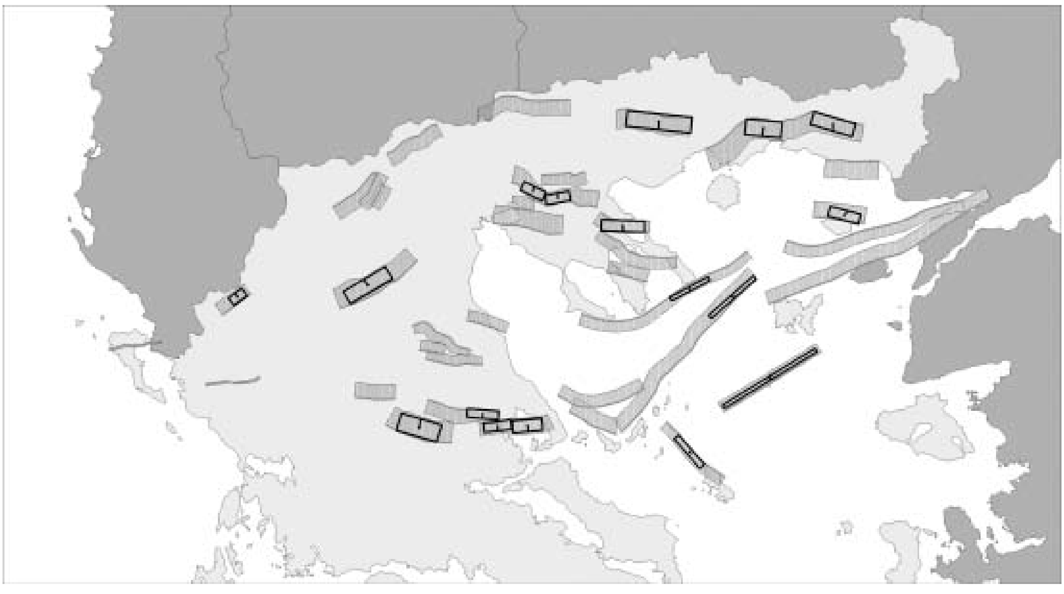

Fig. 1: The Greek Database of Seismogenic Sources showing the CSSs and the ISSs layers.

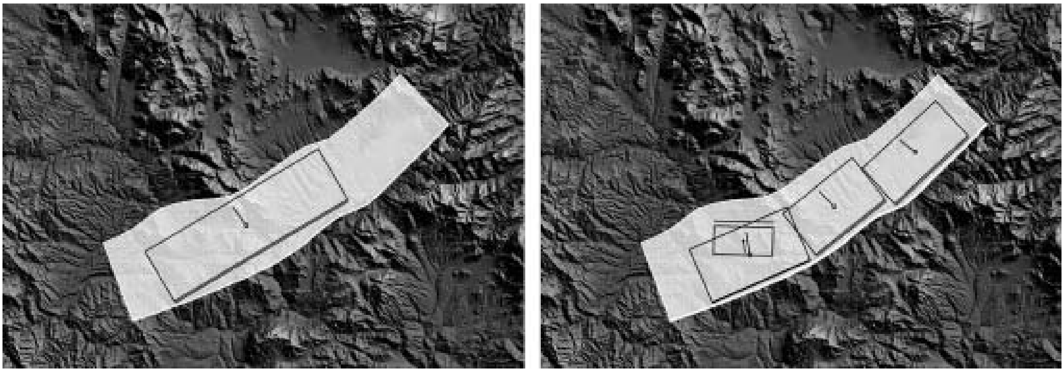

Fig. 2 - The example of the Kozani CSS (Western Macedonia) showing on the left map the ISS activated by the 1995 earthquake and, on the right map, the three fault segments recognized based on geological, morphotectonic and palaeoseismological data.

imum magnitude. They are tested against worldwide databases for internal consistence in terms of length, width, average displacement and magnitude. This category of sources favours accuracy of the information supplied over completeness of the sources themselves. As such, they can be used for deterministic assessment of seismic hazard, for calculating earthquake and tsunami scenarios, and for tectonic and geodynamic investigations.

- "Composite Seismogenic Source" (CSS) are still obtained from geological and geophysical data and characterized by geometric (strike, dip, width, depth) and kinematic (rake) parameters, but their length is more loosely defined and spans two or more Individual Sources. They are not assumed to be capable of a specific earthquake but their potential can be derived from existing earthquake catalogues. A CSS is essentially inferred on the basis of regional surface and subsurface geological data, that are exploited well beyond the simple identification of active faults or youthful tectonic features. Opposite to the previous case, this category of sources favours completeness of the record of potential earthquake sources over accuracy of source description. In conjunction with seismicity and modern strain data, CSSs can thus be used for regional probabilistic seismic hazard assessment and for investigating largescale geodynamic processes.

Within the investigated area we recognized, characterized and parametrized almost 40 CSSs and 20 ISSs, the latter associated with instrumental or historical events. Each individual source of GreDaSS will be associated with additional information such as bibliographic references, literature data, geological, seismological or paleoseismological data as well as the most relevant maps, graphs, pictures and drawings. All the information is organized as major layers of a GIS that enables the user to explore all data types at different scales and levels.

Although some of the CSS are still under investigation and the catalogue of historical earthquakes is even longer than the Italian one (e.g. Papazachos and Papazachou, 1997), there is a mismatch between well constrained and localized historical events and faults showing Late Pleistocene-Holocene activity and the clear occurrence of past 'linear morphogenic earthquakes' (Caputo, 2005) as inferred, for example, from palaeoseismological trenches, archaeoseismological investigations or detailed morphotectonic mapping. Accordingly, based on our field experience and the critical review of the geological literature, we are also working at realising a further layer of the database GreDaSS representing potential (or capable) seismogenic sources. The latter are mapped giving emphasis to geological criteria that is to say mainly according to the cumulative effects of Late Quaternary morphogenic events. For example, fresh and polished fault free faces or offset and tilting in Quaternary sediments, river and channel shift, triangular facets are some of the most important evidences. As a consequence, this new layer of the database obviously includes all the faults that are not associated with any specific major earthquake but also the CSSs seismically reactivated in recent times. As an example, in Fig. 2 we show the Kozani CSS (Western Macedonia), which was partially reactivated in 1995 by a 6.6 magnitude event (Papazachos et al., 1995). Following the DISS approach, a single major ISS is drawn (Fig. 2, left map), while geological data (e.g. Mountrakis et al., 1998) show the occurrence of three fault segments each potentially capable of generating moderate-to-strong events (Fig. 2, right map). In this specific case, it is obvious that the western segment boundary was not strong enough to stop propagation during the 1995 event and two of the above fault segments were thus reactivated. However, there is not apparent field evidence for why the third segment did not rupture and similarly there is not much difference between the two segment boundaries (the 'soft' one and the 'strong' one). It remains an open question whether the earthquake could have ruptured also the third segment or if this occurred in the past (or it will in the future), therefore causing a larger magnitude more destructive event. A posteriori it is a relatively easy task to recognize and map ISSs and a lot of work is still to be done on this topic. However, as far as many other Aegean CSSs have similar geological and tectonic settings showing the presence of different segments separated by unknown types of segment boundaries (soft versus strong) and the characteristic behaviour of the ISSs is just an assumption, this example shows the importance and the need of carefully considering these cases in the database.

References

Basili R., Valensise G., Vannoli P., Burrato P., Fracassi U., Mariano S., Tiberti M.M., Boschi E. (2008): The database of individual seismogenic sources (DISS), version 3: summarizing 20 years of research on Italy's Earthquake Geology. Tectonophys., 453(1-4), 20-43.

Caputo R. (2005): Ground effects of large morphogenic earthquakes. J. Geodyn., 40(2-3), 113-118.

Mountrakis D., Pavlides S., Zouros N., Astaras T. and Chatzipetros A., 1998. Seismic fault geometry and kinematics of the 13 May 1995 Western Macedonia (Greece) earthquake, J. Geodyn., 26(2–4), 175-196

Papazachos B. and Papazachou C. (1997): The earthquakes of Greece, Editions ZITI, Thessaloniki, 304 pp.

Papazachos B.C., Panagiotopoulos D.G., Scordilis E.M., Karakaisis G.F., Papaioannou Ch.A., Karakostas B.G., Papadimitriou E.E., Kiratzi A.A., Hatzidimitriou P.M., Leventakis G.N., Voidomatis Ph.S., Peftitselis K.J. and Tsapanos T.M., 1995. Focal properties of the 13th May 1995 large (Ms = 6.6) Earthquake in the Kozani area (North Greece), XV Congress of the Carpatho-Balkan Geological Association, September 17-20, 1995, Athens, Greece, 96-106

Pavlides S.B, Zouros N.C, Chatzipetros A.A., Kostopoulos D.S. and Mountrakis D.M., 1995. The 13 May 1995 western Macedonia, Greece (Kozani Grevena) earthquake; preliminary results, Terra Nova, 7,544-549

Valensise G. and Pantosti D. (Eds) (2001): Database of potential sources for earthquakes larger than M 5.5 in Italy. Ann. Geofisica, 44(4), 797-807.